The organisation and delivery of TB services: an evidence review

April 2015

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EXECUTIVE SUMMARY

Introduction

This report presents the findings of an evidence review on the organisation and delivery of TB services.

The first objective of this review is to present case studies of TB which describe TB services in the following places:

- UK
- New York City
- Canada
- Barcelona
- the Netherlands

The second objective of this review is to identify effective approaches to TB services, together with any estimates of cost-effectiveness or cost-impact, in relation to three key outcomes:

- Reducing diagnostic delay for TB
- Improving TB contract tracing
- Improving TB treatment completion

The places of interest and outcomes chosen were as specified by the Guideline Development Group (GDG) members of the Service Delivery Group (SDG) during the scoping meeting and subsequent development of the review protocol.

Methods

A comprehensive search strategy was developed involving both a database search (n=5197) and a grey literature search (n=180), for studies published/conducted between 2003 and April 2014. A call for evidence was issued to stakeholders between March and April 2014. In addition, an update search was conducted on 5th February 2015 for comparative effectiveness and cost-effectiveness studies published in 2014.

To develop the case studies, papers relating to a set of pre-determined countries and cities – agreed through discussion with the Guideline Development Group – were identified which described key aspects of each case, including epidemiology, service configuration, and service developments. A narrative summary of each case study area was prepared.

For the effectiveness and economics reviews, studies were included which provided estimates of the effectiveness or cost-effectiveness/impact of service delivery interventions or models, with a focus on the three key outcomes. A service delivery intervention/model was defined as any service adaptation, such as process changes, change in delivery setting or mode (including staff), change in structure, accountability or commissioning of a TB service. Quality assessment and data extraction were carried out using standardised forms from the NICE CPH and service delivery methods manuals. Data were synthesized narratively.

Results

Case Studies

Overall, the case study profiles show that all of the included areas (UK and non-UK) have similar high risk population groups including foreign born people, people living with HIV, people who misuse substances, homeless people and prisoners (with the addition of the indigenous population in Canada). There are also broadly similar priorities and policy direction, for example active case finding, targeting high risk groups, surveillance (including strain typing), improving treatment completion including enhanced case management and DOT, although the targeting and accountability for each element may differ.

The findings from the case studies are summarised in the summary statements below.

Summary Statement 1: Service delivery and commissioning

In the UK, commissioning falls to the NHS devolved across 200 area-based clinical commissioning groups (CCGs) working in partnership with Public Health England (PHE) and local government to develop and deliver TB services. PHE provide some national-level support (including surveillance and emergency response to outbreaks), but decisions about how services such as outreach programmes, nursing and DOT provision are commissioned rest at a local level with CCGs. This means that different areas, even neighbouring ones, or areas with similar profiles and incidence rates, may take very different approaches to service organisation and delivery.

The non-UK case studies organise the provision and delivery of TB services in different ways: New York City, Barcelona and the Netherlands all take a centralised approach, and although the lines of accountability may differ by place a centralised approach appears to help ensure clear responsibility for different elements of the service. In NYC, one body (the BTBC) is responsible for the whole system (NYC-DOHMH, 2013). In Barcelona the system is led by the Public Health Service with Public Health Nurses acting as the hub of the system supported by community health workers in high risk community settings and clinical unit nurse managers in the hospital sector (Cayla and Orcau, 2011). Similarly in the Netherlands MHS:GGD-NL specialist doctors, public health nurses and medical assistants have responsibility for providing diagnosis and treatment in the community in particular in those with complex social needs, whilst hospitals provide treatment for more clinically complex cases such as MDR-TB. The Canadian approach is perhaps more similar to the UK, with a mixture of national support and guidance from the national Public Health Agency with more regional decision making (territory or province) on how services are delivered. This appears to result in variation in service delivery, for example mobile clinics in Saskatchewan target a high risk indigenous population, but other areas with high risk groups do not provide this service (Government of Saskatchewan, 2012).

Summary Statement 2: Finance

Financial input appears to differ markedly with over $40,000 US dollars per notified case committed to TB in the Netherlands and Canada, $24,000 per case in NYC based on 2012 data to around $12,000 per case in London based on 2009 data, we were unable to identify

a national picture for TB funding in the UK or funding data for Barcelona (WHO 'country profiles', 2013; Hayward et al, 2010; Menzies et al, 2008).

Summary Statement 3: Legislation

There is a wide range of legislative mechanisms and support for TB prevention and control in the case study areas, including pre-entry screening for immigrants and court ordered detention and treatment in NYC and Canada, and the recent launch of a pre-entry system (PHE, 2014d) and the power to detain and isolate but not treat non-compliant patients in the UK (Ohkado, 2005). The Netherlands take a preventative rather than enforcement approach with sanctions for screening immigrants and compulsory medical examination, but no detainment or enforced treatment, whilst Barcelona had no legislative control measures (Coker et al, 2007, Paolo, 2004; NYC-DOHMH, 2013).

Summary Statement 4: Contact Tracing

All areas included in this review deliver contact tracing using the same method (stone in the pond/concentric circle), with variation found in the staff who delivered it. In Barcelona community health workers recruited as 'peers' of the target group are involved in delivery of contact tracing. In the Netherlands, medical assistants support delivery of contact tracing and in NYC Public Health assistants deliver contact tracing: This may contribute to variations in the effectiveness of the contact tracing activity – see Effectiveness review. It may also impact on the capacity of specialist public health nurses to deliver other elements of services such as DOT or case reviews, where non-clinical staff take on specific tasks and free up clinical time for other activities (Cayla and Orcau, 2011; Ospina, 2012; Boar and de Vries, 2012).

Summary Statement 5: Targeting high risk groups

All case study places actively target high risk groups, although the approaches used differ. Pre-entry screening is well established in NYC and Canada and has been very recently introduced to the UK. NYC, Rotterdam and London also make use of outreach and mobile x-ray units to diagnose underserved groups such as the homeless (de Vries et al, 2007 and 2014; Hayward et al, 2010). However, it is not clear whether MXU outreach activities occur across the Netherlands or only in Rotterdam. Furthermore, in the UK this aspect of the service is only widely used in London (de Vries et al, 2007 and 2014; Hayward et al, 2010). Similarly, mobile outreach clinics being delivered in Northern territories in Saskatchewan (Canada) to high risk indigenous communities are not available in other areas (Government of Saskatchewan, 2012).

Summary Statement 6: Treatment completion

DOT is a core element of service provision to improve adherence and treatment completion in all case study areas, in particular in relation to vulnerable groups or those at risk of non-adherence. However, the availability of DOT appears to differ markedly. In NYC DOT is a core element of the TB service, and many studies have concluded that consistent use of DOT is responsible for much of the decline in TB over recent years (NYC-DOHMH, 2002). In 2012 it formed the basis of the majority of treatment (487 of 651 cases ~ 75%) and is considered the standard of care; in NYC 94% of cases completed treatment within 12 months during this time (NYC-DOHMH, 2013). In Canada, DOT is recommended as the

minimum level of support for patients with risk factors for non-adherence (Pan Canadian Public Health network, 2012), although the levels of delivery of DOT are unknown. In Barcelona again the incorporation of DOT into methadone programmes has been credited with the dramatic decline of TB in people who inject drugs (Cayla and Orcau, 2011). UK data on the provision of DOT is only partially available: between 1.7% and 32% of cases received DOT in different parts of London and 0% in Bradford (Bothamley et al, 2011). Given the epidemiological profile of TB in the UK, it is likely that far fewer people were offered DOT than would benefit from it. However, without data on the proportion of cases who had a risk assessment and were subsequently offered or provided with DOT it is difficult to draw further conclusions.

Summary Statement 7: Staffing

Staffing ratios of nurses (or other staff) differ across the case study areas from 1:12[1] in NYC; 1:18 in the Netherlands and 1:35-45 in Barcelona. There are no UK data available to provide a national picture of TB staff:case ratio (Boer and de Vries, 2011; Bothamley, 2011; Cayla and Orcau, 2011). It should also be noted that in the Netherlands medical assistants support public health nurses to deliver case management including DOT and contact tracing in clients with complex needs in community based clinics. In Barcelona Community Health Workers support contact tracing in culturally similar high risk immigrant groups (Ospina et al, 2012),and in NYC trained Public Health Assistants are responsible for most case management including DOT, active case finding and contact tracing activities as well as providing formal case review as part of the cohort review process. These support workers are likely to off-set the workload of specialist TB nurses in these areas, freeing up clinical time for other duties. In the UK these activities are almost exclusively provided by specialist TB nurses.

Summary Statement 8: Surveillance

Surveillance is consistently prioritised as an important element of service delivery approaches at a national level with national systems for enhanced surveillance and a mandate to report all notified cases in all case study areas. Surveillance is overseen by a national agency in all cases and includes geno-typing/DNA fingerprinting as standard. It should be noted that reliance on surveillance to support service delivery in Barcelona significantly pre-dates the recent National Plan highlighting the need for a national surveillance system (Cayla and Orcau, 2011).

Summary Statement 9: Cohort Review

New York City and the UK are both reported to use Cohort Review as a way to systematically review the management of every case of TB on the basis of treatment completion, contact investigation and case management process (Bothamley, 2011; Munsiff et al, 2006). Case managers are responsible for presenting the review of their cohort. This process is considered one of the most important approaches to programme evaluation, service improvement and ensuring accountability in NYC (Munsiff et al, 2006). Whilst a number of cities in the UK cited delivery of cohort review (London, Manchester, Leeds and Leicester), it is not clear how systematic this approach is across the UK (Bothamley, 2011).

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[1] NYC and Netherlands ratios were calculated based on information and data identified during the review process.

Effectiveness and economics reviews

A total of 31 studies were included in the effectiveness review. Two studies were rated high quality (++), 16 moderate (+) and 13 low (–). From this, 13 studies provided comparative data of a service delivery intervention versus another service delivery intervention which could be linked with the review's three key outcomes: contact tracing, diagnostic delay, and treatment completion.

Four studies were included in the economics review (two of which were also included in the effectiveness review). One study was rated high quality (++), two moderate (+) and one low (–). From this, three studies provided comparative cost data of a service delivery intervention versus another service delivery intervention which could be linked with the review's three key outcomes: contact tracing, diagnostic delay, and treatment completion.

The findings of the comparative data from the effectiveness and economics reviews are summarised in the evidence statements below.

Evidence statement 1: Cohort review can improve contact tracing in TB patients

There is moderate evidence from one London UK study[1] (+) that cohort review can increase contact tracing of at least one contact identified (86% v 77%; p<0.001), compared with before cohort review was implemented. There was no difference in treatment completion (86% v 87%; p=0.6). Other outcomes, such as increased DOT refusal (30% v 10%; p=0.001) were identified as something to address and monitor in future cohort review. Overall, the process was seen as identifying problems and allowing whole system improvement.

There is moderate evidence from one NYC study[2] (+) that continuous cohort review can increase contact tracing over time (at least 90% of patients with appropriate contact investigation: 2004: 95.3% v 1999: 90.5%). Treatment completion rates were similar (86.5% v 85.7%), whilst treatment success was slightly lower over time (2004: 81% v 1999: 83%). Again a large benefit of the process was seen as identifying problems that could then be addressed.

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because there are no obvious differences in the delivery of cohort review in the included studies compared to how it could be delivered in the UK.

1 Anderson et al, 2014 (+)
2 Munsiff et al, 2006 (+)

Evidence statement 2: Nurse led service to improve treatment completion in TB patients and reduce costs

There is moderate evidence from one Bristol UK study[1] (+) that a nurse led service can increase treatment completion rates compared with previous monthly clinics and cases notified to HPA (94% v 84% v 55%; p<0.0001). Other outcomes, such as assessment for DOT were also improved, compared with previous monthly clinics (92% v 5%; p<0.0001). The nurse led service was estimated to save £27,872 per year compared to monthly clinics, due to replacing 268 reviews (£104 each).

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because there are no obvious differences in the delivery of a nurse led service in the included study compared to how it could be delivered in the UK.

1 King et al, 2009 (+)

Evidence statement 3: DNA surveillance of TB cases can support conventional contact tracing

There is moderate evidence from one Netherlands study[1] (+) that DNA surveillance can support conventional contact tracing by increasing epidemiological links based on documented exposure (35% increase; p<0.001), although only 1% of contact investigations were extended. It was seen as being particularly useful training mechanism for inexperienced TB nurses, a method of monitoring the effects of new control policies, and enabling institutional deficiencies to be detected.

Applicability
The evidence is partially applicable to TB service delivery in the UK. This is because this study was conducted in the Netherlands which may have different contact tracing policies from the UK, which means that the expected benefits of DNA surveillance in the UK could be different.

1 Lamberts-van Weezenbeek et al, 2003 (+)

Evidence statement 4: Educational outreach and incentives to GPs can increase TB screening and diagnosis of TB in people presenting at primary care

There is moderate evidence from one London UK study[1] (++) that education outreach visits by specialist TB nurses and academic GPs to GP practices, together with practice computer system prompts and a £7 incentive for TST administration, can increase the proportion of people screened for TB at registration health check, compared with usual practice (57% v 0.4%). This increased the diagnosis of active TB (47% v 34%; OR 1.68, 95% CI 1.05 – 2.68), and latent TB (19% v 9%; OR 3.00, 95% CI 0.98 – 9.20), compared with usual care.

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because there are no obvious differences in the delivery of this type of intervention in the included study compared to how it could be delivered in the UK. However, the study may only be applicable to high incidence TB areas; in areas of the UK with a lower incidence of TB, the rates of people presenting with TB in primary care may be much less.

1 Griffiths et al, 2007 (++)

Evidence statement 5: Community health workers can increase contact tracing in immigrant communities

There is moderate evidence from one Barcelona study[1] (+) that community health workers from immigrant communities working alongside public health nurses can improve contact tracing performed in all TB cases (66% v 55%; p<0.001) and performed in smear positive cases (82% v 66%; p<0.001), compared with public health nurses alone.

Applicability

The evidence is partially applicable to TB service delivery in the UK. This is because the demographics of TB patients and contact tracing policies in the UK may vary from that in Barcelona. The results of the study may be most applicable to areas of the UK where there is a high incidence of TB in people from immigrant communities.

1 Ospina et al, 2012 (+)

Evidence statement 6: Mobile screening can improve treatment completion and active case finding in underserved people

There is strong evidence from two studies (London UK (++),[1] Netherlands (+)[2]) that a community based mobile radiography unit can increase active case finding by between 23-30% in underserved groups in an urban setting, compared with passive case finding/before mobile screening was introduced.

The UK study (++) provides moderate evidence that when a mobile radiography unit is combined with case holding and support it can be used to improve treatment completion (54.6% v 46.2% in first year of treatment), compared with passive case finding. The UK study (++) also provides moderate evidence that the service can be cost-effective, with an ICER of less than £10,000 per QALY.

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because there are no obvious differences in the delivery of mobile screening in the included studies compared to how it could be delivered in the UK. However, the results of the study may be most applicable to areas of the UK where there is a high incidence of TB in underserved groups.

1 Jit et al, 2011 (++)
2 De Vries et al, 2007 (+)

Evidence statement 7: The impact of peer educators on TB testing uptake in under-served groups is mixed

There is mixed evidence from two London UK studies (–)[1] (+)[2] that peer educators working alongside mobile x-ray units can increase uptake of TB testing. One study[1] found that introducing peer educators increased uptake of testing compared with no peer education support (75% v 44%). A subsequent study[2] found no difference in uptake of testing via the mobile x-ray units with or without peer educator support (RR 0.98%; 95% CI 0.80 to 1.20). However, the latter study may have been confounded by control hostels having received peer educator involvement prior to enrolment in this trial, which may have underestimated the effect of peers.

Applicability
The evidence is directly applicable to TB service delivery in the UK. However, the results of the study may be most applicable to areas of the UK where there is a high incidence of TB in underserved people.

1 Hall et al, 2010 (–)

2 Aldridge et al, 2014 (+)

Evidence statement 8: Rapid access referral triggered by radiology coding of abnormal chest x-rays can reduce diagnostic delay in TB patients

There is moderate evidence from one Leicester UK study[1] (+) that rapid access referral triggered by radiology coding of abnormal chest x-rays statistically significantly reduces the duration of symptoms in non-pulmonary TB (78.4 v 122.1 days; p=0.03) and smear positive pulmonary TB (60.2 v 95.9 days; p=0.03), compared with other diagnostic pathways. There was a non-significant reduction in the duration of symptoms in smear negative pulmonary TB (80.4 v 100.1 days; p>0.05). There was a non-significant lower rate of contact tracing with radiology referral compared with other diagnostic pathways (mean number of contacts 4.57 v 4.91; p>0.05).

Applicability
The evidence is directly applicable to TB service delivery in the UK. However, the results may be most applicable to areas of the UK where there is a high incidence of TB.

1 Verma et al, 2011 (+)

Evidence statement 9: Comprehensive MDR-TB control programme can improve treatment completion in MDR-TB patients

There is moderate evidence from one NYC study[1] (+) that a comprehensive MDR-TB control programme can improve treatment completion in MDR-TB patients (44% v 12%; p<0.001) and reduce death prior to treatment completion (39% v 69%; p<0.001, compared with outcomes reported at the start of the programme.

Applicability
The evidence is partially applicable to TB service delivery in the UK. This is because the demographics and management of MDR-TB patients in the UK may vary from that in NYC.

1 Munsiff et al, 2006 (+)

Evidence statement 10: Involuntary detention can improve treatment completion in non-compliant TB patients

There is moderate evidence from one NYC study[1] (+) that involuntary detention followed by court-ordered DOT improves treatment completion in non-compliant patients compared with standard DOT (95% v 89%).

Applicability
The evidence is partially applicable to TB service delivery in the UK. This is because the demographics and management of non-compliant TB patients in the UK may vary from that in NYC.

1 Pursnami et al, 2014 (+)

Evidence statement 11: Testing for latent TB in a HIV service can increase diagnosis of latent TB in HIV patients

There is weak evidence from one Leeds UK study[1] (–) that testing for latent TB in a HIV clinic can improve rates of identification of cases of latent TB (24/101 people tested, of which 4 tests were abnormal). The cost was estimated to be £12,760-£23,720 per year, compared with £14,776 to £53,194 for treating active cases.

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because the demographics of HIV-TB patients and HIV-TB screening policies in this study are likely to be the same as in the rest of the UK.

1 Brian et al, 2009 (–)

Declaration of authors' competing interests

No authors have any competing interests.

Abbreviations used in the report

BCG	Bacillus Calmette-Guérin
CCG	Clinical commissioning group
CI	Confidence interval
CPH	Centre for Public Health (at NICE)
DOT	Directly observed therapy
ETS	Enhanced tuberculosis surveillance
GDG	Guideline development group
GP	General practice
HIV	Human immunodeficiency virus
ICER	Incremental cost-effectiveness ratio
IQR	Interquartile range
LTBI	Latent TB infection
MDR-TB	Multi-drug-resistant TB
NA	Not applicable
NICE	National Institute for Health and Care Excellence
NR	Not reported
NYC	New York City
OR	Odds ratio
PCT	Primary care trust
PHE	Public Health England
QALY	Quality adjusted life year
RCT	Randomised controlled trial
RFLP	Restriction fragment length polymorphism
RR	Relative risk
SDG	Service delivery group
TB	Tuberculosis
TST	Tuberculin skin test
WHO	World Health Organisation

1. Introduction

TB and the United Kingdom

Tuberculosis (TB) is an infectious disease caused by the bacterium Mycobacterium tuberculosis. TB most commonly affects the lungs (also known as respiratory or pulmonary TB), but it can also affect other parts of the body. In the UK in 2011, more than half of reported cases (52%) were pulmonary TB (HPA, 2012).

In England, rates of TB fell progressively until the mid-1980s, but started to rise again in the early 1990s. In 2011 in the UK, the Health Protection Agency (HPA) reported a total of 8963 cases of TB (an increase of 31% from 2001) at a rate of 14.4 cases per 100,000 (an increase of 26% from 2001). In a 12-month period between 2010 and 2011, 436 people reported to have TB died (5% of the 8171 people for whom outcome data was available).

The highest incidence of TB cases recorded in 2011 were in urban areas, and occurred in young adults, people from countries with a high incidence of TB and people with social risk factors for TB, including a history of substance misuse, homelessness or a history of imprisonment.

In addition to the rise in TB over the last two decades, there has been an increase in drug resistant TB, multiple drug resistant TB (MDR-TB) and extensively resistant TB (XDR-TB), which are much harder to treat and generally increase a person's risk of long-term complications or death.   In 2011, there were increases in the proportion of cases resistant to isoniazid (a first-line drug used in the treatment of TB), from 6% in 2010 to 8%.   There were also increases in cases resistant to any first-line drug (7% in 2010 to 8%), and cases resistant to multiple drugs (from 1% in 2010 to 2%). In addition, 58% (47/81) of MDR-TB cases were resistant to at least one second-line drug.

Drug-resistant TB is most often found in those people already vulnerable to TB, commonly socially excluded groups with poor immune status and increased exposure to infection.   In particular, those born outside the UK and in those with social risk factors for TB, including a history of substance misuse, homelessness or a history of imprisonment are at particular risk.

A range of TB treatment and prevention services are established in the UK.   For example, London features 30 main specialist TB services that provide care for TB patients, alongside a specialist hospital for children with complex disease. An NHS-funded "Find and Treat" programme (including a mobile X-Ray unit) is tasked with engaging with underserved and excluded groups.   In addition, five sector-wide clinical networks promote good practice and have in the past supported the local commissioning of TB services (PHAST 2010). However, services vary widely across the UK, both in terms of what is available and how services are configured and delivered.

Organisation and delivery of TB services: Current policy and practice

In April 2013, lead responsibility for improving public health was moved to upper-tier local authorities. This included the duty of coordinating local efforts to protect public health and wellbeing. Public Health funded responsibilities and functions in relation to infectious

diseases have three core providers, Local government, the NHS (NHS England and Clinical Commissioning Groups), and Public Health England (PHE).

A number of different factors influence what and how services are commissioned. In local areas, Health and Wellbeing boards may work alongside CCGs to help ensure appropriate service provision. Current NICE clinical and public health TB guidance should also shape the types of services commissioned and provided. Local authority scrutiny boards may be influential in helping to ensure that appropriate decisions are made regarding health services, and in monitoring service performance.

Following structural changes to the NHS in 2013, most if not all, services relating to the identification, treatment and management of TB will be commissioned through CCGs to clinical service providers and by NHS England for prison public health services.

The newly established PHE has taken responsibility for strategic TB policy across England following its incorporation of the former Health Protection Agency, including national oversight of prevention and control activities. In March 2014 it went out to consultation with a five-year strategy which aims to produce a sustained annual decrease in TB.

The collaborative TB strategy aims to bring together best practice in clinical care, social support and public health to strengthen TB control, leading to a year-on-year decrease in incidence, a reduction in health inequalities associated with the disease, and ultimately to the elimination of TB as a public health problem.

It will achieve this by stimulating action in all local areas, with a particular focus on areas where incidence is highest and the greatest reductions can be achieved (PHE, 2014 p5).

Treatment in the wider UK is also subject to various legal requirements and pieces of official guidance, including:

- the requirement for TB case notification under the Public Health (Infectious Diseases) Regulations 1988;
- the new entrant pre-entry screening programme, and the UK Border Agency's *'UK Tuberculosis Technical Instructions'* (UKTBTI) on screening at the border; and
- Chapter 32 of the Department of Health's immunisation 'Green Book', detailing practices and procedures for BCG vaccination, as well as management of suspected cases, contacts, and outbreaks.

This review

In 2006 the Centre for Clinical Practice at NICE produced clinical guideline CG33 'Tuberculosis: Clinical diagnosis and management of tuberculosis, and measures for its prevention and control' on tuberculosis, which was subsequently updated in 2011 with CG117. In 2012, the Centre for Public Health at NICE produced Public Health Guideline PH37 'Identifying and managing tuberculosis among hard-to-reach groups' which provided additional recommendations to those in the clinical guidelines, focusing on the identification and management of TB in people whose social circumstances, language, culture or lifestyle (or those of their parents or carers) make it difficult to:

- recognise the clinical onset of TB
- access diagnostic and treatment services
- self-administer treatment (or, in the case of children and young people, have treatment administered by a parent or carer)
- attend regular appointments for clinical follow-up.

The Department of Health has asked NICE: To prepare guidance for the NHS in England and Wales on the clinical management and diagnosis of, and measures to prevent and control tuberculosis (TB). This will replace the current guideline, 'Tuberculosis' (NICE clinical guideline 117).

This is an update of 'Tuberculosis' (NICE clinical guideline 117). See section 5.3.1 in update scope for details of which sections will be updated. As part of this work NICE will also carry out an editorial review of all recommendations to ensure that they comply with NICE's duties under equalities legislation.

In addition to updating NICE clinical guideline 117, this guidance will aim to incorporate recommendations from 'Tuberculosis – hard-to-reach groups' (NICE public health guidance 37), where possible. Consultation on the draft scope highlighted the importance of service organisation and delivery to the effective identification, treatment and management of TB across all patient groups, and so it has been included within the final scope of the updated guideline

In January 2014 an initial workshop was held with members of the Guideline Development Group (GDG) in accordance with the [NICE Interim methods guide for developing service guidance (February 2013).](#) to identify key questions and outcomes for this review, and agree the approach that this aspect of the guideline development would take. Key questions and outcome measures for this review were discussed and agreed at this meeting.

This review has been developed as part of the evidence to inform recommendations on the organisation and delivery of TB services. It takes a mixed method approach to identifying, interrogating and presenting the evidence, comprising of a systematic literature search to produce three sections of the report:

- Case study profiles of a set of pre-identified cities and countries
- A systematic review of the evidence of the effectiveness of service interventions or models (and aspects of service models) in these areas.
- A systematic review of the evidence of the cost effectiveness of service interventions or models (and aspects of service models) in these areas.

Aims and objectives

The first objective of this review is to present case studies of TB services – their organisation, delivery and performance against the key outcomes below – in the following areas:
- UK
- New York City

- Canada
- Barcelona
- the Netherlands.

The second objective of this review is to identify effective approaches to delivering TB services, together with any estimates of cost-effectiveness or cost-impact, in relation to three key outcomes:

- Reducing diagnostic delay for TB
- Improving TB contract tracing
- Improving TB treatment completion.

The places of interest and outcomes chosen were as specified by the GDG members of the SDG during the scoping meeting and subsequent development of the review protocol.

Review structure

Chapter 2 of this review contains information on the methodology used to undertake this review, including the searching strategies used, the development and testing of screening tools, the screening procedures themselves, data extraction, and synthesis.

Chapter 3 provides an overview for case study areas on the national or regional patterns of incidence and prevalence over the last 10-20 years, information on sub-populations that are at increased risk for TB, the national, regional, and local strategic TB priorities, details of their finance and accountability arrangements and legislation relevant to tuberculosis, background information and overviews of their service delivery model and specialist staff and setting relevant to tuberculosis in each jurisdiction where available.

Chapter 4 presents a systematic review of the effectiveness of different service models (or elements of service models) for the delivery of TB services.

Chapter 5 presents a systematic review of the cost-effectiveness or cost impact of different service models (or elements of service models) for the delivery of TB services.

Chapter 6 presents a brief discussion of the review, evidence summaries and statements of the evidence identified, and discusses the review limitations.

2. Methods

A systematic review was conducted on the organisation and delivery of TB services, in accordance with the [NICE Interim methods guide for developing service guidance (February 2013).](#) The areas of interest were identified by the GDG as the UK, New York City, Canada, Barcelona, and the Netherlands. The review was split into three parts: a case study approach, an effectiveness review, and an economic review.

Searching

A comprehensive search strategy was developed involving both a database search (n=5197 after duplicates were removed) and a grey literature search (n=180), for studies published between 2003 and April 2014; see Appendix 1 for full details of the search methodology.

Alongside the formal searches, a call for evidence among stakeholders was undertaken between March and April 2014, including members of the GDG and SDG for recommendations on relevant published and unpublished literature, in accordance with the inclusion criteria.

Selection of studies

The evidence identified via the formal literature searches, grey literature search, and the call for evidence, were compiled and screened for the inclusion of:

- Case studies: a sub-set of descriptive literature to provide the background information on epidemiology, legislation, policy, priorities for action, service models/structures or organisational elements, staff and settings in the case study areas
- Effectiveness review: quantitative study designs that provided estimates of the effectiveness of service models or interventions (including comparative studies, non-comparative studies, or evaluations/audits of TB services)
- Economics review: economic analyses of the cost-effectiveness/impact of service models or interventions (including cost-benefit, cost-effectiveness, cost-utility, modelling studies, or cost-impact analyses).

A service delivery intervention/model was defined as any service adaptation, such as process changes, change in delivery setting or mode (including staff), change in structure, accountability or commissioning of a TB service.

Due to the large volume of studies identified in the formal searches, three separate screening phases were undertaken: a high-level sift at title stage, a title and abstract sift, and a full text screening stage. Screening (stages 1 and 2) of the database searches was undertaken and recorded in an ACCESS database. Stage 3 screening was done at the full paper level, with decisions recorded in the ACCESS database. Screening was undertaken by individual reviewers, with any uncertainties flagged for discussion with a second reviewer. Details of the screening criteria at each stage are available in Appendix 2.

Studies from the grey literature and the call for evidence were screened by one reviewer in Microsoft Word. Due to the small volume of studies, screening was undertaken at the full text stage. Included studies were subsequently filtered to:

- Case study background
- Effectiveness review
- Economic review

To ensure that the most recent information was included in the effectiveness and economics review, an update search was conducted on 5th February 2015 for studies published in 2014. Only comparative studies were considered. The case study review was not updated.

The flow of included studies is presented below in Figure 1. Please note that studies could be identified as fitting more than one category. For example studies could have been identified for inclusion in both the effectiveness and economics reviews, and likewise may have been included in both the effectiveness review and case studies.

Critical appraisal

All studies included in the effectiveness or economic components of the review were critically appraised using relevant checklists from the NICE CPH manual and the NICE Interim methods guide for developing service guidance (February 2013). Critical appraisal was undertaken by one reviewer and checked in detail by a second reviewer for each included study in the effectiveness review. Details of the tools used are provided in the next chapter.

Studies or papers used in the case studies were not critically appraised due to the more discursive nature of this component of the review. Rather than present effectiveness data, the aim here was to build descriptive pictures of the way that TB services are organised (in themselves and in relation to wider health services) in each case area.

Data extraction and synthesis

Papers identified as being of relevance to case studies were grouped by location. Due to the large volume of information available for this section, much of which overlapped, extraction was not undertaken for each individual paper. Instead, for each location, a case study extraction sheet was prepared, focussing on key audit questions of relevance to the case studies.

Studies included in the effectiveness and economic elements of the review were extracted into evidence tables. Data extraction was conducted by one reviewer and checked in detail by a second reviewer. Data were synthesized narratively, and studies were grouped on the basis of outcome. A further level of synthesis was subsequently undertaken on studies which provided a comparison of one service delivery model/intervention with another service delivery model/intervention, and which provided outcome data that could be linked with the reviews key outcomes: diagnostic delay, treatment completion or contract tracing.
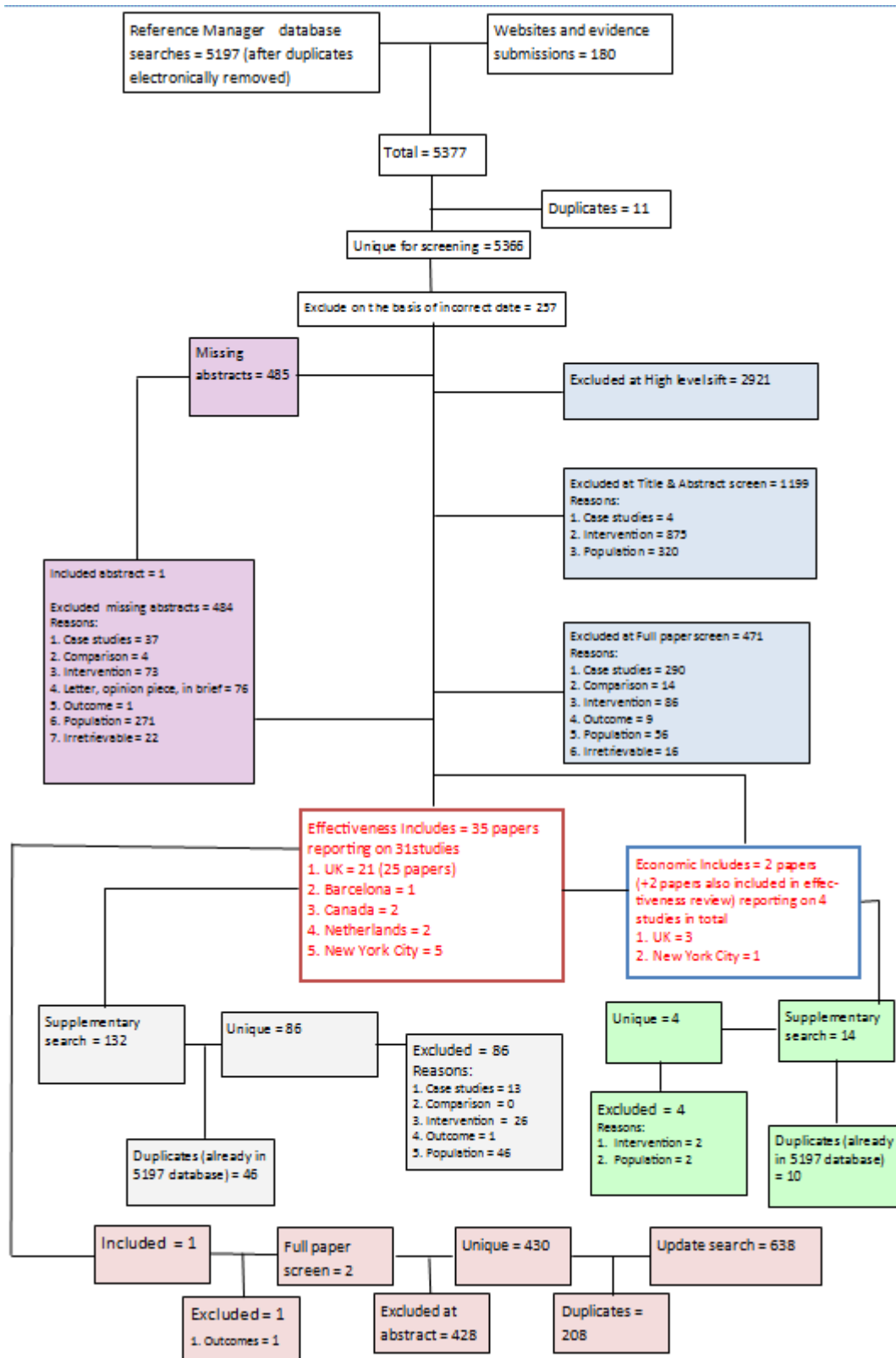
Figure 1 Evidence flow chart

3. Case studies – policy, practice and case study service models

Introduction

This chapter sets out information about the organisation and delivery of TB services (for active and latent TB where information is available) in key countries and cities, using a set of common sub-headings to organise information (where available) on notification rates and population patterns in TB cases, governance, legislation and accountability, financing and cost of healthcare and TB services, staffing and settings related to TB, and a summary of the TB service delivery model for each case. This information is primarily descriptive in nature and was extracted from included papers (in the effectiveness review chapter) or excluded papers that were identified as having potential case study content.

The methods used to search for and identify relevant papers are set out in the preceding chapter.

Data or associations linked to the priority outcomes for this review (or other outcomes) from studies that have not met inclusion criteria for the effectiveness and cost effectiveness sections of this report (chapters 4 'effectiveness review' and 5 'cost effectiveness review') is included at the end of each section.

Case study 1: The United Kingdom

TB notification rates and population patterns

In 2012 the number of notified cases of TB in the UK was 14.2 per 100,000 (ECDC 2014) - one of the highest incidence rates of any Western European country - with 8751 new cases in 2012 (ECDC, 2014). In terms of trends, TB in England and Wales declined from around 117,000 cases in 1913 to around 5000 in 1987 but has since been increasing (Health Protection Agency, 2006).   If current trends continue England is projected to have more TB cases than the USA within two years. (PHE, 2014a).

The rise in the numbers of UK cases is due to a host factors including increased migration from TB-prevalent countries, poor living conditions, and late presentation and diagnosis (Race for Health 2010). Over the years 1988 to 2003 TB notifications doubled in London from just over 20 per 100,000 in 1987 to over 40 per 100,000 by 2010, but rose more slowly in the rest of England and Wales (Anderson, 2007, Relph and Lynn, 2011a).

Fig 1-UK: Rates of TB in England and London 1982 to 2010
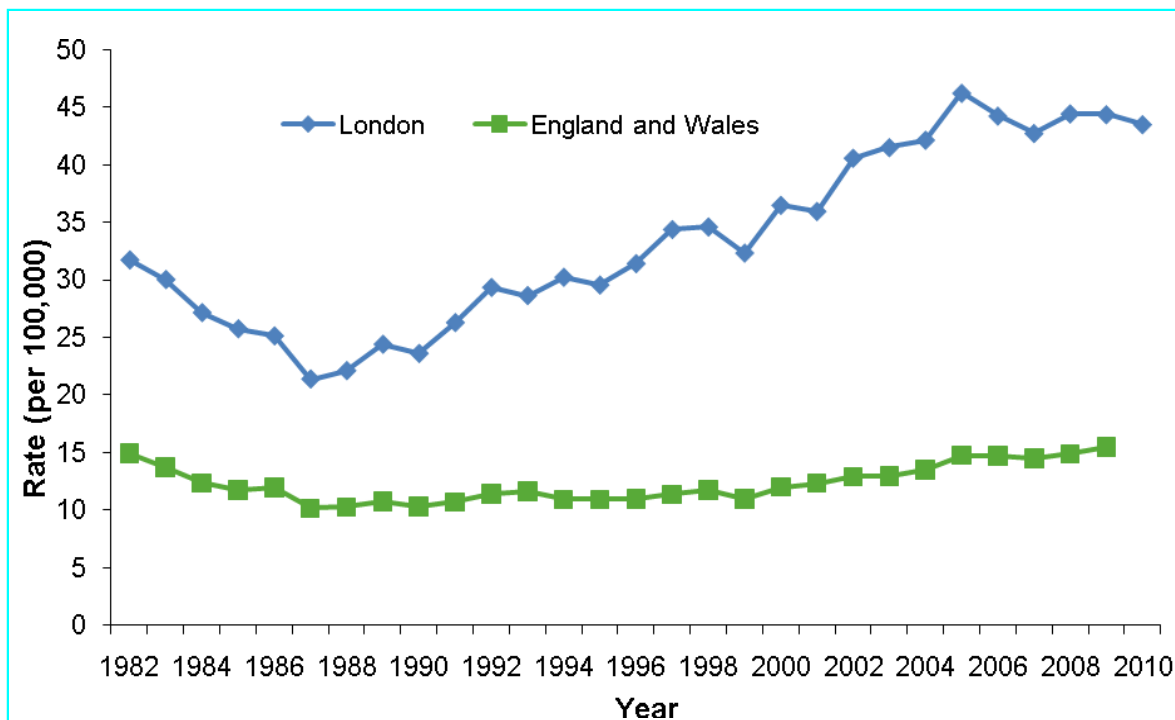
(Relph & Lynn 2011a)

In Wales in 2004, 178 cases were notified, 41.6% in south-east Wales (Metcalf, 2007). Of note is that this area of Wales has two cities (Cardiff and Newport) with large communities of foreign born people from countries with high incidence of TB. In 2013 absolute case numbers were 129, which is a rate of 4.2 per 100,000 population (PHW, 2014)

Scotland in recent decades has experienced lower overall levels of TB – 9.4 incident cases per 100,000 in 2009 than England, although this number had been on the rise in the years up to 2011 (The Scottish Government, 2011).

The incidence of tuberculosis (TB) in Northern Ireland is 3.5 cases per 100,000 population. In 2006, there were a total of 61 new cases of TB notified(Department of Health, Social Services and Public Policy, 2009).   In all countries in the UK those most at risk included those who were immunosuppressed; disadvantaged (including the homeless); those with alcohol problems; and those from certain ethnic backgrounds (for example, being born in countries where TB is classified as high incidence) (Department of Health, Social Services and Public Policy, 2009).

The proportion of TB that occurs among non-UK-born people is 72%, and the proportion from non-white ethnic groups is 78% (Race for Health, 2010; Kon, 2014).   The proportion of foreign born UK TB cases has risen from 52.2% in 1998 to 70.0% in 2012. Foreign born people also have a significantly higher chance of having MDR-TB than UK-born people (ECDC 2014). In 2006 of these cases, 45% originated from South Asia and 39% from sub-Saharan Africa (Health Protection Agency 2006).

Figure 2-UK: rates and cases of TB in non-UK born people including the proportion based on region of birth (Health Protection Agency, 2006)

| TUBERCULOSIS RATES BY PLACE OF BIRTH (BORN IN THE UK V S. NON-UK BORN), ENGLAND, WALES AND NORTHERN IRELAND, 2000–2004 | NON-UK BORN TUBERCULOSIS CASES BY WORLD REGION OF BIRTH, ENGLAND, WALES AND NORTHERN IRELAND, 2004 |

REGION OF BIRTH	NUMBER OF CASES	PROPORTION (%)
SOUTH ASIA	2013	45.3
SUB-SAHARAN AFRICA	1714	38.6
SOUTH EAST ASIA	178	4.0
WESTERN EUROPE	124	2.8
EAST ASIA	98	2.2
CENTRAL EUROPE	86	1.9
SOUTH AND CENTRAL AMERICA AND THE CARIBBEAN	79	1.8
EASTERN MEDITERRANEAN	69	1.6
NORTH AFRICA	46	1.0
NORTH AMERICA AND OCEANIA	19	0.4
EASTERN EUROPE	19	0.4
TOTAL WITH KNOWN	4445	100
REGION OF BIRTH MISSING DATA	162	
TOTAL	4607	

Among children (aged 0-14), UK incidence rates have been relatively stable over the last decade, and comprised 4.7% of all TB cases in 2012 (ECDC 2014, p.126-129). Among children under five years of age, there is an incidence rate of 4.1 per 100,000 (PHE 2014b, p.8).

People living with HIV are at greater risk of TB, in 2006, the proportion of people with TB who were co-infection with HIV was 7.7%, with an incidence rate 0.52 per 100,000 in 2012 (ECDC, 2014)

Being homeless and/or socially marginalised is a risk factor for TB in the UK. Among TB patients for whom data was available in 2013, 2.8% had a history of illegal drug use; 3.2% had a history of alcohol misuse; 2.4% had a history of homelessness; and 2.8% had a history of imprisonment. Overall, **Confidential information removed** of patients had at least one of these risk factors (O'Moore and Railton, 2014). Being of low socio-economic status is a separate recognised risk factor for TB in the UK (PHE, 2014b).

Prisoners are also at increased risk of TB, with people in prisons and other detention centres in England having a TB rate of **Confidential information removed** per 100000 (O'Moore and Railton 2014, p.25). In 2005 in England, Wales and Northern Ireland prisons were the third most common setting for reported TB cases after healthcare and educational establishments (Ahmed,).

In terms of different parts of the UK, the three-year average TB rates 2010-2012 ranged across upper tier local authorities from an average number of cases of 0.0 in the Isles of Scilly unitary authority, to 404.7 cases with a rate of 37.7 per 100,000 in Birmingham (LGA and PHE 2014).   London however has the highest rate of disease (**Confidential information removed** cases per 100,000) (Zenner and Dabrera, 2013).

Overall the incidence of TB in the UK remains on the increase, with around 9,000 cases reported each year, of which 38% occur in London (PHE, 2013).   Per capita, London has the largest amount of TB cases compared to all western European capital cities, almost half of new cases are drug-resistant (Belling, 2012). In terms of the specific demographics of at-risk groups in London:

- People who are foreign make up 85% of all cases (Hayward, 2010)
- The most common ethnic groups represented among those with TB in London (and for whom ethnicity is known) in terms of absolute number of cases are black Africans (28%), Indian (27%), and white (17%), incidence rates are highest among black Africans (223 per 100,000), followed by Indians (184 per 100,000) and lowest (7 per 100,000) among white individuals (Hayward, 2010)
- Homeless and/or socially marginalised people are a high risk group (Hall, 2010; Hayward 2010).   Compared to London's TB notification rate of 44 incident cases per 100,000 the homeless population has up to 300 incident cases per 100,000. Suggested contributing factors to this high rate include: poor nutrition; high rates of use of alcohol, tobacco, and crack cocaine; and a high incidence of mental illness in this group (Burki, 2010).
- In a study into the prevalence of latent TB infection among people in homeless hostels in London, 17% were IGRA positive (Yates, 2012).
- 5% of incident cases in 2009 were in children under 16 years (Hayward 2010).   Of the affected children, 41.3% of all cases were among children born abroad, primarily in Sub-Saharan and Southern Africa, or in the Indian sub-continent (Ruwende, 2010).
- Those with substance misuse (drugs and alcohol) issues make-up 11% of those with TB in London (Hall 2010; Hayward, 2010)
- Prisoners or ex-prisoners are identified as a high risk group although rates were not reported (Hall 2010, p.1; Hayward 2010)
- In London in 2009 5% of those with TB in London were people living with mental health issues (Hayward 2010)

Multi-drug resistant cases have increased from 1.3% of cases in 2003 to 1.6% of cases in 2012. (PHE, 2014), the UK has the fourth highest reported rate in the EU/EEA (ECDC, 2014). People of non-UK origin account for 90% of cases (Jordan, 2012).

Governance, legislation and accountability

There is no comprehensive TB control law in England and Wales, although the Public Health Act (1984) and the Public Health (Infectious Diseases) regulations (1988) support the action of medical authorities. The powers under the Public Health Act (1984) allow the removal of TB patients to hospital and detention when they are unwilling to comply with treatment (Harris & Martin 2004; Da Lomba & Martin, 2004), such measures are needed for about 1.5% of TB patients in urban areas (Bothamley, 2008), although it does not allow compulsory treatment (Okhado, 2005). Unlike a number of other countries, there is no police

or other legal coercion involved in the process of referring newly arrived migrants for screening (Coker, 2006).

Under statute, TB has been notifiable since 1913, and all suspected cases should be notified to the local Consultant in Communicable Disease (CCDC), in 1999, a system of enhanced surveillance was introduced, involving a standardised form which collects both demographic and clinical details of each patient (Health Protection Agency, 2006; Pudney, 2008; Backx 2011; Bothamley, 2011).

England (or UK wide)

In addition to NICE guidance, there are a number of documents that identify priorities for action or recommend interventions to help tackle TB in the UK:

- *Stopping Tuberculosis in England: An Action Plan from the Chief Medical Officer* (2004)
- *British HIV Association (BHIVA) guidelines for the treatment of TB/HIV co-infection* (2005, updated in 2011)*Tuberculosis prevention and treatment: a toolkit for planning, commissioning and delivering high-quality services in England* (2007) from NHS England (DH, 2007) (Relph & Lynn 2011a)

The action plan from the CMO focused on high quality coordinated services for TB diagnosis, treatment, and continuing care, including joint services for patients with TB-HIV co-infection (Backx 2011, p.3).

Specifically, the plan prioritised:

- Increased awareness
- Strong commitment and leadership
- High quality surveillance
- Excellence in clinical care
- Well organised and coordinated patient services
- First class laboratory services
- Highly effective disease control at population level
- An expert workforce
- Leading edge research
- International partnership

The BHIVA guidelines recommend that care took place within a multidisciplinary team, which includes physicians with appropriate expertise, and that all TB patients of unknown HIV status should be offered an HIV test. (Relph & Lynn, 2011a).

The commissioning toolkit provided TB services in England with a framework for assessing their local needs, and for planning and commissioning high-quality services (Relph & Lynn, 2011a), specifically:

- all TB services should identify a lead clinician with overall responsibility for diagnosis and treatment of TB, as a point of contact with commissioners;
- all patients should be allocated a named case worker;
- TB should be treated by specialists who have regular and continuing experience of treating the disease;

- transferred or shared case management with more experienced centres or specialists is considered in areas with low numbers of patients;
- NICE guidelines should be followed; and
- high-incidence areas provide, or have access to, enhanced case management (DH 2007).

In October 2013, Tripartite Agreement between the National Offender Management System, NHS England, and Public Health England which sets out responsibilities in relation to the commissioning, enabling, and delivery of healthcare services in adult prisons in England. (O'Moore and Railton, 2014).   One of the priorities under this agreement and against which it will be measured is aimed at improving the detection and management of TB among prisoners at or near reception along with implementation of an 'opt-out' policy for BBV's

Since the restructuring of health services, TB has been a priority area for Public Health England and a national multi-stakeholder TB oversight group (TBOG) exists to cover this area (Zenner and Dabrera (eds), 2013). This group published a strategy for consultation in March 2014 (PHE, 2014a), the final version is scheduled for release in September 2014.

Wales, Northern Ireland and Scotland:

A national policy or action plan for Tuberculosis in Wales was not identified in the literature search

SIGN guidance on TB for Scotland was issued in 2009, the TB Action Plan for Scotland, released two years later, covers four main areas:

- Effective laboratory services and diagnostic tools – what are the best models of service for Scotland in terms of laboratory diagnostic services?
- Effective clinical services in the broad sense – covering issues around: identification, management and treatment of TB; models of care; and best use of resources locally and nationally.   This also covers the associated issues such as drug resistant TB and co-infection issues (HIV).
- Effective surveillance – assessment of current surveillance systems and options for improvement.
- Effective public health services – covering: population level approaches to tackling TB, including contact tracing; detecting TB in risk groups; approaches to vaccination, and awareness raising (The Scottish Government 2011)

Northern Ireland created a *"Service Framework for Respiratory Health and Well-being"*, which includes the following performance indicators for TB
- Establish a system to ensure that all new migrants (new arrivals from high risk countries who are registering with GPs) are screened and provided with BCG vaccination according to NICE guidelines
- Percentage of patients requiring hospital admission with confirmed sputum smear positive TB who are placed in a single room at time of admission to hospital
- Percentage of patients where prescribed treatment has been carried out in accordance with NICE Guidance

- Percentage of patients who are managed by a specialist TB service (clinician who is a respiratory physician or appropriately trained infectious disease physician / paediatrician who has regular ongoing expertise in managing tuberculosis, and specialist TB nurse) (B 33 Department of Health, Social Services and Public Policy 2009 pp. 27-8)

Financing and costs of Healthcare and TB services in the UK

TB care in the UK is free at point of access even ton those with no recourse to public funding for other things (such as illegal immigrants), however, there was no data available on the national (UK or England) costs of Tuberculosis treatment and control available in the literature. The UK did not submit financial information to the World health organisation in their most recent country profiles.

Among 30 specialist TB services (not including in-patient care) in the greater London area 29 services provided details on their funding, eight were funded through acute hospital Trusts, 19 were funded through PCTs or PCT Community Service providers (now all likely to be a combination of clinical commissioning groups, NHS England and other commissioning bodies); seven also received some fixed term funding (funding source not reported), whilst two services were unsure how they were funded (Hayward, 2010 p.99). In the 2009-2010 period, the total cost for these services in relation to the prescribing of the four main TB antibiotics was £298,662. Overall the total costs of TB services for inpatient admissions to PCTs (the funding body at that time) in London was estimated to be £4 million, of which £3.2 million was for non-elective admissions with an overall costs for all TB services across London estimated at £25 million (Hayward et al, 2010), which equates to £7246 (based on the absolute notified case number of 3,450 in London in 2009 reported in Hayward et al, 2010).

Staffing and settings related to TB control in the UK

There is no standard organisation of staff, settings or service delivery personnel from either a clinical or healthcare perspective.

Bothamley et al 2011, surveyed big cities across the UK on various TB targets including whether they had achieved the target of 1:40 nurse to TB case ratio. The survey identified that cities which had not achieved this ratio were more likely to have more than 6% loss to follow-up (p<0.05), and less likely to use World TB day as a means of promoting TB awareness and outreach. Further details of this study can be found in the effectiveness review and data extraction tables in Appendix 4.

Public Health England have 26 dedicated health protection units across 15 centres/4 regions in the UK (https://www.gov.uk/contacts-phe-regions-and-local-centres, PHE 2014c). These local health protection teams lead Public Health England's response to all health related incidents including communicable disease outbreaks. Activities include:

- local disease surveillance
- maintaining alert systems
- investigating and managing health protection incidents and outbreaks
- delivering and monitoring national action plans for infectious diseases at local level

The health protection units are the primary contact for health professionals who require expert health protection advice, including out of hours

Summary of the UK service delivery model

At a national level, current TB control strategies are primarily aimed at early diagnosis and treatment to prevent spread (Zenner and Dabrera (eds), 2013). In the UK tuberculosis treatment and control is a combination of national action for some aspects and the local commissioning of TB services and programs based on identified need.

Centralisation of service delivery, commissioning and associated finance

In the UK, there are a number of national elements to the service model including legislation, policy, , surveillance collation and a centralised agency (Public Health England-PHE), however, the centralised agency is primarily focussed on co-ordination and support not the delivery of services. Service delivery and commissioning is devolved to clinical commissioning groups who make local commissioning decisions about hospitals, community health and primary care. This includes developing, funding, delivering and evaluating a range of services including health promotion, treatment and care based on local population needs. This means that TB service provision in the UK can be very variable; whilst national standards for Tuberculosis are available (NICE 2011, 2012) decision making on implementation and prioritisation for commissioning is sub-national resulting in potential for fragmentation across local government or even clinical commissioning groups boundaries.

There was not data on the national financial picture for Tuberculosis in the UK and they did not submit this information to WHO for publication in their country profiles (WHO, 2013). Based on the available data in literature identified the only financial estimate that can be made is in London (Hayward et al, 2010). In 2010 a total £25million was spent on TB services in London as a whole –after conversion to dollars this is $12,180 per notified case.

Legal powers

In the UK legal powers are limited powers under the Public Health Act (1984) to remove TB patients to hospital and detention when they are unwilling to comply with treatment (Harris & Martin 2004; Da Lomba & Martin, 2004), although this does not extend to compulsory treatment (Ohkado, 2005).

The newly rolled out pre-entry screening programme (PHE, 2014d) involves a mandatory PTB screening of persons applying for a long-term (>6 months) UK visa from high incidence TB countries (>40/100,000). This programme aims to identify cases of active pulmonary TB in prospective migrants before arrival into the UK. This scheme is not set up to detect latent TB.

TB is a notifiable disease notification is mandated.

Contact Tracing

Contact tracing should be delivered in the UK using the stone in the pond method, where invitation to testing is based on a prioritisation exercise determined by level of contact and the subsequent rate identified in that circle compared with the background rate, although some groups are tested at a lesser degree of exposure for example those living with HIV due to their immune-compromise status and consequences of TB infection in this group (DOH, 1998)**.**

Contact Tracing is generally led by TB nurses on identification of a new case (in some cases with support of peer educators), however, in an outbreak situation it is likely to be led and managed by Public Health England.

Targeting high risk groups, active case finding and reducing diagnostic delay

Until recently there was an immigrant (on-entry) screening programme at UK borders and in immigration removal centres for people from high incidence areas. However, Pre-entry TB screening

for active pulmonary disease in all long-term visa applicants coming from high incidence countries to the UK has been rolled out from September 2012, following a successful pilot from October 2005. It is anticipated that roll out will be complete on 31 March 2014 (PHE, 2014c). The system replaces the on-entry screening at UK airports. Pre-entry screening is administered through the UK Home Office. Public Health England (PHE) collaborates with Home Office to support these activities (PHE, 2013)

There does not appear to any additional systematic national approach to the active identification of cases in high risk groups. In some places in the UK there has been a focus on at-risk groups (drug users, homeless people, prisoners, undocumented migrants) for both diagnosis and treatment support. Specific screening programs for high risk groups using technologies, such as MXUs, have been used since 2005 in London by the 'Find and Treat' service which facilitates diagnosis and outreach approaches to TB control among hard-to-reach groups (Hayward et al, 2010).

Treatment Completion

There is the model of case management and enhanced case management for people with TB, which is the comprehensive follow-up of a suspected or confirmed TB case, usually carried out by a collaborative multidisciplinary team (MDT) (RCN, 2013).   Standard case management is coordinated by a case manager for non-complicated patients who are able to self-medicate and attend follow-up appointments in hospital or community setting, and a typical schedule of such a process can be seen in the table 1-UK below:

Table 1-UK: case management in the UK (RCN, 2013 p.7)

Stage	Procedure
Diagnostic work-up	Initial interview including clinical history and relevant investigations ordered
Start of treatment	Seen by TB physician and case manager, contact investigations initiated, given one month of medication
One week	Home visit (assess patient environment and complete contact list within five working days)
Two weeks	Seen by case manager as an outpatient or in the community
One month	Seen by case manager as an outpatient or in the community, given one month of medication
Two months	Seen by TB physician and case manager to switch from initiation to continuation regimen, given one month of medication. Confirmation of drug sensitivity or record that no drug sensitivity yet available (to be reviewed regularly until either culture negative or sensitivities documented)
Three months	As for month one
Four months	As for month one
Five months	As for month one
Six months	Seen by TB physician and case manager, treatment stopped and outcome reported.

Enhanced case management (ECM), is co-ordinated by a named case manager working alongside a specialist multidisciplinary TB team, and is used on "socially complex" cases where patients have suspected TB, it generally includes the delivery of treatment using Directly Observed Therapy (DOT). It is intended to reduce the risk of patients disengaging with services prior to the completion of diagnosis.   As well as the standard case management detailed above and DOT, it can also include:

- expert management for clinically complex TB;

- negative pressure facilities appropriate for prolonged isolation;

- skilled outreach and advocacy workers in touch with allied agencies to address patients' housing, addiction, welfare benefits, and other social care needs; and

- flexible clinic opening hours, appointment systems, and community DOT options (RCN,

2013, p. 7-8).

Staffing

Based on the available literature there was no means of estimating the average nurse to case ratio for the whole of the UK. However, Bothamley et al 2011, identified that cities which had not achieved a ratio of 1:40 nurse to TB cases were more likely to have more than 6% loss to follow-up (p<0.05), and less likely to use World TB day as a means of promoting TB awareness and outreach; "Manchester was most poorly resourced and showed the highest rate of increase of TB" (Bothamley, 2011 p.896).

Health Protection Services staff (provided by Public Health England), based in health protection teams, provide specialist advice and operational support for the local NHS, local authorities and other agencies. There are 26 Health Protection teams across the four Public Health England regions (London, North of England, South of England, and Midlands and East of England) (PHE, 2014d).

Surveillance

There is an Enhanced Tuberculosis Surveillance (ETS) system, introduced in 1999 to improve the completeness of TB reporting, because it was estimated that somewhere between 7 and 27% TB cases went un-notified in the UK.   Reporting is improved through record linkage with cases of *Mycobacterium tuberculosis* isolates from reference laboratories in the UK Mycobacterial Network (MycobNet) (Van Hest, 2008).   The completeness of TB notification reporting has improved since the development of this system (PHE annual TB update 2014).

This included the introduction by the Health Protection Agency (now PHE) of a web-based TB surveillance system targeted at improved data completeness, accuracy, and information accessibility (Backx, 2011).   Another surveillance improvement has been the DNA fingerprinting of all UK strains from April 2010

Cohort Review

Cohort review (recommended by NICE: PH37, 2012) is a common procedure in a number of places in the UK (Birmingham, London, Manchester, Leeds. Leicester report delivery of this intervention, Bothamley, 2010).   It is a systematic quarterly (or more often) review of the management of every case of TB in a locality.   Cases are reviewed on the basis of treatment completion, contact investigation and case management needs and outcomes.

MDR-TB advisory service

The Multidrug-Resistant Tuberculosis Advisory Service was established in 2008, and is a national service intended to provide clinicians with access to expert advice via a "virtual" electronic committee of TB experts (Davies, 2009). It was based on a similar service in operation in the Baltic States and operates via a secure website (Jordan, 2012).

The Multidrug-Resistant Tuberculosis Advisory Service is operated by a part-time co-ordinator who is employed 3 days a week, and who is overseen by a lead clinician employed for a half session (2 hours a week) (Jordan, 2012). Finally, the Multidrug-Resistant Tuberculosis Advisory Service is based in Liverpool Heart and Chest Hospital and its "virtual" expert committee offers advice via email (Davies, 2009).

Case study 2: New York City

TB notification rates and population patterns

New York City (NYC) is a major US metropolitan areas which experienced a resurgence in TB in the latter part of the 20th Century: In the period 1979 to 1992 there was an almost three-fold increase in TB incidence. This has been attributed to a decreased political commitment to control TB, combined with increases in poverty, prison crowding, TB circulating in homeless shelters, nosocomial transmission, and the HIV epidemic (Frieden, 2009).   The incidence rate reached a peak in 1992 with 52.0 cases per 100,000 people reported (compared with 10.4 per 100,000 in the US as a whole). In Harlem, the rate exceeded 200 cases per 100,000 at this time (Sarmiento, 2006).

By 2008 the incidence rate had reduced to 10.8 per 100,000 (895 cases), further reducing to 651 cases in 2012 - the lowest number since the disease became reportable in 1897 (NYC-DOHMH, 2012. In 2013, NYC reported its first increase in TB incidence rates in a decade (n=656 per 100,000 new cases), equating to an incidence rate of 8.0 per 100,000 people, a 1% increase from 2012 (NYC-DOHMH, 2013, p.5). Despite the progress made in NYC in reducing incidence of TB, its rate remains high in relation to the rest of the US: Approximately 2.5 times the rate of the USA as a whole (Posey, 2014; NYC-DOHMH, 2012).

 Figure 1 -NY: Tuberculosis cases and incidence rates, New York City, 1982-2013 (NYC-DOHMH, 2013)
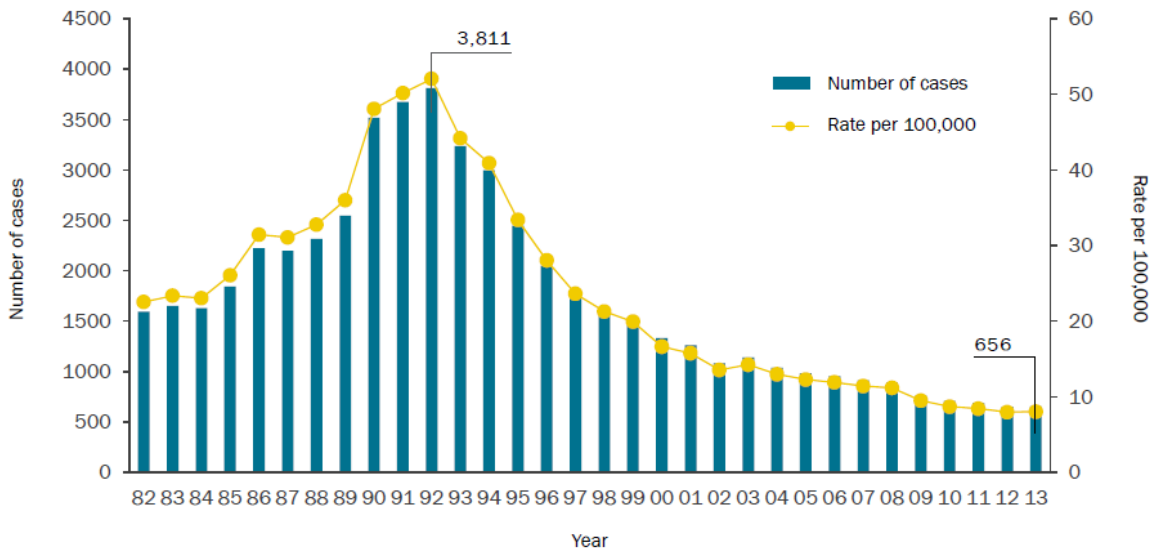
Like other areas, NYC experiences differences in incidence rates between different population groups. People who were foreign-born made up 84% of the TB caseload in 2013, and are the focus of a range of targeted interventions.   Figure 2-NYC below depicts the changes in the rate of TB among foreign and US born citizens in the last 20 years.

Figure 2-NYC: Tuberculosis cases and rates by birth in New York City, 1992-2013 (NYC-DOHMH, 2013)
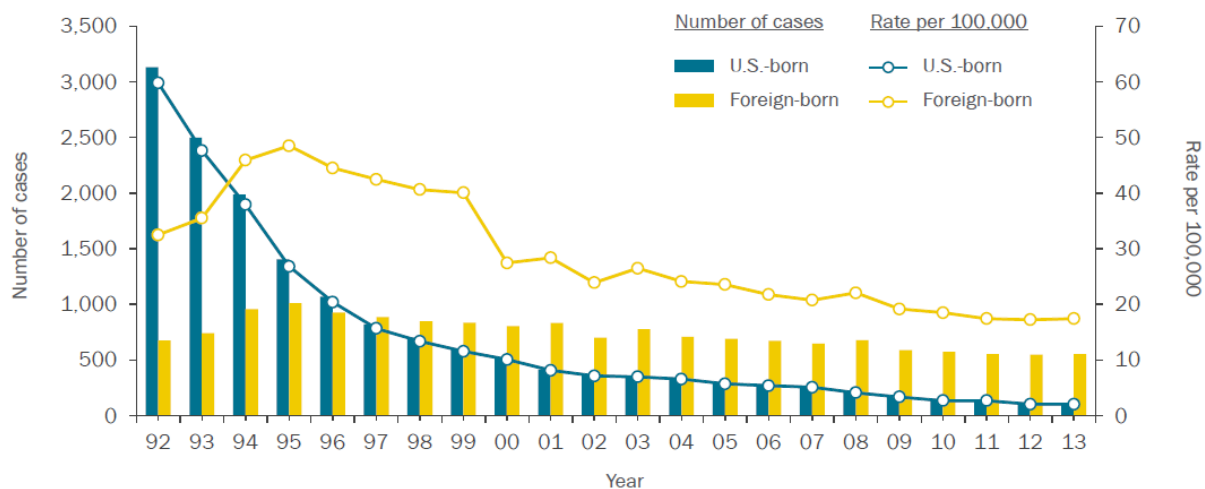
1. Rates prior to 2000 are based on 1990 U.S. Census data. Rates for 2000-2005 are based on 2000 U.S. Census data. Rates after 2005 are based on 3-year American Community Survey data centered on the given year or the most recent available data. 2. U.S.-born includes individuals born in the U.S. and U.S. territories. One case had unknown country of birth.

A number of other groups are associated with increased risk of having TB in NYC, for example around 13% of U.S. born people with TB reported a history of homelessness in the 12 months prior to TB diagnosis (NYC-DOHMH, 2012). In 2013 more than 50% of overall NYC TB cases lived somewhere where at least 20% of residents had incomes below the federal poverty limit. U.S.-born people with TB tend to live in more deprived communities than foreign-born people with TB - 14% of U.S. born TB cases in NYC lived in an area where 40% or more residents were below the federal poverty limit, compared with 7% of foreign-born cases (NYC-DOHMH, 2013). People living with HIV are also at greater risk of TB due to their immune-compromised status, however rates in this group have shown improvement in recent years with 39 cases in 2013, a 35% decrease from 2012 and a 77% decrease from 2004 (NYC-DOHMH, 2013).

Governance, legislation, and accountability

In the US, the Government Department of Health and Human Services devolves many responsibilities for health protection to the Centres for Disease Control and Prevention, which in turn devolves some local responsibilities for TB prevention and control to named control centres. In NYC, the Department of Health and Mental Hygiene is the accountable organisation for TB control which it delivers through the Bureau of Tuberculosis Control (BTBC).

The following is the current (*2013*) mission statement for NYC BTBC:
"MISSION: The mission of the Bureau of Tuberculosis Control (BTBC) is to prevent the spread of tuberculosis (TB) and to eliminate it as a public health problem in New York City. GOALS:
- To identify all individuals with suspected and confirmed TB disease and ensure their appropriate treatment, ideally on directly observed therapy

- To ensure that individuals who are at high risk for progression from TB infection to active disease complete treatment for TB infection and do not develop disease"

Furthermore, case management and treatment outcomes for all TB cases and their contacts are reviewed by the BTBC Assistant Commissioner in quarterly cohort review meetings) alongside the policy of on-going research and evaluation within the BTBC (Frieden 2008).

BTBC mandated activities in NYC include:

1. Ensuring suspected and confirmed cases of TB are reported and documented.
2. Conducting intensive case interviews, maintaining outreach programs so cases remain under medical supervision until completion of a full course of treatment and identified contacts receive appropriate medical care.
3. Monitoring and documenting the treatment status of all patients with active TB.
4. Setting standards and guidelines, and providing consultation, on the prevention, diagnosis, and treatment of latent TB infection and disease in New York City.
5. Operating clinical sites (including chest clinics) throughout NYC providing state-of-the-art care for suspected or confirmed cases and their close contacts, at no cost to the patient.
6. Ensuring care in accordance with New York State Public Health Law.
7. Collaborating with community-based organizations, health and social agencies to improve case-finding, prevention and control of TB through education, outreach, and targeted screening in communities at high risk (p.2 DOHMH, 2002).

In NYC detention of persistently non-adherent TB patients is authorised for patients who are unwilling to adhere to recommendations for treatment, and who may pose a public health threat (NYC-DOHMH, 2013).   These provisions are detailed in Section 11.47 of the NYC Health Code, and the burden of proof supporting the detention of an individual rests with the Health Department (Munsiff 2008).   The use of detention has fallen over time, with a rate of 1.7% of reported TB cases being detained in this way in the period 1993 to 1995, compared to 1.1% of cases in the period 2002 to 2009 (Pursnani 2014). These procedures have been in place since 1993, and are intended for people for whom less restrictive measures are likely to fail, or who have already failed. Criteria for regulatory action include considerations of diagnosis; the absence of evidence of treatment completion; the assessed risk of the patient being impossible to locate; the usefulness of court ordered DOT as an alternative, and a consideration of whether the patient accepts the truth of their diagnosis of active TB The actual detention occurs on a locked ward at Bellevue Hospital Centre (Pursnani, 2010). An attorney is also provided, and each patient is entitled to a legal hearing and judicial review of their continued detention every 90 days (Pursnani, 2014). In terms of other legislation, the NYC Health Code mandates that a portion of the initial culture from all culture-positive TB patients be sent to the NYC Public Health Laboratory for genotyping (NYC-DOHMH, 2013). In addition to this state-level legislation, at the federal level, the Immigration and Nationality Act, and the Public Health Service Act require medical examination for refugees/immigrants into U.S. persons with non-infectious tuberculosis are recommended to have follow-up within 30 days of arrival; TB is classified as a communicable disease of public health significance under the Public Service Health Act), and the act, where pre-screening prior to migration identifies active TB a course of treatment including DOT prior to migration is required (Lee et al, 2013).

Financing and cost of Healthcare and TB services in NYC

Tuberculosis control is considered to be both a health and political priority in New York, and what have been referred to as "substantial funds" have been available in a "reliable" supply for its control for over a decade (Cayla and Orcau, 2011; Frieden, 2008). Federal, state and city funding for TB treatment and services in NYC was increased in the 1990's in an effort to curb high TB rates, and the city spent more than US$1 billion on its treatment and control. Much of this money was used to develop an infrastructure intended to both treat patients and interrupt transmission. BTBC currently receives city, state and federal funding. Following the significant increase in TB in the 1980's and early 1990's, DOT was introduced to reinforce TB treatment and control activities. This increased spending to more than $400 million for 3 years (McEvoy and Maguire, 1995 [secondary ref Ohkado et al, 2004]). Calculating this over 1 year at the peak of resurgence (1992), this equates to $34,085 per case. In 2013, the BTBC had an operational budget of approximately $16 million, of which 38% was from the federal government (~$6 million), 12% was from New York State (~$2 million), and 50% was from New York City (NYC-DOHMH, 2013, p.13), this equates to $24,577 per case

Figure 3-NYC: Federal funding for disease prevention in New York City (2006), Frieden et al, 2008 p.975
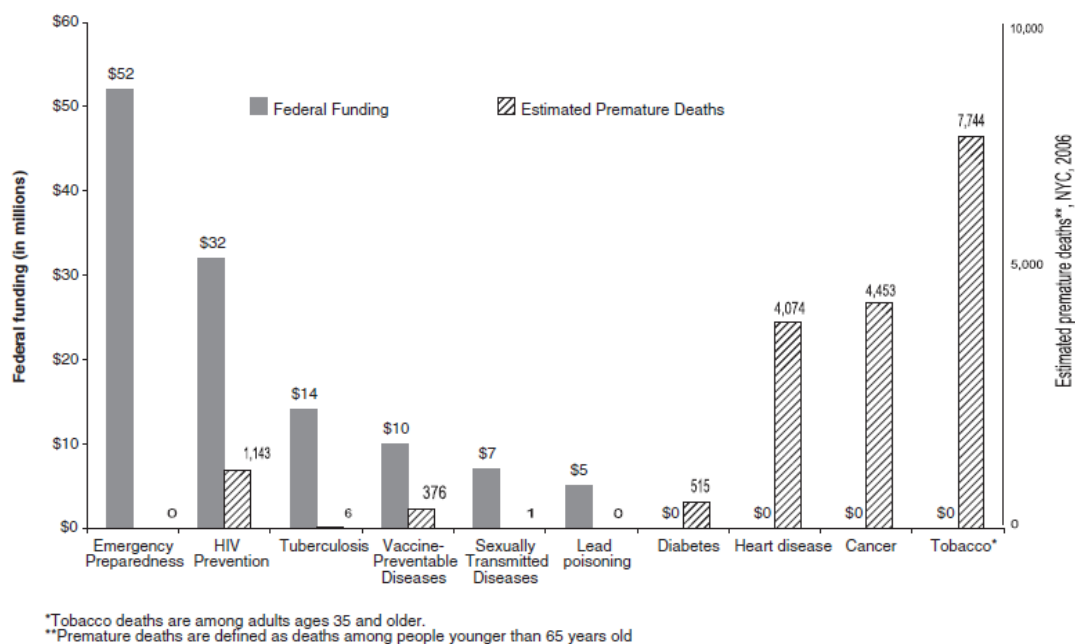
Figure 1 Comparison of federal funding for disease prevention with premature deaths, New York City, 2006

Figure 3- NYC above illustrates federal funding against the estimated number of premature deaths by condition in NYC in 2006 (Frieden et al, 2008). The significant amount of federal in addition to local funding, as well as the political will behind TB control, has been proposed as an underpinning reason for the improvements seen in NYC compared to other areas (Hayward et al, 2010). The figure above illustrates that many leading causes of premature mortality such as heart disease and some cancers do not receive federal funding. Since 1992 DOT has been provided by the Department of Health (DOH), and additional DOT programmes have been funded by the New York State Department of Health (NYSDOH)

and Medicaid (Gupta, 2004), and all services provided by BTBC are free of charge (Munsiff, 2008, p.63)..

Staffing and settings related to TB control in NYC

The staff roles and functions at BTBC involved in TB treatment and control can be summarised as follows (NYC-DOHMH, 2013, Munsiff, 2008; Udeagu, 2007),:

- **Case managers** undertake multidisciplinary coordination for medical and psychosocial needs, and promote completion of TB treatment including DOT.   They also address any barriers to treatment adherence; arrange follow-up appointments or referrals; update the DOHMH TB registry.
- **Index patient case managers** provide information as requested to the network epidemiologist; keep track of the TB status of all the contacts of the index patient (regardless of who is case managing the contacts), and report the outcome of the contact investigation at the DOHMH Cohort Review
- **Public health nurses (PHN)** are primary care managers for BTBC clinic patients, and receive support from public health advisors (PHA). They are also responsible for performing monthly assessment of TB patients
- **Public health advisors (PHA)** are outreach workers who support PHN in field work and DOT, and monitor patients treated by medical providers at non-BTBC clinics
- **BTBC physicians** treat/supervise management of patients at BTBC clinics and provide consultation to non-BTBC providers and BTBC PHAs assigned to manage non-BTBC clinic cases.
- **BTBC director** reviews cohorts of confirmed TB cases quarterly in a multidisciplinary staff meeting to ensure cases managed appropriately

Epidemiologists/social workers (from BTBC partner organisations) are involved with TB case management where needed (Udeagu 2007; Munsiff 2008; NYC-DOHMH, 2013).

In terms of staffing levels, as of 2013 the BTBC had 212 full-time employees and 38 part-time/ volunteer staff focussed on TB control (NYC-DOHMH, 2013, p.13). Taking a conservative approach of assuming only 50% (n=56) of the 212 employees (and none of the volunteers) provide treatment and control activities (i.e. case management, DOT, contact tracing), this equates to a ratio of 1:12 cases to staff[2].

BTBC provides TB diagnosis, treatment and case management in 10 clinics in NYC, (Udeagu et al, 2007), based on recent figures (n=651 cases in 2012; NYC DOHMH, 2013) this equates to approx. 65 cases being managed by each clinic per annum. Outreach work ensures that services are provided in or near to places that high risk groups congregate such as the mobile screening unit (MXU) activities described above.

There were 22,919 hospital admissions of NYC residents from the beginning of 1990 to the end of 2006, which had a principal diagnosis of TB (Parrinello et al, 2012).   Hospital settings

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[2] Term nurses not used as expert testimony in PH37 indicated that it is not generally nurses who deliver case management, DOT or contact tracing in NYC but trained Public Health Advisors who make up around 50% of the workforce (Sara Hemming personal communication, 2011)..

in NYC are varied: aside from Bellevue Hospital Chest Centre (where patients not compliant with treatment may be detained in a dedicated ward, Pursnani et al, 2014) there are no specialist TB wards in NYC (Murphy et al, 2008).

Summary of the New York City service delivery model

The New York City model features centralisation of commissioning, coordination and accountability. There is also investment in community-based work targeting high-risk groups, which is centrally managed by the BTBC.

Centralisation of service delivery, commissioning and finance

In New York the Bureau of Tuberculosis Control (BTBC). Commission and manage the TB control programme centrally. This is a unified vertical programme using prescribed TB protocols ensuring BTBC is notified of every TB patient receiving care and includes the recording and monitoring of all clinic activities. This approach has dual benefits, for surveillance and performance management, in particular case management and treatment completion outcomes (Hayward et al, 2010).

In addition the cohort review model of delivery has been credited as one of the BTBC's "most important methods of program evaluation"; Munsiff et al, (2006) cites a number processes ensuring accountability and positive outcomes:

- The Bureau Director reviews the management of each case and ensures accountability by providing oversight and addressing any case-management issues;
- Clinicians, managers, and public health advisors consult on difficult cases, especially non-adherent patients, those with MDR-TB or cases with numerous contacts in several settings;
- It is a method for tracking against national objectives on a regular basis (Munsiff, 2006)

Based on the available data in 2012 NYC was estimated to be spending in the region of $24,000 US dollars per notified case, at the peak of resurgence (1992) and investment ($400 million over 3 years) this was estimated to be in the region of $34,000 per case.

Legal powers

In addition to USA legislation and powers the commissioner of health in NYC has the power to issue orders for implementation of DOT and also for detention of patients who are persistently non-adherent to TB treatment (NYC-DOHMH 2013; Paolo, 2004), these powers are in addition to the legal and legislative powers described for US above.

Contact tracing

Contact tracing is considered a core activity by the BTBC who are responsible for conducting follow-up investigations of people in contact with confirmed TB cases, with a ratio of 10 contacts to one TB case. In 2008 of the 4,488 contacts evaluated, 801 (18%) were found to have latent TB infection (Hayward et al, 2008; NYC DOHMH, 2008).

Targeting high risk groups, active case finding and supporting treatment completion

In 2007, a new initiative commenced - Partners in TB Control". This initiative was formed through a collaboration with the Department of Homeless Services and medical service providers. It involved screening and providing DOT (directly observed therapy) at 20 homeless shelters. As a result, in 2008, 2,175 homeless persons were screened.

Directly Observed Therapy is the mainstay of treatment completion support in NYC, with a long term focus on using this intervention specifically the marked increase in the use of DOT (from less than 30% of patients on DOT in the late 1980s to over 70% in 2003), being attributed to supporting delivery of a treatment completion rate of 93.9% (NYC-DOHMH, 2003)

Staffing

Based on the available literature it was conservatively estimated there was a ratio of 1:12 cases to staff in NYC.

Surveillance, identification of TB clusters and community engagement

When a TB case is confirmed, geno-typing takes place to identify clusters from which the recent TB cases have risen. Once a specific community is identified by strain typing, an outreach initiative raising awareness and providing education is initiated using a partnership approach with local service providers and community-based organisations (including congregate sites such as schools, work-places etc.), where the specified TB cases/clusters had previously been identified; sites are classified and prioritised according to whether TB transmission would be probable, possible, or unlikely (Hayward et al, 2010).

Operation of chest centres

Ten chest centres are operated throughout the city. Each provides TB diagnostic testing, outpatient medical and nursing care, treatment for latent and active TB, social service assistance and HIV counselling and testing at no cost to the patient. These chest centres reported 8% of all confirmed TB cases and identified 18% of all patients suspected of having TB (Udeagu, 2007)

Other Providers

In addition to the services offered by the BTBC, several New York State-sponsored sites provide DOT to TB patients, either in a clinic or in the field. Arrangements are made to accommodate the patients' schedules. Non-BTBC physicians who have patients with active TB can either refer the patient to a BTBC Chest Centre, or act as the patient's TB care provider themselves (Munsiff et al, 2008).

Service performance and factors associated with reducing time taken to diagnosis, improving contact tracing and increasing treatment completion: additional data

Performance Indicators (surveillance, monitoring and centralise reporting)
In 2013 the following performance measures were reported for NYC - they form the basis of performance management for TB locally and nationally (DOHMH, 2013).

Table 1-NY: BTBC core performance management indicators – outcomes 2008-2012

	Target	2008	2009	2010	2011	2012
Treatment completed (within 12 months)-%	**93**	**89**	**92**	**93**	**92**	**94**
Treatment initiated within 7 days of specimen collection-%	**Increase**	**-**	**96**	**92**	**91**	**89**
Started on recommended initial 4 drug treatment-%	93	95	95	93	98	98

	Target	2008	2009	2010	2011	2012
Sputum culture conversion within 60 days of treatment initiation-%	62	-	59	67	65	72
% eligible cases with contacts elicited	**100**	**94**	**96**	**96**	**96**	**95**
% contact evaluated	**93**	**81**	**86**	**81**	**82**	**80**
% contacts initiated on treatment for TB infection	88	74	79	80	76	80
% eligible contacts who completed treatment	**79**	**65**	**67**	**68**	**66**	**-**

In NYC, treatment completion rates have remained high (> 89%) over at least a decade, as has elicitation of contacts from cases (90%, 2002 to 95%, 2013), although neither have reached target consistently.

Additional factors the NYC Bureau of TB Control (BTBC) monitor include drug susceptibility testing results, HIV status, laboratory and provider reporting, evaluation and treatment of newly-arrived immigrants and refugees with abnormal chest x-rays read overseas.

Time taken for diagnosis
In a cross-sectional survey of TB patients in Harlem, New York (a socio-economically deprived neighbourhood with issues of homelessness, substance misuse and high rates people living with HIV), it was found that there was an average total delay of 18 weeks between symptom onset and diagnosis of TB, with on average 7.5 weeks attributed to health care system delays. Cases visited on average 1.6 sources of care before diagnosis, with delays attributed to missed opportunity to diagnose primarily in primary care offices or A&E (no reason for this was alluded to).   There was a longer delay (10.5 weeks delay) attributed to not seeking treatment, with the most common responses for delay in seeking care being "didn't think it was serious" (29.1%), others include financial issues (medical care cost, transport cost and lack of insurance) as the reason for delay (18.2%), (Sarmiento, 2006) The authors did not make any suggestions for service changes or interventions to manage these issues.

The use of incentives has shown some success in relation to reducing diagnostic delay, for example, a monetary incentive has been shown to reduce the time taken to obtain x-ray (median 2 days versus 11 days without incentive p<.0001) (Perlman, 2003) and has also been associated with increased attendance for x-ray (79% versus 14% with no incentive p < .0001; OR = 23; [CI= 9.5–57]). During the years 1995 to1998, a $5 travel token was supplied, but from 1999, patients were offered an additional $25 cash incentive (as well as the travel token) contingent on adherence to referral within 7 days.

One service model that works across NYC is that of Project Renewal Inc (since 1987), which uses mobile outreach to homeless people, providing free medical care. This outreach model was originally conceived as an emergency medicine model focussed on trauma and immediate care, however, due to the morbidity encountered in the population it broadened out into a comprehensive outreach/treatment model by 2003.   Healthcare is provided by a physician or physician's assistant, a social worker, and a driver/outreach worker. The service uses a set weekly schedule continually adjusted to the needs of the community, the

mobile unit parks in areas where the homeless congregate, for example in the vicinity of soup kitchens, drop-in centres, and shelters (Nuttbrock, 2003). This model is a broad outreach model that is not specifically focussed on TB it covers physical (including communicable disease), psychiatric and substance use interventions. Although universal screening for infections common among homeless people is not routinely performed, staff are knowledgeable about risk factors and diseases in this population and patients presenting with symptoms will be tested.

Contact Tracing

In 2002 DOHMH reported that more effective surveillance methods, prompt initiation of contact investigations and treatment of infected contacts have contributed to success in TB control in NYC in particular:

- 90% of patients with smear positive tuberculosis had contacts identified, with a contact case ratio of almost eight overall.
- A higher number of expanded contact investigations were conducted (no number reported) due to better identification of settings where there was a high risk of transmission

Treatment Completion

In 2002 and 2003 DOHMH reported of a number of accomplishments in TB control in NYC. The use of appropriate anti-tuberculosis treatment under DOT may have been a significant contributor to success, specifically the marked increase in the use of DOT (from less than 30% of patients on DOT in the late 1980s to over 70% in 2003), supporting delivery of a treatment completion rate of 93.9%. The graph below Figure NY-4 depicts the trends over a 25 year period in relation to number of TB cases and % of cases on DOT.

Rates of treatment completion supported by DOT have remained high. It is also worth noting that DOT is the standard of care for patients treated for suspected or confirmed TB in NYC (NYC-DOHMH, 2013 p.10). 455 confirmed TB cases were enrolled in DOT, BTBC staff made approximately 20,300 home and field visits to perform DOT for 504 TB cases and suspects. The proportion of cases/suspected cases who received DOT was not reported. The success in treatment completion rates is also likely to have an impact on MDR-TB rates in NYC/USA.

Figure 4-NY: Tuberculosis cases on Directly Observed Therapy (DOT) in New York City 1979-2003 (NYC-DOHMH, 2003).

Figure 9
Tuberculosis Cases on Directly Observed Therapy[1]
New York City, 1978-2003

[1]Of those who were diagnosed while alive and received some treatment on an outpatient basis.
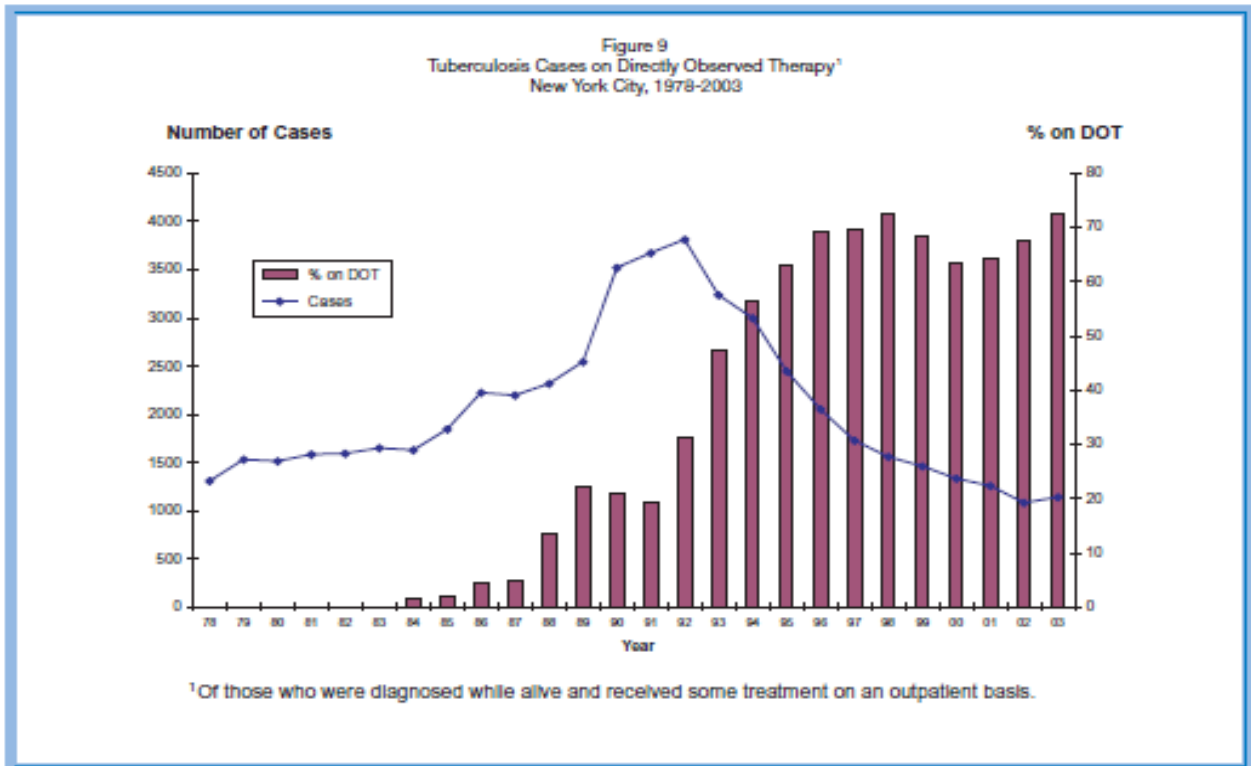
The BTBC is trialling Video Directly Observed Therapy (VDOT), 32 patients were enrolled in the VDOT program in 2013 using smartphones pre-programmed with video chat software, the outcomes of this trail are not yet reported in the published literature, (NYC-DOHMH, 2013).

The use of incentives in conjunction with a syringe program in injecting drug users is considered an effective intervention to improve adherence to TB treatment. The incentive was the equivalent of $100/month incentive for adherence (Cayla and Orcau, 2011; Perlman, 2003), In multivariate logistic regression analysis, use of the incentive was highly independently associated with increased adherence (OR = 22.9; 95% CI = 10–52) Perlman et al, 2003.

Other factors associated with improved outcomes for TB control in NYC
The location- or co-location - of services may also be a factor contributing to improved outcomes.   For example, co-locating TB screening and preventive therapy in drug treatment programs at places like methadone maintenance program facilities has been suggested to improve drug users' adherence to TB services (Perlman, 2003).   Other findings show that using street outreach to engage drug users in community sites where drugs are bought and sold may be an effective approach in recruiting high-risk populations of injecting and non-injecting drug users for TST screening (Factor, 2011).

Case study 3: Canada

TB notification rates and population patterns

TB cases have been declining in Canada since the 1970's, but the extent to which Canada – as many other countries did - experienced a surge in cases in the 80's and 90's is not clear because systematic reporting of the national rate only began in 1993. Since then, incidence rates have fallen from 5.4 cases per 100,000 for the years 2000-2004, to a record low of 4.6 per 100,000 in 2010 (Young, 2011; Klotz, 2012; Orr, 2009; Greenaway, 2013). Canada currently has the lowest average TB death rate in the world, with under 1 TB death per 100,000 people in 2013 (WHO 2013), and one of the lowest TB notification rates at a population level: MDR-TB was 0.57% of new cases and 1.6% of retreatment cases which equates to an absolute case number of 9 in 2012 (WHO, 2013).

Despite low overall rates, there are significant geographic and population differences in the incidence of TB between Canada and other low-incidence countries such as USA, UK and mainland Europe.   Three rural northern regions (Northwest Territories, Northern Canada and Nunavut) show persistently high incidence rates between 2005-09 of 24.8, 58.4 and 153.0 per 100,000 respectively (Nguyen, 2003; Menzies, 2008) , far higher than the national rate at this time (4.9 per 100,000).(Young, 2011). Indigenous communities in these areas (universally referred to as Aboriginals, a term which in Canada includes the First Nation, Inuit and Metis communities) experience higher TB rates than the general population, which contribute to overall rates in these areas. (Young, 2011; Cook, 2006; Klotz, 2012; Cook 2004,; Nguyen, 2003; Orr, 2009; Communicable Disease Policy Advisory Committee, 2012; Manitoba Public Health, 2014; Government of Saskatchewan, 2012; Aspler 2010; Canadian Government, 2014), with rates in 2010 of 304 per 100,000, or more than 66 times the rate in Canada overall (Orr, 2009) in this Nanvut where the population is more than 80% Inuit. Despite Aboriginal people in Canada being only 4% of the Canadian population, this population account for 21.2% of all TB cases, up from 14.7% in 1970 (Cook, 2006; Greenaway 2013).

People born overseas constitute the largest sub-group of people with TB in Canada in terms of absolute case numbers (Lanlois-Klassen 2011; Canadian Government 2014), with 15 cases per 100,000 identified in this group in 2009 (Communicable Disease Policy Advisory Committee, 2012). This is lower than the rate found in the Aboriginal communities but constitutes a larger overall number of cases, with foreign-born people accounting for 65% of active TB cases in 2006   In 2006 some foreign-born subgroups (for example refugees from sub-Saharan Africa and Asia) were up to 500 times more likely to have active TB compared with non-Aboriginal, Canadian-born persons (Greenaway, 2011; Greenaway, 2013; Manitoba Public Health, 2014).   Foreign-born people also constitute a group of 1.5 million persons in Canada with LTBI (Pottie, 2014) and are most likely to have drug resistant TB with 90% of MDR-TB cases between 1997 and 2008, and 4 of 5 XDR-TB in this group (Minion 2013).

Figure 1-CA:Annual case ntiouifications and incidence rates by population in Canada: 2002-2012 (source: Public Health Agency of Canada [accessed 12-09-2014])

Other Canadian high risk groups follow similar profiles to those experienced elsewhere: People with HIV are at greater risk of TB, as are people who are homeless or who are vulnerable or marginalised in other ways (for example, those with mental illness, people who abuse substances, those living in poverty, and people with comorbidities linked with increased TB risk: Communicable Disease Policy Advisory Committee, 2012). These risk factors have generally only been identified in urban areas (Government of Saskatchewan, 2012; Khan, 2011).

Governance, legislation and accountability

In Canada there is a federal framework for action on the prevention and control of TB (Canadian Government 2014), which aims to reduce the national incidence of reported TB in Canada to 3.6 per 100,000 or less by 2015.   The framework has three "key areas of focus", intended to reduce the incidence and burden of TB within Aboriginal and foreign-born populations as follows.

1. Optimising and enhancing prevention and control through early detection and treatment of persons who have active TB disease, and the investigation of their contacts to improve surveillance.

2. Facilitating the identification and treatment of latent TB infection for those at high risk through early detection and treatment of individuals with latent TB infection who are at high risk of progression (for example those with HIV infection, smoking or diabetes).

3. Championing collaborative action to address the underlying risk factors for TB. In addition to above risk factors, other social determinants (for example poverty, overcrowded housing, poor ventilation, and homelessness) may increase the exposure or risk of progression from latent to active TB disease.

Other policies and strategies that sit outside this framework include using the technique of second-line drug susceptibility testing as standard (Minion, 2013).

Reporting active TB cases is mandated in all Canadian jurisdictions (Rea, 2013), and all provinces and territories have legislation requiring physicians, laboratories and other health officials to report cases of active TB disease to the provincial/territorial ministry/department of health (Pan-Canadian Public Health Network, 2012).

There is a range of legislation relevant to TB in Canada, mostly focusing on new entrants and high risk groups. At a federal level, the 'Immigration and Refugee Protection Act [2001]' allows for the inadmissibility on health grounds of a refugee if their condition is considered a danger to public health, The 'Indian[3] Act [1985]' allows provisions for compulsory hospitalisation and treatment for infectious disease in Aboriginals, additionally the council of a band (a group of selected people or the chief), can make additional bylaws to provide for the health of residents on their reserve and to prevent the spread of infectious diseases, Finally the 'Quarantine Act [2005]' allows for the screening, medical assessment, isolation and arrest without warrant of a traveller entering Canada by a quarantine officer if there are reasonable grounds to suspect that they have a communicable disease. The act includes provisions for court ordered assessment, medical examination, and treatment for preventing or controlling the spread of a communicable disease if there is considered a risk of significant harm to public health; and other reasonable means are not available to prevent or control the risk (Pan-Canadian Public Health Network, 2012). Each territory has capacity to pass local legislation, for example in Manitoba there is additional legislation to support immunisation (for example BCG), restriction of any activity or employment that could spread disease, requirements for organisations and employers to exclude a person, quarantine a premises or close a school, and apprehension of a person with TB if they fail to observe an order pursuant to legal appeals (Manitoba Government, 2006).

In Canada apart from a focus on pre-entry screening for immigrants little information was found on TB control models. There is an established an immigrant arrival surveillance programme, where new immigrants are "flagged" from their initial medical evaluation in country of origin, (this is reported to Canadian immigration authorities prior to immigration). Behind this is a worldwide network of physicians designated by Citizenship and Immigration Canada (CIC) who are responsible for medical evaluations of all immigrants/refugee applicants seeking residence in Canada. New permanent residents suspected of having LTBI at pre-immigration screening, are referred by the CIC to provincial health departments for medical surveillance, a process called post-landing surveillance.   Upon entry to Canada, immigrants flagged in this way for LTBI must give their written consent for medical surveillance (Richards et al, 2005).

In October 2011, the federal and provincial ministers of health, along with the British Columbia First National Health Council and the Vancouver First Nations Health Society signed the British Columbia Tripartite Framework Agreement on First Nations Health governance.   This was designed to ensure that BC First Nation peoples have a major role in the planning and management of health services for First Nation peoples, including TB services (Communicable Disease Policy Advisory Committee, 2012).

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[3] The term 'Indian' was previously used to refer to native Canadian populations, but has largely fallen out of use in recent years and is now considered pejorative. 'Aboriginal' is now used to refer to native Canadian populations, and includes people who are First Nation, Inuit and Metis.

Unlike many other low incidence countries, indigenous people continue to be a priority for TB control in Canada (Canadian Government, 2014). The group is well defined in Canada, which facilitates the targeting of interventions (Nguyen, 2003), but the status of indigenous people as "hard to reach" (Aspler, 2010), and the presence of a large existing pool of LTBI persons in indigenous settlements (Cook, 2006) make the identification and treatment of TB in these groups challenging. Further barriers to diagnosis and treatment in Aboriginals include crowded and poorly ventilated housing barriers to accessing health care (such as reliance on labs or hospitals that are primarily urban focussed in the south of the country); as well as cultural and historical barriers to early diagnosis and care; and fear of stigma (Nguyen et al, 2003; Government of Saskatchewan, 2012). To manage some of these issues mobile clinics and telecare are provided in remote northern settings away from urban centres; however, this approach (mobile clinics) is said to be unique to Saskatchewan (Government of Saskatchewan, 2012), outcome data for treatment completion or other outcomes from this approach was not presented.

Financing and cost of Healthcare and TB services in Canada

Medicare is the publicly funded universal health insurance system (Government of Canada, 2011) provided under the *Canada Health Act* (1984) and the health insurance legislation of the individual provinces and territories. Under the terms of this Act, all legal residents of Canada are entitled to receive "insured services" without co-payment. Approximately 70% of Canadian health expenditure comes from public sources, with the rest paid privately (both through private insurance, and through out-of-pocket payments.

Care and treatment for TB is funded through Medicare. In 2004, total TB-related costs in Canada were $74 million ($47,290 per active TB case), which breaks down as follows:

Research spending	$4.5 million (or 6% of the total)
Non-research-related federal spending	$16.3 million (22%)
Provincial/territorial spending	$53.1 million (72%)
Active TB treatment spending provincial/territorial expenditures)	$31 million or (59% of
Source: Menzies, 2008	

In 2012 the overall cost of TB to Canada was estimated to be $84.4 million a year (Government of Saskatchewan 2012, p.3), which would thus equate to Canadian $ 50,059 per case based on 2012 notifications to WHO (WHO, 2013), this equates to approx. $ 46087 US dollars. Costs for treating MDR-TB in Canada have been estimated at between $41,225 to $195,078 per case, not including the additional costs of screening, education, prevention, training, the lost productivity of the patient, or costs to families or communities (Government of Saskatchewan 2012,).

Staffing and settings related to TB control in Canada

In Canada, most TB patients are treated as outpatients, even at time of diagnosis which may lead to the inability of clinical staff to isolate re-activated cases among homeless persons (i.e. shelters) (Khan, 2011).

The identified literature did not provide any detail on the staffing of TB or generalised public health services in Canada.

Summary of the Canadian service Delivery Model

In Canada tuberculosis control is a combination of national action support specific elements combined with the local commissioning of TB services and programs at a provincial or territorial level.

Centralisation of service delivery, commissioning and associated finance

In Canada, there are a number of national elements to the service model including legislation, policy, laboratory services, surveillance collation and a centralised agency (the Public Health Agency of Canada - PHAC), however, the centralised agency is primarily focussed on co-ordination and support not the delivery of services. Service delivery and commissioning is devolved to provincial/territorial level and in some cases municipal governments encompassing both public health and health care services via hospitals, community health and primary care. These responsibilities include case finding, case management, contact tracing, training and education and establishing local policy and legislation. This includes developing, funding, delivering and evaluating a range of services including health promotion, treatment and care based on local population needs and may result in further de-centralisation of service delivery to a level below the provincial/territorial or municipal government. Whilst national standards for Tuberculosis are available (Canadian Tuberculosis Standard, 2013) as is information on best practice for local implementation (Pan-Canadian Public Health Network, 2012) decision making on implementation and prioritisation for commissioning is sub-national this is relatively similar to the framework within which TB services are commissioned and delivered in the UK.

Based on the available data in 2012 Canada was estimated to be spending in the region of $46,000 US dollars per notified case.

Legal powers

Canada have national legislation to support communicable disease control (including TB) specifically in relation to entry of refugees and migrants if there is a danger to public health (Refugee and Quarantine act) at Canadian Borders. This can include inadmissibility of refugees and immigrants suspected of communicable disease the powers to demand screening, medical assessment, isolation and arrest without warrant of a traveller entering Canada by a quarantine officer on reasonable grounds to suspect that the traveller has or might have a communicable disease, provision for court orders is also available.

Locally provisions for compulsory hospitalisation and treatment under the 'Indians Act' as well as the capacity for local byelaws are available on reserve; with each territory government also having powers to pass byelaws including immunisation, quarantine, exclusions and premise closure, in addition to the court orders available nationally.

Contact Tracing

Contact tracing is delivered in Canada, based on a single model using the recognised concentric circle/stone in the pond method where invitation to testing is based on a prioritisation exercise determined by level of contact and the subsequent rate identified in that circle compared with the background rate**.**

Contact Tracing and outbreak investigation are led and managed by public health authorities and include consideration of molecular genotyping, social network analysis and geographic information

systems in support of conventional epidemiological methods (Pan-Canadian Public health network, 2012)

Targeting High Risk Groups (Immigrant Population) – National and Local

Immigrants pre-entry screening (National model)

1. New immigrants "flagged" from initial medical evaluation in country of origin, which is reported to Canadian immigration authorities (pre-immigration).

2. New permanent residents suspected of LTBI at pre-immigration screening referred by Citizenship and Immigration Canada (*CIC: a worldwide network of designated physicians*) to provincial health departments for medical surveillance.

3. Upon entry to Canada, immigrants flagged for LTBI must sign written consent for medical surveillance

Immigrant port-entry surveillance (Provincial/Territorial decision making)

1. Post-landing surveillance administered by local providers in area of settlement

See Appendix 3 for a model depicting the post-entry surveillance process for following up individuals placed under medical surveillance for TB following entry to Canada

Montreal model

- Entrants declaring intended residence in Montreal with LTBI are referred to 'Montreal Chest Institute (MCI)'
  - o each person issued letter via regular mail,
  - o if persons fail to report to MCI they are issued two reminders
- In Montreal, post-landing TB surveillance has been integrated into the local TB control programme (a single centre), and is not delivered in the community by local practitioners.

Richards, (2005), suggest that decentralised programmes relying on diverse groups of community practitioners are likely to perform much worse than the centralised Montreal model. This model is discussed further in the effectiveness chapter

Targeting High Risk Groups (Indigenous Population)

The Strategic Community Risk Assessment and Planning for Enhanced TB Programme (SCRAP TB): is an initiative aimed at First Nations and Inuit reserve communities as part of the National TB Elimination Strategy in targeted community settings taking an outreach community development and partnership approach.

Treatment Completion

No details on specific programs to support treatment completion in Canada was available, the Pan-Canadian Public Health Network recommend that DOT is the minimum level of support for patients with risk factors for non-adherence, population groups with historically increased rates of treatment failure or relapse or with inadequate rates of treatment completion, defined as default rates of 5% or greater, Further more they recommend that all jurisdictions across Canada have capacity to provide DOT, however, in the identified literature there were no effectiveness or descriptive publications

discussing implementation of these programs.

Staffing

Based on the available literature there was no means of estimating the overall case to staff/clinician ratio in Canada.

Surveillance

TB surveillance is structured to require local public health authorities to report all TB cases to provincial or territorial TB programmes, who in turn submit reports of TB cases which meet case definition for national-level surveillance to the Canadian TB Reporting System (CTBRS), a system managed by the Public Health Agency of Canada (Greenaway, 2013).

Service performance and factors associated with reducing time taken to diagnosis, improving contact tracing and increasing treatment completion: additional data

Time taken to diagnosis

In Canada the Strategic Community Risk Assessment and Planning for Enhanced TB Programme (SCRAP TB) is an initiative aimed at First Nations and Inuit reserve communities as part of the National TB Elimination Strategy has a number of key areas of focus including: Finding and treating cases, Contact tracing and preventative therapy, Surveillance and screening, Health education, Research, BCG (First Nations and Inuit Health Branch, Health Canada, 2007)

Pilot studies have identified the following results:

Knowledge and awareness outcomes:
   • Increase in TB knowledge for all group members
   • Stronger ties with outside TB partners
   • Increased communication between health teams & Doctors "Thinking TB"
   • Increased awareness of TB program both inside and outside the community, including increased cooperation between programs

TB diagnosis and management outcomes:
   • Increased referrals to TB program (potentially reducing diagnostic delay)
   • Increased numbers on LTBI treatment

Data was not presented for any of these outcomes.

Other factors associated with improved outcomes for TB control in Canada:

There is a lack of general information in the identified literature on what aspects or factors of Canadian services have been associated with improved outcomes. One cited barrier to treatment is language difficulties for clinicians when treating foreign-born patients (Gardam, 2009).

Case study 4: Barcelona

TB notification rates and population patterns

Barcelona is the capital city of the autonomous community[4] of Catalonia and is Spain's 2nd largest city. It has a population of 1.6 million within the City, increasing to around 5 million in the metropolitan urban area that extends beyond the city limits. It is the sixth-most populous urban area in the European Union after Paris, London, Madrid, the Ruhr area and Milan. TB rates in Barcelona have varied significantly since the mid-eighties, peaking in the early nineties at 67 per 100,000 residents, reducing by 2010 to a 26 per 100,000 residents (Cayla & Orcau 2011; Borrell, 2009; Millet, 2009). TB rates have declined by approximately 10% annually from the early 1990's until 2000, after which the decline slowed to an average 3–4% per annum.

The peak in TB prevalence (Fig 1-BA) in the early 1990's has been attributed to its prevalence in HIV-infected injecting drug users (Cayla and Orcau, 2011). The slow in the decline has been attributed to a large increase in immigration, from TB-endemic countries (Marco, 2012).

Figure 1-BA – TB prevalence in Barcelona 1986 to 2010 in all age groups *(Cayla and Orcau, 2011)*
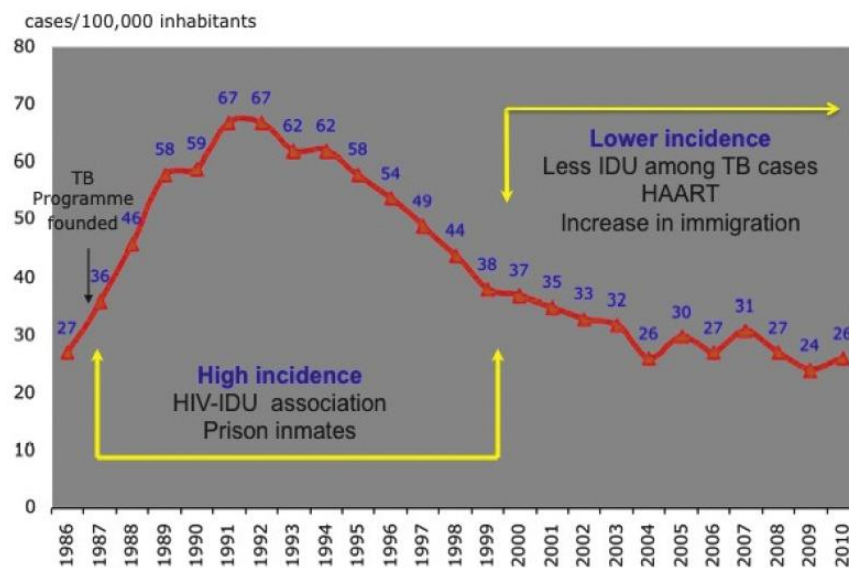
Over a similar period there has been a decline in the incidence of TB in children equating to an average reduction of 3.7% a year, although this decline is smaller than that seen in all age groups (see Fig2-BA below).

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[4] An **autonomous community** is a first-level political and administrative division of Spain created in accordance with the Spanish constitution of 1978, with the aim of guaranteeing the **autonomy** of the nationalities and regions that integrate the Spanish nation (http://en.wikipedia.org/wiki/Autonomous_communities_of_Spain [accessed 11-09-2014])

Figure 2-BA – TB prevalence in Barcelona 1986 to 2010 in children *(Nelson, 2010)*
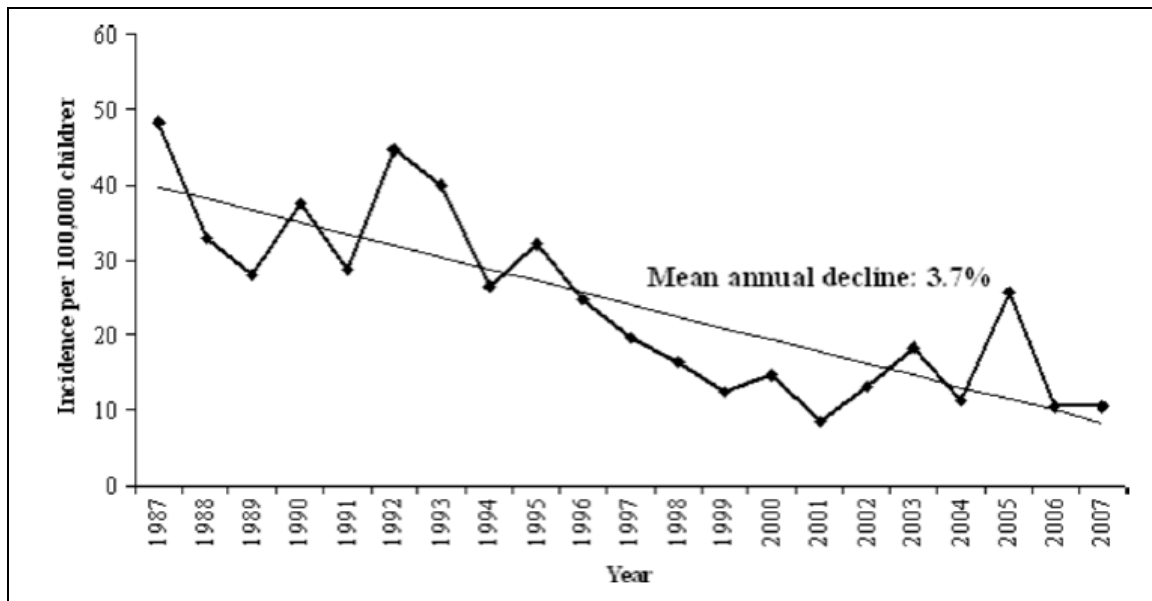
There is no data on MDR-TB in Barcelona, at a national level MDR-TB in Spain is 0.22% of new and 7.1% of re-treatment cases with a total burden of 37 cases in 2012 (WHO, 2013), this may indicate a relatively low burden of MDR-TB in Barcelona.

Being foreign born is currently the major risk factor for TB in Barcelona. From 1999 to 2010 more than three million immigrants arrived in Spain (Ospina, 2012), with the proportion of TB notifications in Barcelona from this group increasing from 5.6% in 1996 to 48.7% by 2009 - despite being only 20.7% of the total Barcelona population (Borrell, 2009; Marco, 2012). Immigrants tend to be younger than Spanish-born TB cases, and have higher drug-resistance rates, up to 82.4% develop the disease as a result of the reactivation of latent TB and only a small proportion (2.8%) were ill on arrival in Spain (Ospina, 2012; Borrell, 2009).

Recent statistics show that in 2012 8.9% of cases in Spain have HIV co-infection (WHO, 2013); no Barcelona specific statistics were available.

Spanish-born TB patients in Barcelona – in contrast to foreign born people with TB - were more likely to manifest the pulmonary forms of the disease; have diabetes; be over fifty years of age; and to make more use of illegal drugs and alcohol (Borrell, 2009). Alcohol misuers make up between 14.4% and 27.3% TB cases in Barcelona (Millet, 2011; Ospina, 2012). Intravenous drug use (IDU) is associated with increased risk of TB, with 5.2% of all culture confirmed TB cases between 1995-97 in Barcelona being identified in people classified as users; during a 7 year follow-up this group were also more likely to have TB reoccurrence – at a rate 3.6 times that of non-IDU TB cases (Millet, 2009).

In Barcelona 40.3% of prisoners in one research cohort were found to have LTBI, which was attributed with multiple – and often overlapping – risk factors being present; for example prisoners with LTBI were significantly more likely to have been born in Eastern Europe (OR 4.3, 95%CI 1.4–12.8), North Africa (OR 2.2, 95%CI 1.01–4.7), sub-Saharan Africa (OR 7.6,

95%CI 1.3–44), or Latin America (OR 3.8, 95%CI 1.5–9.3) with 7.5% of immigrants also indicating prior IDU and 32.1% previous incarceration (Marco, 2012).

In Barcelona inner city residents have an incidence rate 3 or 4 times greater than the city average (the city average has a rate ratio of 1.6 compared to the national picture). This has been attributed to overlaps with other sub-populations at higher risk for example, drug users and homeless people (Dominkovics, 2011; Ospina, 2012; Borrell, 2009; Millet, 2009). Residence in inner city Barcelona is also associated with higher rates of unsuccessful TB treatment (Nelson, 2010), and higher rates of TB reoccurrence (Millet, 2013), this again may have overlaps with populations at increased risk of reoccurrence such as IDU.

Governance, legislation and accountability

The National Plan for the Prevention and Control of Tuberculosis in Spain (Tuberculosis Working Group Incorporating Scientific Societies, Autonomous Communities, and the Ministry of Health and Consumer Affairs, 2009) sets out a basic f criteria for all TB control programs in Spain in each of the following areas:

1. Early detection and diagnosis; (Reduce delay to < 1 month, active case finding raise awareness to maintain clinical suspicion, develop and implement isolation protocols)
2. Treatment; (Free treatment and improve treatment completion rates)
3. Surveillance; (Establishment of a national register (including microbiological information on drug resistance), at present surveillance is only regulated at the level of each autonomous community)
4. Contact investigations (Ensuring a contact investigation is carried out for every case, ensuring all notifications are recorded in the national register)

This plan provides a basic set of criteria that should be met by all current and future TB control programs in Spain ((Tuberculosis Working Group Incorporating Scientific Societies, Autonomous Communities, and the Ministry of Health and Consumer Affairs, 2009). The responsibility for delivering these programs is devolved to each autonomous community.

TB is a mandatory notification disease in Spain (Ospina, 2012) and surveillance is regulated by Real Decreto 2210/1995, an act initially drafted by Red Nacional de Vigilancia Epidemiológica (RENAVE) and subsequently developed in the Sistema de Enfermedades de Declaración Obligatoria (EDO)p protocols and the specific legislation of each autonomous community (National TB Plan, 2009).

Spain has no legal compulsory measures to support TB control, this lack of legislative structure has been suggested to create an approach reliant on social and individual interests and social consensus instead of enforcement (Coker et al, 2007).

Financing and cost of Healthcare and TB services in Barcelona

The Spanish National Health System (*Sistema Nacional de Salud,* or *SNS*) is the collective name for public health services in Spain.   Management of these services is in a transition and is being progressively transferred to Spain's distinct autonomous communities of Spain, although some continue to be administered via the central Spanish government, and others are administered through cooperation between some or all of the autonomous communities.

Financing of the Spanish health system is the responsibility of the autonomous communities. TB treatment is free to all at point of care in Spain. Spain did not report their overall financial contribution to TB WHO for their recent country profiles (WHO, 2013).

Details of specific funding and commissioning arrangements in Barcelona were not identified in the evidence identified for this review.

Staffing and settings related to TB control in Barcelona

The structure of TB services and the interaction of different elements are depicted below in Fig 3-BA. In large cities such as Barcelona, maintaining the TB program in a Public Health structure that also performs surveillance and control of other notifiable diseases and epidemic outbreaks is considered crucial in achieving long-term resource and management expertise (Cayla and Orcau, 2011).

The link between surveillance, control, operational research, and regular contact between all health workers involved in TB control including clinicians, microbiologists, epidemiologists, and social service managers underpins the service, this multi-disciplinary method is a core decision making approach to deployment of staff such as community health workers (CHW's)(Cayla and Orcau, 2011).

The program features weekly meetings, ongoing contact of the program coordinator with each CHW, and monthly meetings with DOT experts.   There is also ongoing validation of contact tracing information gathered by the CHWs (Ospina, 2012) via surveillance activities such as genotyping

Hospitals
All large hospitals in the city have clinical units that carry out TB diagnosis, treatment, patient monitoring, and contact tracing among household contacts (Cayla and Orcau, 2011), staff in these units also liaise with public health nursing, and oversee DOT provision.

In the last decade TB services were reorganised in response to large scale immigration and to concentrate the contact tracing (outside household contact) in five TB Units. The city is divided into four health areas and in each area there is an integrated TB working committee which is representative of all health workers involved in TB control.

Staff
The specific role and function the TB case manager nurse in Barcelona's clinical units is the key professional in those facilities and the main link with public health nursing who are the hub of the local network (having relationships with each separate service provider), each team also includes a physician.

The primary role of Public Health nurses (PHN) is to carry out follow-up with patients and perform contact tracing but it needs to be noted that they (along with CHW) are also in charge of other communicable diseases – TB represents about 40% of the total workload (Cayla and Orcau, 2011).In terms of staff ratios, there are 12 PHN for about 500 cases a year (ratio 1:35-45), along with 6 CHW. There is close coordination with the Unit Clinic case manager nurse to allow for proper management of cases (Cayla and Orcau, 2011)

The CHW resourcing levels are based on immigrant TB patient characteristics (i.e. the number of cases from each country of origin) (Cayla and Orcau, 2011). Ospina, (2012) give some more detailed breakdowns of the number of hours taken by five different CHWs to work with their respective communities on cases:

- Asia [Pakistan, India, Bangladesh] – 12 hours for 112 cases
- North Africa [Morocco, Algeria, Tunisia and Arab countries] – 20 hours for 70 cases
- Sub-Saharan Africa – 12 hours for 32 cases
- China – 6 hours for 22 cases
- Latin America – 20 hours for 152 cases (Ospina, 2012)

Summary of the Barcelona service delivery model

The Barcelona model involves centralised coordination, clear relationships between key organisations (e.g. prisons, clinical units) and investment in a community based model of work which targets identified high risk groups. Specialist public health nurses are the hub of the network, as shown below.

Centralisation of service delivery, commissioning and finance

TB services are governed throughout Spain by the Public Health Service in conjunction with local primary care, the notifiable person and lead for contact tracing comes from the public health system. Public health professionals work with the wider health system which is a combination of clinical, public health, social care, criminal justice and voluntary/community elements. The system depicted in the figure below (source: Cayla and Orcau 2011) attempts to represent the city-wide control program and the relationships between different providers . .

Figure 3-BA – Barcelona TB programme – organisational aspects *(from: Cayla and Orcau, 2011)*
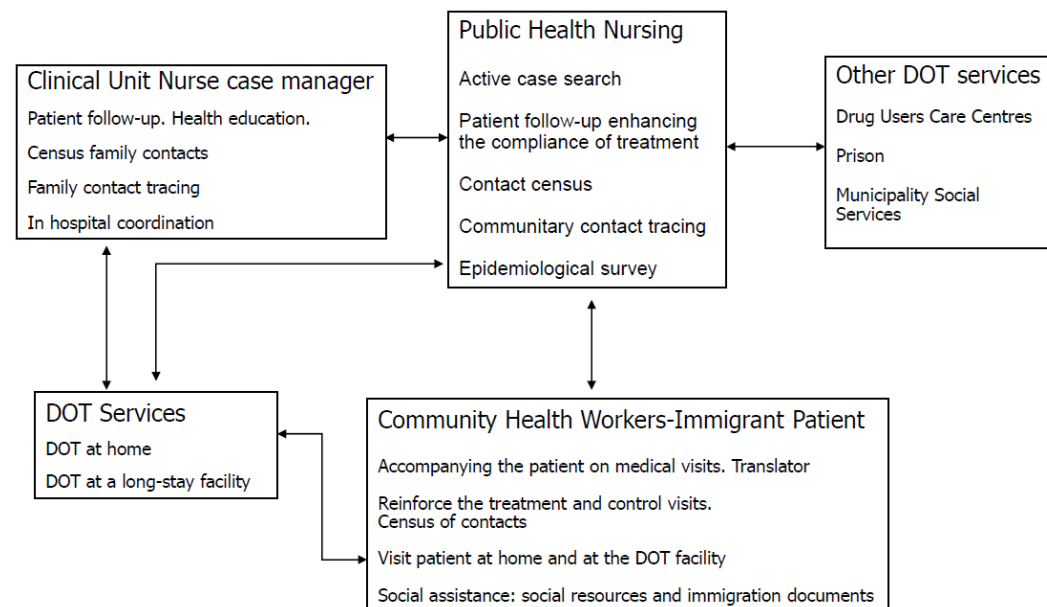
There was no data on Barcelona or the National finances related to TB in the identified literature.

Legal powers

Spain reported they had no legislative public health powers to control TB (Coker et al, 2007)

Contact Tracing

Contact investigations are the responsibility of and carried out by public health services, the process for contact investigations is described in the national plan which states that they should use the concentric circle method and invite contacts for testing based on a prioritisation exercise:

- **High priority**: close contacts / persons in prolonged contact with index cases (>6 hours a day); children under 5 years of age; and immunocompromised contacts.

- **Medium priority**: persons in daily contact with the index case, but for less than 6 hours a day.

- **Low priority**: casual contacts (not daily)

Targeting high risk population groups and active case finding

At the peak of resurgence in the early 1990's the focus for TB control was on targeting injecting drug users and the delivery of treatment including DOT in methadone clinics. However, as the profile of TB cases has changed, targeting of high risk groups has adapted and currently focusses immigrant groups from TB endemic countries. In particular there is targeted recruitment, engagement and training community health care workers (CHWs) who come from social and cultural environments similar to the high risk groups. They offer community- based educational support in which patients are conceptualised as actors controlling TB transmission. Their specific duties include:

- follow-up of cases/contacts

- house visits

- providing counselling and information on treatments

- providing health information (public and private educational sessions),

- community mobilisation (assisting obtaining residence permits/housing/health-care application/food bank (Ospina, 2012).

Supporting treatment completion

DOT is a programme component for patients with predictors of poor adherence (homeless, IDU, prisoners), DOT is incorporated into methadone programs, which includes formal connection of these programmes with the work of Community Health Workers (CHWs) and Public Health Nurses (PHNs) (Cayla & Orcau, 2011).

Surveillance and case registration

Barcelona has had a long term policy of TB case registration, since 1987, the city's TB Prevention and Control Programme has undertaken the registration of almost every TB case among local residents, including prison inmates (Marco, 2012). This involves the administration of epidemiological surveys by public health nurses on all detected cases (Millet, 2011).

Surveillance particularly focuses on identifying groups at high risk to support program targeting. The local Epidemiology Service collects data on TB cases reported by physicians via the aforementioned epidemiological questionnaires, and also undertakes active surveillance for undeclared cases. Sources for the latter include microbiological laboratories, hospital discharges, the city mortality registry, reports from social service agencies, with HIV and TB registers being linked and monitored accordingly (Cayla & Orcau, 2011; Millet, 2011; Millet, 2013). This focus and prioritisation of surveillance pre-dates the National Plan and priorities.

Service performance and factors associated with reducing time taken to diagnosis,   improving contact tracing and increasing treatment completion: additional data

Formal research and evaluation on aspects or factors of the local TB service that have contributed to improved outcomes is limited in our identified literature, however, a small number of authors do suggest factors they consider to have impacted positively on TB incidence rates and service improvement in Barcelona. Evidence for the effectiveness of service delivery models and approaches is discussed in the effectiveness chapter.

Use of DOT in methadone clinics to support Treatment Completion
DOT was introduced as a key component of TB treatment in Barcelona in 1987 for patients with predictors of poor adherence in such as homeless, IDU, prisoners. The inclusion of DOT in methadone programs and tight coordination between the TB programs in Barcelona prisons have been identified as important contributory factors in achieving a high level of treatment completion among IDU (Marco, 1998 – cited in Cayla and Orcau, 2011), unfortunately rates were not reported. TB incidence decreased following the introduction of DOT to support treatment completion in methadone clinics alongside anti-retroviral treatments in IDU-HIV patients, however the increase in rates of immigration from 2000 onwards has coincided with attenuation in the decline, and the profile for targeted TB programmes has shifted away from injecting drug users to immigrants from TB endemic countries (Cayla and Orcau, 2011).

Community Health Workers to support Treatment Completion
In 2003, in response to changing epidemiological profile of TB and to target improvements in the follow-up of the immigrant TB patients and their contacts, the Barcelona control programme began an intervention strategy using community health workers (CHWs). CHWs are members of the target TB sub-population groups who are integrated into a healthcare team. They are trained in TB and psychosocial skills, and their role is focused on connecting immigrant patients to Barcelona's healthcare system. They work in coordination with public health nurses and health-care personnel in activities aimed at improving treatment adherence and contact tracing, and at preventing and controlling outbreaks control in domestic, occupational and leisure settings. CHWs duties have involved educational sessions in private homes and associations for immigrants to reach the target population in their daily settings outside of working hours. Other activities have included "mediation", translation and "cultural interpretation" to attempt to improve the relationship between patients and health care personnel. They also aim to help patients deal with TB-related stigma, and social and occupational discrimination, as well as providing referral to appropriate support services if the domestic, social, and labour situation of patients and their contacts, indicate a need (this is to aid both adherence and contact tracing).

Cayla & Orcau (2011) suggest that CHWs have contributed to a positive improvement in TB control programmes in Barcelona, as part of broader information, education, communication (IEC) approach. The impact of CHWs has been formally assessed in relation to contact tracing (see effectiveness review chapter), however, outcomes in relation to treatment completion were not available in the identified in the literature.

Contact Tracing

New TB cases are notified to the Barcelona TB Control Program. A multi-disciplinary team evaluates the need for community health worker intervention, depending on the specific group of problems presented by an individual and other attributes such as their birthplace, language, and culture.   Each case is assigned to a PHN (public health nurse) and a community health worker (CHW) and contact tracing is initiated (Ospina, 2012), see effectiveness review chapter (chapter 4) for formal evaluation of the outcomes of the programme.

Other outcomes/activities/interventions:

Technology

A recent proof of concept study provides an initial assessment of one proposed improvement to planning and commissioning procedures for TB in Barcelona: The use of geospatial planning tools to create spatial density maps of TB incidence, in order to better understand where TB services need to be provided (Dominkovics, 2011). This method can help to detect high risk geographical areas, allowing improved targeting of services as it provides both spatial and temporal information supporting monitoring of the dispersion of TB cases, it can be used to identify places where high concentrations of new urban TB cases and case clusters are emerging, supporting service changes for example geographic targeting of outreach and active case finding activities.

Co-location of services

The co-location of TB treatment services including provision of DOT in some methadone clinics has been proposed as a significant factor in achieving high treatment completion rates in the city (Cayla & Orcau, 2011).

Case study 5: The Netherlands

TB notification rates and population patterns

In 1995, the TB prevalence rate in the Netherlands was 10.5 per 100,000, and has subsequently fallen over the last two decades to 5.7 per 100,000 in 2012 (ECDC, 2014). Cases of MDR TB form only 1.6% of new and 3.2% of re-treatment cases with an absolute total of 11 cases in 2012 (WHO, 2013), XDR-TB cases are nil (ECDC, 2014). Incidence varies between areas, urban areas Rotterdam for example had an incidence rate of 18.9 per 100,000 in 2009 and Amsterdam had an incidence rate of 21.3 per 100,000 in 2009.

Foreign-born people who migrate into the Netherlands are at increased risk for TB and comprise 73.2% of all cases of TB in the Netherlands (ECDC, 2014). Migrants with TB tend to be younger than Dutch-born people who are newly diagnosed cases; 39.5 year versus, 45.6 years of age respectively, (ECDC, 2014).

Recent statistics show that in 2012 6.9% of TB cases in the Netherlands have HIV co-infection (WHO, 2013). In Rotterdam in particular drug users and homeless people have been identified as high risk group (van Hest, 2008). Prisoners in the Netherlands are also at an elevated risk of TB, with an incidence rate of 74.3 per 100,000, which is 13 times the national average (ECDC 2014).

Governance, legislation and accountability

Under public health laws in the Netherlands, Local Authorities via the Municipal Health Service: GGD-Nederland (MHS: GGD-NL) are responsible for communicable disease including TB, and have responsibility for contact investigations, outbreak investigations, screening and supporting treatment - for example via DOT(de Vries and van Hest, 2006).

National population screening for TB in identified high risk groups (i.e. homeless people, prisoners, and drug users) is licensed according to Dutch law. The mobile x-ray unit (MXU) screening service provided by MHS: GGD-NL has recently been granted a renewed population screening license (Health Council of the Netherlands, 2012).

The Netherlands has two legal mechanisms to support TB control. These are: compulsory screening, which involves the application for a screening order by public health authorities that can be issued by public health agencies, governmental bodies and immigration offices with no need for court order (Coker et al, 2007); and provision in legislation of the capacity to sanction compulsory medical examination, which does not have to be a court ordered (Coker et al, 2007). The approach taken by the Netherlands can be considered an example of a 'preventive' model focusing on screening, medical examination and vaccination rather than compulsory treatment or detention. There must be suspicion of infectious disease or concern there is a threat to public health to allow issue of an order, and there is a right to appeal an examination codified in the Netherlands (Coker et al, 2007).

Aspects of immigration control may also impact on TB – for example, permanent residence permits are only issued if TB screening is performed a set time after arrival, leading to a high compliance rate (80%) as failure to attend could result the residence permit being revoked (Coker, 2006).

Financing and costs of Healthcare and TB services in the Netherlands

Healthcare in the Netherlands is financed by a dual system. Long-term treatments (27% of the total) are met by state-controlled mandatory insurance, short-term medical treatment (41% of the total) is covered by a system of obligatory private health insurance companies, with the regulation specifying affordability and what treatments are provided. The remainder of healthcare expenditure comes from taxes (14%), out of pocket payments (9%), additional optional health insurance packages (4%) and other sources (4%).

TB treatment is not subject to the above financing structures and is free to all at point of care, except that charges are made for services that are directly related to testing on behalf of employers/checking travellers going to other countries. Based on details provided to the WHO the Netherlands spent $43 million on TB in 2012, which equates to $44,885 per case according to recently reported notification rates (WHO, 2013).

In the Netherlands Municipal Health Services (MHS) are funded by the public sector at the level of municipalities and cover the cost of GGD-NL who is responsible for delivery of Public Health services including TB in the Netherlands (Boer & de Vries, 2011). The cost of screening risk groups by other organisations is covered by service level agreements with GGD-NL contracting relevant bodies. The need to screen immigrants arises from the Aliens Act; the Public Health Act assigns the responsibility to the municipalities, who bear the cost, as requiring payment is anticipated to impact negatively on a co-operation.

LTBI testing and treatment is also not restricted to people with medical insurance, the cost of treating uninsured tuberculosis patients is generally met by the municipalities on the basis of the Public Health Act or the budget of the 'Illegal Immigrants Financial Support Programme' in the case of undocumented migrants, otherwise insurers pay for treatment.

There was no evidence available detailing specific cost of the MHS across the Netherlands, or the way that the overall financial information for TB reported to WHO in 2013 is allocated to different system components.

Staffing and settings related to TB control in the Netherlands

Community based care

The Netherlands is covered by a network of public health TB services, which includes 27 (FTE) specialist TB doctors (Boer & de Vries, 2011) and 65 specialist TB nurses (Lambregts-van Weezenbeek, 2003). Based on the case notifications reported by ECDC (2014), that equates to 1 TB nurse specialist per ~18 notifications, and 1 specialist TB doctor per ~33 notifications (based on 2012 notification rates).

Medical technical assistants (no numbers provided) are an additional resource in MHS:GGD-NL offices they are involved in delivering activities such as vaccination, screening and contact tracing.

The MHS: GGD-NL has 37 local front offices within 28 municipal health services (Boer & de Vries, 2011). These are the settings where regular TB clinics are held for vaccination and diagnosis additionally treatment is administered here. For example the MHS in Amsterdam

has clinical facilities for consultation, patient supervision and provides regular screening for the following groups for TB: Immigrants, substance misusers, sailors, TB case contacts (*identified by MHS – CI investigations*), any patient referred by GPs, travellers to other countries (*when req'd*), healthcare workers, they are delivered via regular scheduled clinics at pre-specified times (GGD-Amsterdam, 2014)

With regard to community settings outside the MHS: GGD-NL offices a periodic radiological screening programme was re-introduced in May 2002 (due to RFLP findings to identify transmissions and new cases) in Rotterdam, using a mobile digital X-ray unit (MXU). The target of this unit is the "hard to reach" in day and night shelters and hostels, methadone-dispensing centres and safe drug consumption rooms, and the street prostitution zone in Rotterdam. It is not clear whether this approach is used in other cities in the Netherlands, however, regular clinics as described above for TB case finding are available via the MHS across the national network.

Hospital settings

Clinical care in the hospital sector is primarily delivered by pulmonologists it is recommended in the national TB plan that these clinicians make regional arrangements regarding the clinical treatment of tuberculosis patients, leaving direct supervision (for example of DOT) to the municipal health services if practicable or ensuring there is support from MHS:GGD-NL for supervision (Boer & de Vries, 2011)

In these settings (hospitals/sanatoria), the consultants provide daily telephone expert advice service to TB professionals and medical specialists in the field. The hospitals concentrate on in-patient and clinical care, while the public health TB clinics work through a network of local health and social care agencies to provide preventive treatment, contact tracing, out-patient care and DOT, as well as active case finding among vulnerable populations.(deVries and van Hest, 2006; de Vries et al, 2007)

In the laboratory sector, there are 20-30 centres undertaking various types of mycobacterial tests across the Netherlands. (Boer & de Vries, 2011).

Summary of the Netherlands Service Delivery Model

The Netherlands model focuses on collaboration between clinical, laboratory and public health personnel, at the local, regional and national levels, combined with vertical links between the levels. It is designed to be complementary in its component parts: the clinic for patients with complex clinical conditions the public health system for individuals with social problems and their contacts. (Boer & de Vries, 2011).

Centralisation of service delivery, commissioning and finance

IN the MHS:GGD-NL offices TB doctors, specialist nurses are medical assistants work side by side with TB clinics functioning as a "one-stop-TB-shops" for all basic diagnostic and treatment facilities (Hayward et al, 2010). In particular the community based MHS:GGD-NL offices target underserved groups and this model has been identified as particularly valuable to these socially excluded groups who frequently require enhanced case management and DOT to prevent loss to follow-up (Hayward et al, 2010). This service is commissioned locally to a national model including other communicable disease topics at a community level, they work hand in hand with the secondary care sector.

Based on the available data in 2012 the Netherlands was estimated to be spending in the region of

$44,000 US dollars per notified case.

Legal powers

In the Netherlands legal compulsory measures include screening, which involves the application for a screening order by public health authorities that can be issued by public health agencies, governmental bodies and immigration offices without need for court order and the legal capacity to sanction compulsory medical examination, which again does not have to be a court ordered (Coker et al, 2007).

Contact Tracing

MHS:GGD-NL are responsible for TB control (contact investigations) across the Netherlands via a network of regional offices with specialist staff. Contact investigations are performed by the local Municipal Health Services (MHS) branch, according to the ''stone in the pond principle''.   Contacts with signs and symptoms of active TB or with suspected TB are referred for follow-up at the local MHS office. Follow-up consultations involves clinical examination, a CXR, sputum collection, possible referral for further diagnostic evaluation, and mycobacterial culturing followed by DNA fingerprinting at the National Institute for Public Health and the Environment (Borgen et al, 2008).

If the observed prevalence of infection is markedly above the expected value, the investigation is extended to the next circle (less direct contacts) until the prevalence of infection in the subsequent circle is not above that expected according to age-specific background prevalence (Styblo et al, 1997 cited in Borgen et al, 2008). Medical assistants as well as nurses have contact tracing responsibilities.

Targeting high risk groups, active case finding and reducing diagnostic delay

There has been a focus on at-risk groups (drug users, homeless people, prisoners, undocumented migrants) for both diagnosis and treatment support. Specific screening programs for high risk groups and a target of two x-rays per annum for homeless people are examples (de Vries et al, 2007). Technologies, such as MXUs, facilitate appropriate and efficient outreach approaches to TB control among difficult-to-reach groups (de Vries, 2014).

There is also a special targeting of asylum seekers and refugees, based on local epidemiological data about the incidence of tuberculosis in these groups.   Even in situations where screening is not compulsory, individuals are still invited to attend screening via letter.   All immigrants are screened, whether or not they are symptomatic (Coker, 2006)

Supporting treatment completion and DOT

MHS:GGD-NL are responsible for TB control (in particular supporting treatment completion in socially complex cases in the community) across the Netherlands via their regional office and specialist staff.

In particular targeted work with cases who are identified as having a high chance of treatment interruption or loss to follow-up using directly observed therapy by trained staff in particular nurses. That is why (in 2004 for example) coverage levels of DOT in key groups increased considerably, with 71% of drug users, 59% of homeless persons, 55% of prisoners and 47% of immigrants of undocumented immigrant status receiving DOT (Hayward et al, 2010).

Staffing

Based on the available literature it was estimated there was a ratio of 1:18 cases to specialist TB nurses and 1:33 cases to specialist TB doctors in the Netherlands using 2012 notification rates.

Surveillance

Knowledge of individual fingerprints (which has been a long term aspect of TB control in the Netherlands) and clusters of TB patients are considered indispensable for underpinning proposals for change of local TB control strategies and convincing local authorities of the rationale for service continuation (de Vries, 2014), the surveillance system is administered at a national level.

> **Partnerships between secondary care and community services**
>
> Hospital based services and public health TB clinics in the community work closely together. Hospitals focus on inpatient and clinical care, public health TB clinics (the MHS:GGD-NL offices) focus on prevention, contact tracing, out-patient care, DOT and active case finding (Hayward et al, 2010). These services are supported by two former TB sanatoria, providing tertiary in-patient care for patients with complex medical or psycho-social needs (deVries and van Hest, 2006; de Vries et al, 2007; Boer & de Vries 2011). For example the treatment of MDR/XDR tuberculosis patients should take place under the supervision of one of the two tuberculosis centres (sanatoria), it is expected that almost all such patients will receive clinical treatment in one of these centres for a time (Boer & de Vries 2011).

Service performance and factors associated with reducing time taken to diagnosis, improving contact tracing and increasing treatment completion: additional data

Time taken to diagnosis

The mobile x-ray unit MXU screening program is an outreach model targeting high risk groups in places that they may congregate for example homeless shelters and substance misuse treatment centres in the Netherlands. It focusses on active case finding and regular re-screening to improve the speed of diagnosis and has a target of two chest x-rays per person per annum. The flexibility offered by the MXU (multiple sites, different days/times) has been highlighted as of particular importance when targeting homeless people. Another advantage is that it allows active case finding to take place with no need for referral, reducing potential risk of loss to follow-up (van Hest, 2008; de Vries, 2006). In 2000, the contribution of active case finding to overall case finding was 23%, with 14% from active case finding initiatives for example via MXU in high risk groups.

Contact Tracing

De Vries & Van Hest (2006) report an observational qualitative study which assessed contact investigations undertaken by specialist public health nurses in the Netherlands. The study highlighted two key issues that were impacting on contacting testing: Two factors were identified as key to successful implementation:

1. Nurses were inappropriately testing contacts who based on the stone in the pond principle were in an outer circle (or level) with regard to identification of the contacts who needed investigation (i.e. close (1st) vs casual (2nd) vs community (3rd)), for example before a decision to upscale the investigation to casual contacts if these casual contacts presented, due to being 'worried' they were tested. The authors suggested this was evidence that individual health and not population health principles were driving testing decisions.

2. Additionally whilst children were always prioritised for testing (due to their higher risk) because HIV status was not assessed when determining contact status (i.e. close vs. casual vs. community) but only at the point of testing then some immunocompromised individuals may not have been tested despite being a group who should be automatically irrespective of their contact level.

The study recommends that increasing staff knowledge about the dynamics of transmission and the underlying prevalence of disease within different sub-communities is vital for helping them to undertake appropriate contact investigations, and enabling effective prioritisation of diagnostic testing.

A retrospective evaluation of a large scale contact investigation at a supermarket following TB diagnosis in an employee TB using genotyping identified that improved selectiveness of contacts for testing (*The number of customers screened in order to find one case of recent infection was 114, varying from 43 for customers who visited the supermarket twice per week or more, to 4,148 for customers who visited less than once per month*) using better prioritisation of contacts in a systematic way was estimated to be able to halve the numbers needed to test to find one case new case of TB. In total 1,293 customers were investigated by TST, analysis identified that 56-58% of the detected TB cases were due to remote infection and, unlikely to be related to exposure in the supermarket. Further it was recommended that maintaining a greater clinical suspicion for TB for example via awareness raising campaigns among general practitioners and medical specialists might have led to earlier diagnosis and treatment of recent TB cases and could have further removed the need for such a large scale contact investigation considering the investigation cost an estimated EURO 500,000 the financial implications are clear (Borgen et al, 2008).

Other factors associated with improved outcomes for TB control in the Netherlands

Technology
In the Netherlands, a Universal Mobile Telecommunications System, which provides wireless connection between the mobile TB service and the local computerised client information system has been in use since 2005. The aim of the system was to use the technology to allow the checking of personal data on participants at the point of service delivery to produce more accurate real-time assessment and a reduction in clients being lost to follow up Van- Hest, (2008). This study found that using the technology in this way allowed for improved assessment of the reach and impact of the MXU screening program. The MXU programme reached about two-third of the estimated target population at least once annually in 2008. The intended coverage (at least two chest X-rays per person per year) was about 23%, assessment of which was supported by use of UMTS across multiple sites (van Hest 2008).

Co-location of services
In a modelling study to estimate MXU coverage it was identifies that the work mobile TB screening programmes is assisted by the fact that the unit allows services to be delivered at a location where two other major needs of the target population (methadone and shelter) are also located. The use of an 'opt out' strategy and "strong" persuasion by the staff of the social and medical services to participate was also said to improve involvement preventing a negative response (van Hest, 2008). Incentives, such as chocolate bars, were provided although a positive response for testing attendance was not attributed to them (van Hest, 2008).

Incentives
Incentives such as public transport tickets, priority accommodation in shelters, voluntary admission to specialized TB hospitals, and assistance applying for temporary residence

permits have been identified as having a positive impact on attendance for testing in high risk groups such as homeless people and drug misusers (de Vries and van-Hest, 2006). It could be surmised that priority accommodation and support in residence permit applications is a better support mechanism with greater value to the recipient compared to chocolate noted above.

Case studies: Summary

The UK case study was developed to enable comparisons of services, service delivery structures, organisation and where possible outcomes with other case study areas.

The non UK case studies were discussed with members of the GDG and selected to provide examples of different approaches to the organisation of TB services, with the aim, where applicable, of drawing comparisons with the UK approach. Data on relevant outcomes has been collated and presented where available. Both New York City (NYC) and Barcelona (BA) were selected to offer evidence on the organisation of services in metropolitan cities where populations have often multiple and over-lapping risk factors for TB – the pan city approaches described may be applicable to London and other large cities such as Manchester or Birmingham. The Netherlands and Canada were selected to provide information and evidence on whole-country approaches to TB control, where both urban and rural issues are relevant to service planning and delivery. Canada in particular has dispersed population profiles across the country, but is able to maintain low national incidence rates.

Each case study also featured epidemiological characteristics comparable to aspects of the UK profile, for example higher rates in immigrant populations from high incidence countries and in population groups such as homeless people, people living with HIV, and people who misuse substances.

Overall, the case study profiles show that all of the included areas (UK and non-UK) have similar high risk population groups including foreign born people, people living with HIV, people who misuse substances, homeless people and prisoners (with the addition of the indigenous population in Canada), and broadly similar priorities and policy direction for example active case finding, targeting high risk groups, surveillance (including strain typing), improving treatment completion including enhanced case management and DOT, although the targeting and accountability for each element may have differed.

The table below sets out a comparison of commissioning footprint, finance, staffing ratios and outreach approach for the case study areas.

	UK	**NYC**	**Barcelona**	**Netherlands**	**Canada**
Commissioning Footprint	Local	City wide	City wide	National[5]	Regional
Finance per notified case (US $)	12,000	24,000	N/A	44,000	46,000
Staff[6]:case ratio	N/A	1:12	1:35-45	1:18	N/A
Mobile Outreach	London	NYC	N/A	Rotterdam	Saskatchewan

N/A = not available

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[5] This relates to both community (MHS:GGD-NL) and hospital based services, although municipal health services are also likely include some local decision making to focus the service on local need.
[6] Nurses or those who deliver contact tracing, and support treatment completion inc.DOT as a minimum, and may also deliver case management feedback at cohort review meetings.

The findings from the case studies are summarised in the summary statements below.

Summary Statement 1: Service delivery and commissioning

In the UK, commissioning falls to the NHS devolved across 200 area-based clinical commissioning groups (CCGs) working in partnership with Public Health England and local government to develop and deliver TB services. Public Health England provide some national-level support (including surveillance and emergency response to outbreaks), but decisions about how services such as outreach programmes, nursing and DOT provision are commissioned rest at a local level with CCGs. This means that different areas, even neighbouring ones, or areas with similar profiles and incidence rates, may take very different approaches to service organisation and delivery.

The non-UK case studies organise the provision and delivery of TB services in different ways: New York City, Barcelona and the Netherlands all take a centralised approach, and although the lines of accountability may differ by place a centralised approach appears to help ensure clear responsibility for different elements of the service. In NYC, one body (the BTBC) is responsible for the whole system (NYC-DOHMH, 2013). In Barcelona the system is led by the Public Health Service with Public Health Nurses acting as the hub of the system supported by community health workers in high risk community settings and clinical unit nurse managers in the hospital sector (Cayla and Orcau, 2011). Similarly in the Netherlands MHS:GGD-NL specialist doctors, public health nurses and medical assistants have responsibility for providing diagnosis and treatment in the community in particular in those with complex social needs, whilst hospitals provide treatment for more clinically complex cases such as MDR-TB. The Canadian approach is perhaps more similar to the UK, with a mixture of national support and guidance from the national Public Health Agency with more regional decision making (territory or province) on how services are delivered. This appears to result in variation in service delivery, for example mobile clinics in Saskatchewan target a high risk indigenous population, but other areas with high risk groups do not provide this service (Government of Saskatchewan, 2012).

Summary Statement 2: Finance

Financial input appears to differ markedly with over $40,000 US dollars per notified case committed to TB in the Netherlands and Canada, $24,000 per case in NYC based on 2012 data to around $12,000 per case in London based on 2009 data, we were unable to identify a national picture for TB funding in the UK or funding data for Barcelona (WHO 'country profiles', 2013; Hayward et al, 2010; Menzies et al, 2008).

Summary Statement 3: Legislation

There are a wide range of legislative mechanisms and support for TB prevention and control in the case study areas, including pre-entry screening for immigrants and court ordered detention and treatment in NYC and Canada, and the recent launch of a pre-entry system (PHE, 2014d) and the power to detain and isolate but not treat non-compliant patients in the UK (Ohkado, 2005). The Netherlands take a preventative rather than enforcement approach with sanctions for screening immigrants and compulsory medical examination, but no detainment or enforced treatment, whilst Barcelona had no legislative control measures (Coker et al, 2007, Paolo, 2004; NYC-DOHMH, 2013).

Summary Statement 4: Contact Tracing

All areas included in this review deliver contact tracing using the same method (stone in the pond/concentric circle), with variation found in the staff who delivered it. In Barcelona community health workers recruited as 'peers' of the target group are involved in delivery of contact tracing. In the Netherlands, medical assistants support delivery of contact tracing and in NYC Public Health assistants deliver contact tracing: This may contribute to variations in the effectiveness of the contact tracing activity – see Effectiveness review. It may also impact on the capacity of specialist public health nurses to deliver other elements of services such as DOT or case reviews, where non-clinical staff take on specific tasks and free up clinical time for other activities (Cayla and Orcau, 2011; Ospina, 2012; Boar and de Vries, 2012).

Summary Statement 5: Targeting high risk groups

All case study places actively target high risk groups, although the approaches used differ. Pre-entry screening is well established in NYC and Canada and has been very recently introduced to the UK. NYC, Rotterdam and London also make use of outreach and mobile x-ray units to diagnose underserved groups such as the homeless (de Vries et al, 2007 and 2014; Hayward et al, 2010). However, it is not clear whether MXU outreach activities occur across the Netherlands or only in Rotterdam. Furthermore, in the UK this aspect of the service is only widely used in London (de Vries et al, 2007 and 2014; Hayward et al, 2010). Similarly, mobile outreach clinics being delivered in Northern territories in Saskatchewan (Canada) to high risk indigenous communities are not available in other areas (Government of Saskatchewan, 2012).

Summary Statement 6: Treatment completion

DOT is a core element of service provision to improve adherence and treatment completion in all case study areas, in particular in relation to vulnerable groups or those at risk of non-adherence. However, the availability of DOT appears to differ markedly. In NYC DOT is a core element of the TB service, and many studies have concluded that consistent use of DOT is responsible for much of the decline in TB over recent years (NYC-DOHMH, 2002). In 2012 it formed the basis of the majority of treatment (487 of 651 cases ~ 75%) and is considered the standard of care, in NYC 94% of cases completed treatment within 12 months during this time (NYC-DOHMH, 2013). In Canada, DOT is recommended as the minimum level of support for patients with risk factors for non-adherence (Pan Canadian Public Health network, 2012), although the levels of delivery of DOT are unknown. In Barcelona again the incorporation of DOT into methadone programs has been credited with the dramatic decline of TB in people who inject drugs (Cayla and Orcau, 2011). UK data on the provision of DOT is only partially available: between 1.7 and 32% of cases received DOT in London and 0% in Bradford (Bothamley et al, 2011). Given the epidemiological profile of TB in the UK, it is likely that far fewer people were offered DOT than would benefit from it however without data on the proportion of cases who had a risk assessment and were subsequently offered or provided with DOT it is difficult to draw further conclusions.

Summary Statement 7: Staffing

Staffing ratios of nurses (or other staff) differ across the case study areas from 1:12[7] in NYC; 1:18 in the Netherlands and 1:35-45 in Barcelona. There is no UK data available to provide a national picture of TB staff:case ratio (Boer and de Vries, 2011; Bothamley, 2011; Cayla and Orcau, 2011). It should also be noted that in the Netherlands medical assistants support public health nurses to deliver case management including DOT and contact tracing in clients with complex needs in community based clinics. In Barcelona Community Health Workers support contact tracing in culturally similar high risk immigrant groups (Ospina et al, 2012),and in NYC trained Public Health Assistants are responsible for most case management including DOT, active case finding and contact tracing activities as well as providing formal case review as part of the cohort review process. These support workers are likely to off-set the workload of specialist TB nurses in these areas, freeing up clinical time for other duties. In the UK these activities are almost exclusively provided by specialist TB nurses.

Summary Statement 8: Surveillance

Surveillance is consistently prioritised as an important element of service delivery approaches at a national level with national systems for enhanced surveillance and a mandate to report all notified cases in all case study areas. Surveillance is overseen by a national agency in all cases and includes geno-typing/DNA fingerprinting as standard. It should be noted reliance on surveillance to support service delivery in Barcelona significantly pre-dates the recent National Plan highlighting the need for a national surveillance system (Cayla and Orcau, 2011).

Summary Statement 9: Cohort Review

New York City and the UK are both reported to use Cohort Review as a way to systematically review the management of every case of TB on the basis of treatment completion, contact investigation and case management process (Bothamley, 2011; Munsiff et al, 2006). Case managers are responsible for presenting the review of their cohort, this process is considered one of the most important approaches to program evaluation, service improvement and ensuring accountability in NYC (Munsiff et al, 2006). Whilst a number of cities in the UK cited delivery of cohort review (London, Manchester, Leeds and Leicester), it is not clear how systematic this approach is across the UK (Bothamley, 2011).

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[7] NYC and Netherlands ratios were calculated based on information and data identified during the review process.

4. Effectiveness review

This chapter presents a systematic review of the effectiveness of specific TB service delivery models and interventions that could be identified in the literature. A broad range of study designs were included so as to be as inclusive as possible. However, studies were restricted to the case study locations, namely: the UK; the Netherlands; Canada; New York City; and Barcelona. Furthermore, quantitative outcome data had to be reported; in particular, data pertaining to outcomes related to contact tracing, diagnostic delay, or treatment completion.

Included studies

A total of 31 studies, reported in 35 papers, were identified for inclusion. The flow diagram of included studies, together with the methods used to identify the studies, is presented in the Methods chapter earlier in this report.

As described in the Methods chapter, there is some overlap in the studies included in the effectiveness and economics reviews. In particular, two studies (Jit et al 2011, and King et al, 2011) were identified for inclusion in both the effectiveness and economics screening process and as such they appear in both reviews. However, the focus of the effectiveness review here is on the clinical outcomes, whilst the focus in the economics review is on economic outcomes; thus duplication of information has been minimised as much as possible.

Critical appraisal of included studies

Of the 31 studies included, two studies were rated high quality (++), 16 moderate (+) and 13 low (–). However, due to the variety of study designs included in this review there was no single critical appraisal tool that could be used across all of the study designs. As such, several different tools were used, as set out in the NICE CPH manual and the NICE Interim methods guide for developing service guidance (February 2013).

Studies that were before and after studies, cohort studies or randomised controlled trials were appraised using checklist F from the CPH manual. Sixteen studies had these types of study design and were appraised using checklist F. The critical appraisal results for these studies are shown in Table 1. One study was rated as 'all or most of the checklist criteria have been fulfilled and where they have not been, the conclusions are very unlikely to alter' (++); 14 studies were rated as 'some of the checklist criteria have been fulfilled, where they have not, or not adequately described, the conclusions are unlikely to alter' (+) quality; and one study was rated as 'few or no checklist criteria have been fulfilled and the conclusions are likely to alter' (–).

Twelve studies that had utilised an audit design, national/regional/local reports or evaluation, or a cross-sectional design were critically appraised using checklist 1.3, 1.5 and 1.7, respectively, from the NICE Interim methods guide for developing service guidance (February 2013), which are tools specifically focused on these types of study designs. Checklists 1.3, 1.5, and 1.7 provide a detailed assessment of how well the individual studies were conducted against specific criteria related to their study designs, but they do not provide overall ratings of study quality in relation the reliability of the results produced. However, these studies would be classified as low quality evidence due to the high potential

for confounding and bias that can occur in these types of study designs. As such, these 12 studies have been deemed low quality (–).

Studies that utilised a health economic design or modelling design were critically appraised using checklist I from the CPH manual. Three studies were critically appraised using this tool and the critical appraisal of these studies is presented below in Table 2. One study was rated as minor limitation (++), and 2 studies as potentially serious limitations (+).

The individual critical appraisal checklists used for each study are available from the authors upon request.

Characteristics of included studies

An overview of the 31 included studies, split on the basis of location, is presented in Table 3 with more detailed individual extraction sheets available in Appendix 4.

A wide range of study designs have been included in the review, ranging from audits of current practice to cluster RCTs of different models of TB service delivery. The studies also involve a range of populations across many different settings. The evidence is summarised under the key outcome headings, set out below. Any studies that did not report on those three outcomes were grouped as 'other' outcomes. Within these four categories, studies have been further grouped on the basis of whether they provide comparative or non-comparative data.

Table 1 Critical appraisal using checklist F (N=16)

Reference	Design	Population			Method of allocation to intervention/comparison										Outcomes						Analysis						Summary	
		1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	4.6	5.1	5.2
Aldridge et al, 2014	pcRCT	+	+	+	+	+	+	+	++	+	NR	++	++	++	++	++	++	++	++	++	++	++	NR	++	++	++	+	++
Anderson et al 2014	BA	+	+	+	NA	++	NA	NA	NA	NA	NR	++	++	++	++	++	++	++	+	++	+	NA	NR	++	++	++	+	++
Anger et al, et al, 2007	Coh	+	++	++	NA	+	NA	NA	NA	NA	NA	+	+	+	++	++	++	++	NA	++	NA	NA	NR	++	+	++	+	+
De Vries et al, 2007	BA	++	++	NR	NA	++	NA	NA	NA	NA	NR	+	+	+	++	++	++	++	NR	NR	+	NA	NR	++	++	++	+	+
Griffiths et al., 2007	pcRCT	++	++	++	++	++	++	+	++	+	+	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++
Hall et al, 2010	BA (a)	+	+	NR	NA	—	NA	NA	NA	NR	NR	NR	+	+	+	NR	+	+	NR	NR	NR	NA	NR	NR	NR	NR	–	+
Lamberts et al 2003	Coh	++	++	++	NA	++	NA	NA	NA	NA	NR	NR	+	+	+	++	++	++	NR	NR	NR	NA	NR	++	NR	++	+	+
Lynch et al 2013	Coh (a)	+	+	+	NA	+	NA	NA	NA	NA	NA	+	+	+	+	+	+	++	NR	NR	NA	NA	NR	+	+	+	+	+
Munsiff et al, 2006 [a]	Coh	++	+	+	NA	++	NA	NA	NA	NA	NR	++	+	+	++	++	+	++	NR	+	NR	NA	NR	+	+	+	+	+
Munsiff et al, 2006 [b]	Coh	++	++	+	NA	+	NA	NA	NA	NA	NR	+	+	+	++	+	+	++	NR	++	–	NA	NR	++	+	++	+	+
Ospina et al, et al, 2012	BA	++	+	+	NA	+	NA	NA	NA	NA	NR	NR	+	+	+	+	+	++	+	+	+	NA	NR	++	+	++	+	+
Panchal et al, 2012	Coh (a)	+	+	NR	NA	+	NA	NA	NA	NA	NR	NR	+	+	+	+	+	+	NR	++	NR	NA	NR	+	NR	+	+	+
Pursnani et al 2014	Coh	++	+	++	NA	+	NA	NA	NA	NA	NR	NR	+	+	++	++	++	++	+	++	++	NA	NR	+	++	+	+	+
Udeagu et al, 2007	BA	+	++	++	NA	++	NA	NA	NA	NA	NR	NR	+	+	+	++	++	++	+	+	NR	NA	NR	+	+	++	+	+
Van Hest et al, 2008	Coh	+	++	++	NA	++	NA	NA	++	NA	++	++	++	++	++	++	+	++	++	++	NA	NA	NR	++	+	++	+	++

	Design	1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	4.6	5.1	5.2
Verma et al, 2011	Coh(a)	+	+	+	NA	+	NA	NA	NA	NA	NR	+	+	+	+	+	+	++	+	+	NA	NA	NR	++	+	+	+	+

Scoring Key: ++ Yes; + Partly; – No; NA not applicable; NR not reported.

Key to questions:
1.1 Is the source population or source area well described?
1.2 Is the eligible population or area representative of the source population or area?
1.3 Do the selected participants or areas represent the eligible population or area?
2.1 Allocation to intervention (or comparison). How was selection bias minimised?
2.2 Were interventions (and comparisons) well described and appropriate?
2.3 Was the allocation concealed?
2.4 Were participants and/or investigators blind to exposure and comparison?
2.5 Was the exposure to the intervention and comparison adequate?
2.6 Was contamination acceptably low?
2.7 Were other interventions similar in both groups?
2.8 Were all participants accounted for at study conclusion?
2.9 Did the setting reflect usual UK practice?
2.10 Did the intervention or control comparison reflect usual UK practice?
3.1 Were outcome measures reliable?
3.2 Were all outcome measurements complete?
3.3 Were all important outcomes assessed?
3.4 Were outcomes relevant?
3.5 Were there similar follow-up times in exposure and comparison groups?
3.6 Was follow-up time meaningful?
4.1 Were exposure and comparison groups similar at baseline? If not, were these adjusted?
4.2 Was Intention to Treat (ITT) analysis conducted?
4.3 Was the study sufficiently powered to detect an intervention effect (if one exists)?
4.4 Were the estimates of effect size given or calculable?
4.5 Were the analytical methods appropriate?
4.6 Was the precision of intervention effects given or calculable? Were they meaningful?
5.1 Are the study results internally valid? (i.e. unbiased)
5.2 Are the study results generalisable to the source population? (i.e. externally valid)

Key to section 5 1 (internal validity):
++ All or most of the checklist criteria have been fulfilled; where they have not been, the conclusions are very unlikely to alter
+ Some of the checklist criteria have been fulfilled, where they have not, or not adequately described, the conclusions are unlikely to alter
– Few or no checklist criteria have been fulfilled and the conclusions are likely to alter

Key to section 5 2 (external validity):
++ All or most of the checklist criteria have been fulfilled; where they have not been, the study is likely to be generalisable
+ Some of the checklist criteria have been fulfilled, where they have not, or not adequately described, the study is likely to be partly generalisable
– Few or no checklist criteria have been fulfilled and the study is unlikely to be generalisable

Key to 'Design' column:
pcRCT   pragmatic cluster randomised controlled trial
BA   before-after
Coh   cohort study
(a)   abstract only publication

Table 2 Critical appraisal of the economic and modelling studies (N=3)

Reference	Design	Applicability								Overall applicability	Study limitations											Overall quality
		1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8		2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	2.11	
Jit et al, 2011	CU	++	++	++	++	++	++	++	++	++	++	++	++	++	+	++	+	++	++	++	-	++
King et al, 2009 (abstract)	CI (a)	++	++	++	?	++	NA	NA	NA	++	NA	NA	+	++	++	?	+	?	NA	NA	?	+
Tian et al, 2013	M	++	++	+	NA	+	NA	NA	NA	+	++	++	+	++	++	NA	NA	NA	NA	-	-	+

Key to scoring: ++ Yes; + Partly; - No; NA Not applicable; ? Unclear

Key to questions:
1.1 Is the study population appropriate for the topic being evaluated?
1.2 Are the interventions appropriate for the topic being evaluated?
1.3 Is the system in which the study was conducted sufficiently similar to the current UK context?
1.4 Was/were the perspective(s) clearly stated and what were they?
1.5 Are all direct health effects on individuals included, and are all other effects included where they are material?
1.6 Are all future costs and outcomes discounted appropriately?
1.7 Is the value of health effects expressed in terms of quality-adjusted life years (QALYs)?
1.8 Are costs and outcomes from other sectors fully and appropriately measured and valued?
2.1 Does the model structure adequately reflect the nature of the topic under evaluation?
2.2 Is the time horizon sufficiently long to reflect all important differences in costs and outcomes?
2.3 Are all important and relevant outcomes included?
2.4 Are the estimates of baseline outcomes from the best available source?
2.5 Are the estimates of relative 'treatment' effects from the best available source?
2.6 Are all important and relevant costs included?
2.7 Are the estimates of resource use from the best available source?
2.8 Are the unit costs of resources from the best available source?
2.9 Is an appropriate incremental analysis presented or can it be calculated from the data?
2.10 Are all important parameters whose values are uncertain subjected to appropriate sensitivity analysis?
2.11 Is there any potential conflict of interest?

Key to overall applicability:
++ directly applicable
+ partially applicable
– not applicable

Key to overall quality:
++ minor limitations
+ potentially serious limitations
– very serious limitations

Key to 'Design' column:
CI   cost impact
CU   cost utility
M   Modelling study (not economic)
(a)   abstract only publication

Table 3 Characteristics of the included studies (31 studies)

Study (quality)	Type of study	Setting	Population	Intervention	Comparator	Key clinical outcomes	Key results
UK – National (5 studies)							
Backx et al, 2011 (–)	Audit	Services offering adult HIV care	236 adult HIV positive patients starting therapy for active TB	Current(2007/8) management of TB-HIV co-infection	National standards	• Treatment completion • Diagnostic delay • HIV testing	Treatment completion was close to national target (81% v 85%), but more than half of patients experienced diagnostic delay.
Bothamley et al, 2011 (–)	National evaluation	TB services in big Cities in the UK	12 Cities in the UK	Current management of TB in the respective City/PCT	Different Cities in UK and TB action plan	• Treatment completion • DOT • Target of 1 nurse to 40 TB patients	Treatment completion varied from 75.8% to 86.6%. Proportion receiving DOT varied from 0% to 32%. Several cities did not achieve the target of 1:40 nurses to patients.
Cullen, 2012 (–)	National report	Online TB service	64 TB case queries by people accessing online TB service	Online service to increase case discussion of MDRTB	NA	• Cases confirmed with MDRTB • Increase in case discussion	41/64 cases confirmed as MDRTB. Case discussion increased by 45%.
Panchal et al, 2012 (+)	Retrospective cohort	Primary care	857 foreign born TB cases	Primary care registry to target LTBI testing among immigrants, based on HIV status	NA	• Proportion immigrant TB cases preventable	63% (511/857) cases of TB cases in immigrants were estimated to be preventable if screened at GP registration.
Van Hest et al, 2008 (+)	Retrospective cohort	TB service in England	28,678 observed TB cases	Enhanced tuberculosis surveillance (ETS)	Before ETS was introduced	• Record completion	The proportion of records complete has increased since ETS (78% records complete in 1999 v 84% in 2002).
UK – London (9 studies)							
Aldridge et al, 2014 (+)	Cluster RCT	Hostels in London	22 hostels for intervention 24 hostels for control	Peer educators plus current practice for encouraging hostel residents to take up mobile digital x-ray screening.	Current practice of hostel staff encouraging mobile digital x-ray screening.	• Screening uptake	Screening uptake was not statistically significantly different with peers (Poisson regression: RR 0.98%; 95% CI 0.80 to 1.20) The screening uptake rate was 45% (IQR 33,55) in the intervention group and 40% (IQR 25,61) in the control group. However, the authors identified that the results may have been confounded by the control hostels previously having peer

Study (quality)	Type of study	Setting	Population	Intervention	Comparator	Key clinical outcomes	Key results
							involvement.
Anderson et al 2013 (linked to White et al, 2011 and Anderson, 2010) (+)	Before and after	North central London TB service	557 pre-cohort review 752 post-cohort review	Following implementation of cohort review	Before cohort review	• Treatment completion • DOT • HIV testing • Contact tracing	Treatment completion was similar: 87% pre v 86% post cohort review (p=0.6). Proportion of patients requiring DOT increased from 16% to 21%. (p=0.049). One or more contact identified for all cases increased from 77% to 86% (p<0.001) Contacts assessed for all cases increased from 74% to 81% (p<0.001).
Bothamley et al, 2009 (partially linked to SLA 2013) (−)	Audit	Homerton hospital, London	155 people receiving TB care	Current management (2007) of TB	Audits conducted in 2005 and 2006	• Diagnostic delay • Treatment completion • HIV testing	**Confidential information removed**
Griffiths et al, 2007 (++)	Pragmatic cluster RCT	General practice	93,970 patients newly registered with GP	TB screening at GP registration health check - £7 incentive for TST	Usual care in GP surgeries	• TB cases identified • TST undertaken • BCG coverage	Active and latent TB diagnosis increased (active 47% v 34%; latent 19% v 9%). TST testing increased (8.5% v 0.4%) as did BCG coverage (2.7% v 0.4%).
Hall et al, 2010 (−)	Before and after	Community	7 peer educators recruited 3200 hard-to-reach people	Peer educators (former TB patients with previous drug use/homelessness history)	Presumably before peer educators but no detail given	• Active case finding (screening)	Active case finding increased from 44% to 75%.
Hayward (PHAST), 2010 (−)	Local report	TB services in London	29 TB services in	Current practice (2008) across London	NA	• Treatment completion • Diagnostic delay	All services provided sputum smear results within one day. Treatment completion varied across London with an average of 82.6%. DOT use ranged from 0-32%.
Jit et al, 2011 (++)	Economic evaluation alongside a cohort study	Community, including hostels and shelters	668 underserved people at risk of TB	Find and Treat service	Passive case finding	• Treatment completion	Treatment completion rates increased from 46% to 55% in the first year of treatment.

Study (quality)	Type of study	Setting	Population	Intervention	Comparator	Key clinical outcomes	Key results
London Health Programmes case for change, 2011 (also linked to model of care) (–)	Local report	TB services in London	3,302 TB cases in London	Current practice (2010)	National targets	• Treatment completion	Treatment completion in London was above the 85% target although some areas were below this (Tower Hamlets was the lowest at 79%).
Story et al, 2009 (–)	Local report	Community	133 underserved TB cases referred to Find and Treat	Find and Treat	NA	• Treatment completion • People returned to treatment services	Find and treat returned 67% of patients to treatment and was associated with 38% treatment completion rates.
UK Non-London Urban (5 studies)							
Browne et al, 2013 (–)	Local report	Private homes and places of worship in high incidence area of UK	66 people with TB	Social network approach to cluster investigation	NA	• Contact tracing	77 additional contacts identified themselves for screening and 77% were tested for TB.
King et al, 2009 (+)	Before and after study (linked to cost impact)	Community based TB service in Bristol, UK	147 people referred to TB service	Community-based TB nurse-led service	Monthly clinic visit (2006a) Reported to HPA (2006b)	• Treatment completion • Assessment for DOT • HIV counselling • Monthly reviews	Treatment completion was 94% with nurse led service, co pared with 84% with monthly clinics and 55% in HPA reported patients (p<0.0001). Assessment for DOT increased from 5% with monthly clinics to 92% with nurse led service (p<0.0001). HIV counselling increased from 32% with monthly clinics to 69% with nurse led service (p<0.005).
Lynch et al, 2013 (+)	Retrospective cohort	Tertiary referral centre, Centre of	223 people referred to service	Rapid access TB service	NA	• Diagnostic delay	92% of cases were seen within 14 days of rapid access radiology referral.

Study (quality)	Type of study	Setting	Population	Intervention	Comparator	Key clinical outcomes	Key results
		England					
Monk, TB Update, 2014 (–)	Regional report	TB service in Leicestershire	People with suspected TB (number NR)	Rapid access service model (introduced 2005)	Before introduction of model	• Annual TB cases	The number of cases of TB has steadily decreased since the introduction of rapid access service (In 2005 the number of cases was 308, compared with 251 in 2010)
Verma et al, 2011 (+)	Retrospective cohort	Leicester TB service	588 patients accessing the TB service between 2007-9	Rapid access TB clinic in radiology	Other pathways to diagnosis	• Diagnostic delay • Contact tracing	Average duration of symptoms was statistically significantly less with rapid access for non-pulmonary TB (78.4 v 122.1 days (p=0.03) and smear positive pulmonary TB 60.2 v 95.9 (p=0.03), compared with other pathways to diagnosis. There was a non-significant lower rate of contact tracing (mean number of contacts 4.57 v 4.91; p>0.05).
UK – Rural (1 study)							
Abubakar et al, 2006 (–)	Audit	District general hospital, Hertfordshire	32 confirmed TB cases	Current practice in 2002/3	NA	• Contact tracing	82% of patients had 2-24 contacts traced, and 73% of contacts had been seen by specialist nurse.
UK – Prison (1 study)							
Ahmed et al, 2007 (–)	Cross sectional	Yorkshire prison	Contacts of 1 case of TB	Stone in pond method of contact tracing in prison	NA	• Contact tracing	Stone in pond method identified 34/600 contacts, of which 3 required therapy.
NYC (5 studies)							
Anger et al,, 2012 (+)	Retrospective cohort	Community	30,561 contacts (of 5,182 cases)	NYC TB service with a focus on contact tracing	NA	• Proportion tested and diagnosed • Treatment completion • Number needed to treat	89% of contacts were eligible for TST testing, and 27% were TST positive. 48% of people completed LTBI therapy. The number needed to treat to prevent 1 TB case was 88 contacts.
Munsiff et al, 2006 [a] (+)	Retrospective cohort	NYC TB service	1039 TB cases	NYC cohort review in 2004	Cohort review in 1999	• Treatment completion • Treatment success	Treatment success: 2004: 80.6% v 1999: 82.8% Treatment completion: 2004: 86.5% v 1999: 85.7%

Study (quality)	Type of study	Setting	Population	Intervention	Comparator	Key clinical outcomes	Key results
Munsiff et al, 2006 [b] (+)	Retrospective cohort	NYC TB service	856 TB patients with MDR-TB	MDR-TB treatment unit	Before MDR-TB co-ordinator	• Treatment completion	Treatment completion increased significantly from 11.6% in 1992 to 43.5% in 1997 (p<0.001).
Pursnani et al, 2014 (+)	Retrospective cohort	Bellevue hospital, NYC	149 TB patients	Involuntary detention because of non-adherence	Court ordered outpatient DOT	• Treatment completion	95% of detained patients completed therapy compared with 89% undergoing DOT
Udeagu et al, 2007 (+)	Before and after	NYC TB service	445 TB patients	Case management framework 2003-2005	2002 service	• Patient education • Offered DOT	Patients offered DOT increased from 32% to 74% (p<0.001), knowledge of resistance increased from 36% to 61% (0.001).
Netherlands (2 studies)							
De Vries et al, 2007 (+)	Before and after	Mobile TB screening	Illicit drug users and homeless people living in Rotterdam	Mobile screening	Before mobile screening	• Cases found through active case finding • Annual notification in this group	Mobile screening increased active case finding from 30% to 59% (p<0.001). The annual notification rate in drug users/homeless people decreased from 533 to 244.
Lamberts et al, 2003 (+)	Before and after study	National TB service	People with TB in Netherlands	DNA fingerprint surveillance using RFLP	Epidemiological link was compared with before RFLP	• Contact investigations re-opened or extended • Epi links among clustered cases	1% of contact investigations were extended/re-opened. Epi links among clustered cases increased by 3%. Epi links based on documented exposure significantly increased by 35% (p<0.001)
Canada (2 studies)							
Richards et al, 2005 (−)	Audit	Regionally centralised TB programme in Montreal	493 immigrants in Montreal with LTBI	Physician treatment decisions	Canadian TB standards	• Adherence to LTBI standards	87% of physician treatment decisions adhered to guidelines. Clinicians with high-volume of patients more likely to recommend TST and LTBI treatment than clinicians with low-volume of patients : TST: 77% vs. 46% (p<0.001) LTBI treatment: 86% vs. 71% (p = 0.03)
Tian et al, 2013	Agent based modelling	Hypothetical aboriginal community	15,00 simulated people	Hypothetical scenarios of contact	The various scenarios and no contact	• Contact tracing	Prioritising contact tracing by age and ethnicity improved TB control significantly,

Study (quality)	Type of study	Setting	Population	Intervention	Comparator	Key clinical outcomes	Key results
(+)		in Saskatchewan		tracing targets	tracing		as did reducing loss to follow-up.
Barcelona (1 study)							
Ospina et al,, 2012 (+)	Before and after	Community	960 foreign born TB cases	Public health nurse and 5 community health workers (CHW)	Public health nurse alone	• Contact tracing	Contact tracing performed increased from 55% to 66% (p<0.001).

Many of these studies report on several outcomes; thus this table is an oversimplification.

Contact Tracing

Nine studies reported on contact tracing, see Table 4 for an overview of the studies.

Comparative studies

Five studies provided comparative estimates of contact tracing; one was conducted in London (Anderson et al), one in Leicester (Verma et al), one in the Netherlands (Lamberts-van Weezenbeek), one in Barcelona (Ospina), and one in Saskatchewan, Canada (Tian).

Comparisons with another service model/intervention

Anderson et al, 2014, conducted a before and after study of the cohort review process in London. The implementation of cohort review resulted in one or more contacts identified for all cases increasing from 77% to 86% (p<0.001), and contacts assessed for all cases increasing from 74% to 81% (p<0.001).

Lamberts-van Weezenbeek et al, 2002, compared the epidemiological link obtained with DNA fingerprint surveillance using restriction fragment length polymorphism (RFLP), with the epidemiological link with conventional contact tracing. DNA surveillance increased the clustered cases detected from 21% to 24%, although only 1% of contact investigations needed to be extended.

Ospina et al,, 2012, conducted a retrospective cohort study comparing contact tracing in Barcelona with public health nurses alone, compared with public health nurses and five community health workers (one from each of the following communities: Asia, North Africa, Sub-Saharan Africa, China, and Latin America). The introduction of community health workers increased the proportion of contact tracing being performed from 55% to 66% in all TB cases.

Verma et al, 2011, conducted a retrospective cohort of rapid access in radiology versus other diagnostic pathways between 2007 and 2009 in Leicester. Rapid access was associated with non-significantly fewer contacts traced (4.57 v 4.91, p>0.05) and a non-significantly lower % associated with contacts (81.6 v 90%, p>0.05), compared with other diagnostic pathways.

Comparisons with guidelines or across services or hypothetical changes

Tian et al, 2013, undertook a form of mathematical modelling, known as agent based simulation, of possible contact tracing scenarios in Saskatchewan, Canada. A total of 15,000 people were simulated across the following scenarios: scope; speed; degree of loss to follow-up; prioritisation. Results indicated that reducing the loss to follow-up rate and prioritising by age and ethnicity can have the biggest impacts on reducing TB burden in the future.

Non-comparative studies

Four studies provided non-comparative estimates of contact tracing; three were conducted in the UK (Abubakar et al, Ahmed et al, and Browne) and one in NYC (Anger et al,).

Anger et al, 2012, conducted a retrospective cohort study of the NYC TB service. A total of 30,561 contacts of 5,182 TB cases were identified. Of these contacts, 89% were eligible for

TST testing and 27% were positive. The number of contacts needed to be treated to prevent one case of TB was estimated at 88 contacts.

Abubakar et al, 2007, conducted an audit at a district hospital in Hertfordshire, UK, in 2002/3. There were a total of 32 confirmed TB cases, of which 82% of patients had between 2 and 24 contacts traced.

Ahmed et al, 2007, conducted a case study review of the method used to trace contacts of 1 case of TB occurring in a Yorkshire prison. The stone in pond method was used within the prison to trace contacts, which identified 34/600 prison contacts, of which 2 were diagnosed with LTBI and 1 with active TB infection, and commenced therapy.

Browne et al, 2013, reported on a social network approach to cluster investigation, which was conducted in private homes and places of worship in a high incidence area of the UK (possibly Birmingham, although this was not clearly stated). The social network approach identified 77 contacts, of which 77% were tested for TB.

Table 4 Studies reporting on contact tracing (9 studies)

Study	Type of study	Setting	Population	Intervention	Comparator	Key results for contact tracing
Non comparative (4 studies)						
Abubakar et al, 2006	Audit	District general hospital, Hertfordshire, UK	32 confirmed TB cases	Current practice in 2002/3	NA	82% of patients had 2-24 contacts traced.
Ahmed et al, 2007	Cross sectional	Yorkshire prison, UK	Contacts of 1 case of TB	Stone in pond method of contact tracing in prison	NA	Stone in pond method identified 34/600 contacts, of which 3 required therapy.
Anger et al,, 2012	Retrospective cohort	Community, NYC	30,561 contacts (of 5,182 cases)	NYC TB service with a focus on contact tracing	NA	89% of contacts were eligible for TST testing, and 27% were TST positive. 48% of people completed LTBI therapy. The number needed to treat to prevent 1 TB case was 88 contacts.
Browne et al, 2013	Local report	Private homes and places of worship in high incidence area of UK (likely Birmingham)	66 people with TB	Social network approach to cluster investigation	NA	77 additional contacts identified themselves for screening and 77% were tested for TB.
Comparative (5 studies)						
Anderson et al 2013	Before and after	North central London TB service	557 pre-cohort review 752 post-cohort review	Following implementation of cohort review	Before cohort review	One or more contact identified for all cases increased from 77% to 86% (p<0.001) Contacts assessed for all cases increased from 74% to 81% (p<0.001).
Lamberts et al, 2003	Before and after study	National TB service, Netherlands	People with TB in Netherlands	DNA fingerprint surveillance using RFLP	Epidemiological link was compared with before RFLP	1% of contact investigations were extended/re-opened. Epi links among clustered cases increased by 3% (from 21% to 24%). Epi links based on documented exposure significantly increased by 35% (p<0.001)
Ospina et al,, 2012	Before and after	Community, Barcelona, Spain	960 foreign born TB cases	Public health nurse and 5 community health workers (CHW)	Public health nurse alone	Contact tracing performed increased from 55% to 66%.
Tian et al, 2013	Agent based modelling	Hypothetical aboriginal community in Saskatchewan, Canada	15,00 simulated people	Hypothetical scenarios of contact tracing targets	The various scenarios and no contact tracing	Prioritising contact tracing by age and ethnicity improved TB control significantly, as did reducing loss to follow-up. Increasing speed and scope of contact tracing had less of an impact.
Verma et al 2011	Retrospective cohort	Leicester TB service	588 patients accessing the TB service between 2007-9	Rapid access TB clinic in radiology	Other pathways to diagnosis	Rapid access was associated with non-significantly fewer contacts traced (4.57 v 4.91, p>0.05) and a non-significantly lower % associated with contacts (81.6 v 90%, p>0.05), compared with other diagnostic pathways.

Many of these studies report on several outcomes; thus this table is an oversimplification

Outcomes related to diagnostic delay

Ten studies reported on the impact of interventions aimed at reducing the time taken to diagnosis, or outcomes such as active case finding that could reasonably be assumed to impact upon diagnostic delay. See Table 5 for an overview of the studies.

Comparative studies

Seven studies provided comparative estimates of outcomes that could be linked with diagnostic delay; one was conducted in the Netherlands (de Vries), and five were conducted in the UK (Aldridge et al, Backx et al, Bothamley et al, Griffiths et al, Hall et al, Verma et al).

Comparisons with guidelines, previous audits or across services
Backx et al, 2011, conducted an audit of the management of TB-HIV co-infection in services offering adult HIV care in the UK, compared with National UK standards which recommend that sputum smear positive results should be available within 24 hours. The time between sample taken and results received was same or next day for 45% of samples, 2-3 days for 16.7% of samples, and 4+ days for 25% of samples.

Bothamley et al, 2011, conducted an audit of TB care in Homerton Hospital, London, in 2007, compared with audits conducted in 2005 and 2006. **Confidential information removed.**

Comparisons with another service model/intervention
Aldridge et al, 2014, conducted a cluster RCT of peer educators plus current practice, versus current practice alone, for encouraging people in hostels to uptake mobile digital x-ray screening. Current practice involved hostel staff encouraging mobile screening. Peer educators were not associated with a statistically significantly different rate of uptake compared with current practice (Poisson regression: RR 0.98%; 95% CI 0.80 to 1.20). However, the authors identified that the results may have been confounded by the control hostels previously having peer involvement.

De Vries et al, 2007, conducted a before and after study of mobile TB screening in illicit drug users and homeless people living in Rotterdam. Mobile screening was found to increase the active case finding from 30% to 59%. The annual notification rate in drug users and homeless people was also found to have decreased from 533 before mobile screening to 244 cases after the introduction of mobile screening.

Griffiths et al, 2007, conducted a cluster RCT of education and incentive for TB screening at GP registration health check, compared with usual care in GP surgeries in London. The proportion of patients screened for TB at registration health check was 57% with the intervention compared with 0.4% with usual care. The diagnosis of active TB was greater with intervention compared with comparator (47% versus 34%), as was the diagnosis of latent TB (19% versus 9%).

Hall et al, 2010, appeared to use a before and after approach to assess the effectiveness of peer educators to improve active case finding with underserved groups in London. The number of cases found increased from 44% (presumably before peer educators) to 75% with peer educators.

Verma et al, 2011, conducted a retrospective cohort of rapid access in radiology versus other diagnostic pathways between 2007 and 2009 in Leicester. Rapid access was associated with a statistically significantly shorter average duration of symptoms in non-pulmonary TB (78.4 v 122.1 days; p=0.03) and smear positive pulmonary TB (60.2 v 95.9 days; p=0.03), compared with other diagnostic pathways. There was a non-significant reduction in the duration of symptoms in smear negative pulmonary TB (80.4 v 100.1 days; p>0.05).

Non-comparative studies

Three studies provided non-comparative estimates of outcomes that could be linked with diagnostic delay; all three were conducted in the UK (Lynch et al, Van Hest et al, and Hayward et al, 2010).

Hayward et al, 2010 (PHAST), conducted a needs assessment of 29 TB services across London. All 29 services reported that measures were in place to ensure TB samples were processed with liquid culture technology and prompt return of sputum smears results.

Lynch et al, 2013, conducted a cohort study of a rapid access TB service based in a tertiary referral centre in the Centre of England. The rapid access service saw 92% of cases within 14 days of rapid access radiology referral.

Van Hest et al, 2012, conducted a retrospective cohort study of primary care registry to target LTBI 'active case finding' among immigrants based on HIV status. The study estimated that 63% of immigrant TB cases were preventable if screened at GP registration. Patients who were HIV positive were less likely to have TB that was preventable.

Table 5 Studies reporting on outcomes related to diagnostic delay (10 studies)

Study	Type of study	Setting	Population	Intervention	Comparator	Key results
Non-comparative (3 studies)						
Hayward (PHAST), 2010	Local report	TB services in London, UK	29 TB services in	Current practice (2008) across London	NA	29/29 services reported prompt return of sputum smear results were in place, and reported use of liquid cultures.
Lynch et al, 2013	Retrospective cohort	Tertiary referral centre, Centre of England	223 people referred to service	Rapid access TB service	NA	92% of cases were seen within 14 days of rapid access radiology referral.
Van Hest et al, 2012	Retrospective cohort	Primary care in the UK	857 foreign born TB cases	Primary care registry to target LTBI testing among immigrants, based on HIV status	NA	63% of immigrant TB cases were estimated to be preventable if screened at primary care. The proportion of TB cases unpreventable was significantly higher for HIV+ compared with HIV- 19% v 10%; RR (95% CI) = 1.89 (1.25 – 2.84).
Comparative (7 studies)						
Aldridge et al, 2014	Cluster RCT	Hostels in London	22 hostels for intervention 24 hostels for control	Peer educators plus current practice for encouraging hostel residents to take up mobile digital x-ray screening.	Current practice of hostel staff encouraging mobile digital x-ray screening.	Screening uptake was not statistically significantly different with peers (Poisson regression: RR 0.98%; 95% CI 0.80 to 1.20) The screening uptake rate was 45% (IQR 33,55) in the intervention group and 40% (IQR 25,61) in the control group. However, the authors identified that the results may have been confounded by the control hostels previously having peer involvement.
Backx et al, 2011	Audit	Services offering adult HIV care in the UK	236 adult HIV positive patients starting therapy for active TB	Current(2007/8) management of TB-HIV co-infection	National standards	Time between sample taken and results received in 60 sputum smear positive cases: 45% (27/60): same or next day 16.7% (10/60): within 2-3 days
Bothamley et al, 2007 (Audit	Audit	Homerton hospital, London, UK	155 people receiving TB care	Current management (2007)of TB	Audits conducted in 2005 and 2006	**Confidential information removed**

Study	Type of study	Setting	Population	Intervention	Comparator	Key results
B167)						
De Vries et al, 2007	Before and after	Mobile TB screening in the Netherlands	Illicit drug users and homeless people living in Rotterdam	Mobile screening	Before mobile screening	Mobile screening increased active case finding from 30% to 59%. The annual notification rate in drug users/homeless people decreased from 533 to 244.
Griffiths et al, 2007	Pragmatic cluster RCT	General practice, London, UK	93,970 patients newly registered with GP	TB screening at GP registration health check - £7 incentive for TST	Usual care in GP surgeries	Proportion patients screened for TB at registration health check: 57% (13,478/23,573) v 0.4% (84/23,051) TST undertaken 8.5% (1996/23,573) v 0.4% (84/23,051) Active TB Diagnosis :47% (66/141) v 34% (54/157) OR:1.68 (95% CI1.05 – 2.68; p=0.03) Latent TB Diagnosis:19% (11/58) v 9% (5/68) OR: 3.00 (95% CI 0.98 – 9.20; p=0.055)
Hall et al, 2010	Before and after	Community in London, UK	7 peer educators recruited 3200 hard-to-reach people	Peer educators (former TB patients with previous drug use/homelessness history)	Presumably before peer educators but no detail given	Active case finding increased from 44% to 75%
Verma et al 2011	Retrospective cohort	Leicester TB service	588 patients accessing the TB service between 2007-9	Rapid access TB clinic in radiology	Other pathways to diagnosis	Average duration of symptoms was statistically significantly less with rapid access for non-pulmonary TB (78.4 v 122.1 days (p=0.03) and smear positive pulmonary TB 60.2 v 95.9 (p=0.03), compared with other pathways to diagnosis. There was a non-significant reduction in the duration of symptoms in smear negative pulmonary TB (80.4 v 100.1 days; p>0.05).

Many of these studies report on several outcomes; this table is an oversimplification.

Treatment completion

Thirteen studies reported on treatment completion, see Table 6 for an overview of the studies.

Comparative studies

Eleven studies provided comparative estimates of treatment completion; seven were conducted in the UK (Backx et al, Bothamley 2011, Bothamley 2007, HPA, Jit et al, King et al, Model, and PHAST), and three were conducted in NYC (Munsiff et al, Munsiff et al, Pursnami).

Comparisons with guidelines, previous audits or across services

Backx et al, 2011, conducted an audit of the management of HIV-TB co-infection in adult HIV services in the UK, with a comparison made with UK standards. The treatment completion rate was 81.6% compared with the 85% target.

Bothamley et al, 2011, conducted a retrospective cohort study of the current management of TB across 12 Cities in the UK, with comparisons made across cities. Treatment completion rates varied from 75.8% in Sheffield to 86.6% in Leicester.

Bothamley et al, 2007, conducted an audit of Homerton hospital in London in 2007, compared with audits conducted in 2005 and 2006. **Confidential information removed.**

London Health Programmes, London 2011, reported on the treatment completion rates across London. Treatment completion was above the 85% target overall but some areas fell below this, with as low as 79% reported in Tower Hamlets.

Hayward et al (PHAST), 2010, conducted a needs assessment of 29 TB services across London. Treatment completion rates in 2008 across London were estimated at 82.6%, although clinic rates varied from 61.1% (West Middlesex) to 94.6% (Whipps Cross).

Comparisons with another service model/intervention

Anderson et al 2013, conducted a before and after study of the TB service in North Central London with cohort review compared with before cohort review was introduced. The treatment completion rate was similar across time periods: 87% before cohort review and 86% after it was implemented (p=0.6).

Jit et al, 2011, undertook an economic evaluation alongside a cohort study of the Find and Treat service compared with historical passive case finding/usual care in London's underserved population. Find and Treat was associated with 55% treatment completion rates in the first year, compared with 46% with usual care.

King et al, 2009, conducted a before and after study with a cost impact analysis of the introduction of a community-based TB nurse led service compared with monthly clinic visits in Bristol. A TB nurse-led service was associated with 94% treatment completion rates compared with 84% with monthly clinics.

Munsiff et al, 2006, conducted a retrospective cohort study describing the implementation and outcomes of the NYC cohort review process, providing a comparison of cohort review in

2004 and in 1999. The treatment completion rate was 85.7% in 2004 versus 86.5% in 1999, although the treatment success rate was 81% in 2004 versus 83% in 1999.

Munsiff et al, 2006, conducted a retrospective cohort study comparing the MDR-TB co-ordinator with before the introduction of the MDR-TB co-ordinator in NYC. The treatment completion rate was found to be 11.6% before the unit was introduced, compared with 43.5% after it was introduced (p<0.001).

Pursnami et al, 2014, conducted a retrospective cohort comparing involuntary detention versus court ordered outpatient DOT in Bellevue hospital in NYC. Overall, 95% of detained patients were found to have completed treatment compared with 89% undergoing court ordered DOT.

Non-comparative studies

Two studies provided non-comparative estimates of treatment completion; one was conducted in NYC (Anger et al,) and one was conducted in the UK (Story, 2009).

Anger et al, 2012, conducted a retrospective cohort study of the NYC TB service, with a focus on contact tracing. A total of 47.9% of people completed LTBI treatment. It was estimated that 88 contacts needed to be treated to prevent 1 case of TB within four year exposure.

Story et al, 2009, reported on the Find and Treat service based in London. The Find and Treat service returned 67% of people to treatment and was associated with 38% treatment completion rates.

Other outcomes

Five studies did not report on contact tracing, diagnostic delay or treatment completion, and were grouped together as 'other' outcomes; see Table 7 for an overview of these studies.

Table 6 Studies reporting on treatment completion (13 studies)

Study	Type of study	Setting	Population	Intervention	Comparator	Key results
Non comparative (2 studies)						
Anger et al, 2012	Retrospective cohort	NYC TB service	30,561 contacts (of 5,182 cases)	NYC TB service with a focus on contact tracing	NA	47.9% completed LTBI treatment (3,642) 29.2% did not complete LTBI treatment (2,219) 21% did not start LTBI treatment (1,596) 1.8% stopped LTBI treatment due to adverse events (140). To prevent 1 case of TB 88 contacts needed to be treated.
Story et al, 2009	Local report	Community setting in the UK	133 underserved TB cases referred to Find and Treat	Find and Treat	NA	Find and treat returned 67% of patients to treatment and was associated with 38% treatment completion rates.
Comparative (11 studies)						
Anderson 2013	Before and after	North central London TB service	557 pre-cohort review 752 post-cohort review	Following implementation of cohort review	Before cohort review	One or more contact identified for all cases increased from 77% to 86% (p<0.001) Contacts assessed for all cases increased from 74% to 81% (p<0.001).
Backx et al, 2011	Audit	Services offering adult HIV care in the UK	236 adult HIV positive patients starting therapy for active TB	Current(2007/8) management of TB-HIV co-infection	National standards	Treatment completion was close to national target (81.6% v 85% target).
Bothamley et al, 2011	Audit	TB services in big Cities in the UK	12 Cities in the UK	Current management of TB in the respective City/PCT	Different Cities in UK and TB action plan	Proportion TB treatment completed within 12 months (2006-2008): Birmingham East/North: 85.1% Heart of Birmingham Teaching: 83.1% Central Manchester: 83.5% Leeds: 80.9% Bradford and Airedale Teaching: 78.1% Sandwell: 76.8% Leicester City: 86.6% Sheffield: 75.8% London (reported as region, not PCT): 82.6%
Bothamley et al, 2007	Audit	Homerton hospital, London	155 people receiving TB care	Current management (2007)of TB	Audits conducted in 2005 and 2006	**Confidential information removed**

Study	Type of study	Setting	Population	Intervention	Comparator	Key results
Hayward (PHAST), 2010	Local report	TB services in London	29 TB services in	Current practice (2008) across London	Comparisons between areas of London	Treatment completion rates in 2008 across London were estimated at 82.6%, although clinic rates varied from 61.1% (West Middlesex) to 94.6% (Whipps Cross).
Jit et al, 2011	Cohort study (part of econ evaluation)	Community, including hostels and shelters, London	668 underserved people at risk of TB	Find and Treat service	Passive case finding	Treatment completion rates increased from 46% to 55% in the first year of treatment.
King et al, 2009	Before and after study (linked to cost impact)	Community based TB service in Bristol, UK	147 people referred to TB service	Community-based TB nurse-led service	Monthly clinic visit HPA reported cases	Treatment completion was 94% with nurse led service, copared with 84% with monthly clinics and 55% in HPA reported patients (p<0.0001).
Model of care, 2011	Local report	TB services in London	3,302 TB cases in London	Current practice (2010)	National targets	Treatment completion in London was above the 85% target although some areas were below this.
Munsiff et al, 2006 [a])	Retrospective cohort	NYC TB service	1039 TB cases	NYC cohort review process in 2004	Cohort review in 1999	From 1992 to 2004 treatment completion increased by 26.7%.
Munsiff et al, 2006 [b])	Retrospective cohort	NYC TB service	856 TB patients with MDR-TB	MDR-TB treatment unit	Before MDR-TB co-ordinator	Treatment completion increased significantly from 11.6% before MDR-TB co-ordinator to 43.5% after its introduction.
Pursnani et al, 2014	Retrospective cohort	Bellevue hospital, NYC	149 TB patients	Involuntary detention because of non-adherence	Court ordered outpatient DOT	95% of detained patients completed therapy compared with 89% undergoing DOT

Many of these studies report on several outcomes; thus this table is an oversimplification.

Table 7 Studies reporting on 'other' outcomes (5 studies)

Study	Type of study	Setting	Population	Intervention	Comparator	Key results
Non-comparative (1 study)						
Cullen, 2012	National report	Online TB service, UK	64 TB case queries by people accessing online TB service	Online service to increase case discussion of MDR-TB	NA	41/64 cases confirmed as MDRTB. Case discussion increased by 45%.
Comparative (4 studies)						
Monk, TB Update, 2014	Regional report	TB service in Leicestershire, UK	People with suspected TB (number NR)	Rapid access service model	Before introduction of model	The number of cases of TB has steadily decreased since the introduction of rapid access service (graph).
Richards et al, 2005	Audit	Regionally centralised TB programme in Montreal, Canada	493 immigrants in Montreal with LTBI	Physician treatment decisions	Canadian TB standards	87% of physician treatment decisions adhered to guidelines.
Udeagu et al, 2007	Before and after	NYC TB service	445 TB patients	Case management framework 2003-2005	2002 service	Patients offered DOT increased from 32% to 74%, knowledge of resistance increased from 36% to 61%.
Van Hest et al, 2008	Retrospective cohort	TB service in England	28,678 observed TB cases	Enhanced tuberculosis surveillance (ETS)	Before ETS was introduced	The proportion of records complete has increased since ETS.

Many of these studies report on several outcomes; thus this table is an oversimplification.

Comparative studies: synthesis

This section focuses on the 13/31 studies which report on service delivery models or interventions versus a comparison with another service delivery model or intervention, and provide effectiveness data in relation to the three key outcomes. These 13 studies are grouped on the basis of the main outcome they report (in relation to the three key outcomes identified for this review). See Table 8 for an overview of the studies.

To better understand how the interventions reported in the 13 studies were delivered, which population was involved, and what outcomes the interventions achieved, an additional level of synthesis has been undertaken at the level of the intervention and population; see Box 1 to Box 10. Each box includes an evidence statement which summarises the evidence (including strength and applicability) in each area, together with an overview table of the relevant evidence. Detailed extraction sheets of each study are available in Appendix 4, and evidence statements are provided below in the summary.

Table 8 Studies reporting comparative effectiveness data on service delivery models/interventions (N=13)

Study (quality)	Type of study	Setting	Population	Intervention	Comparator	Key results for contact tracing
Contact tracing (3 studies)						
Anderson et al, 2014	Before and after	North central London TB service	557 pre-cohort review 752 post-cohort review	Following implementation of cohort review	Before cohort review	One or more contact identified for all cases increased from 77% to 86% (p<0.001) Contacts assessed for all cases increased from 74% to 81% (p<0.001) NB this study also reported on treatment completion (there was no difference: 87% v 86%; p=0.6).
Lamberts et al, 2003 (+)	Before and after study	National TB service, Netherlands	People with TB in Netherlands	DNA fingerprint surveillance using RFLP	Epidemiological link was compared with before RFLP	1% of contact investigations were extended/re-opened. Epi links among clustered cases increased by 3%. Epi links based on documented exposure significantly increased by 35% (p<0.001)
Ospina et al, 2012 (+)	Before and after	Community, Barcelona, Spain	960 foreign born TB cases	Public health nurse and 5 community health workers (CHW)	Public health nurse alone	Contact tracing performed increased from 55% to 66%.
Diagnostic delay (5 studies)						
Aldridge et al, 2014 (+)	Cluster RCT	Hostels in London	22 hostels for intervention 24 hostels for control	Peer educators plus current practice for encouraging hostel residents to take up mobile digital x-ray screening.	Current practice of hostel staff encouraging mobile digital x-ray screening.	Screening uptake was not statistically significantly different with peers (Poisson regression: RR 0.98%; 95% CI 0.80 to 1.20) The screening uptake rate was 45% (IQR 33,55) in the intervention group and 40% (IQR 25,61) in the control group. However, the authors identified that the results may have been confounded by the control hostels previously having peer involvement.
De Vries et al, 2007 (+)	Before and after	Mobile TB screening in the Netherlands	Illicit drug users and homeless people living in Rotterdam	Mobile screening	Before mobile screening	Mobile screening increased active case finding from 30% to 59%. The annual notification rate in drug users/homeless people decreased from 533 to 244.
Griffiths et al, 2007 (++)	Pragmatic cluster RCT	General practice, London, UK	93,970 patients newly registered with GP	TB screening at GP registration health check - £7 incentive for TST	Usual care in GP surgeries	Proportion patients screened for TB at registration health check: 57% (13,478/23,573) v 0.4% (84/23,051) TST undertaken 8.5% (1996/23,573) v 0.4% (84/23,051) Active TB Diagnosis :47% (66/141) v 34% (54/157) OR:1.68 (95% CI1.05 – 2.68; p=0.03) Latent TB Diagnosis:19% (11/58) v 9% (5/68)

Study (quality)	Type of study	Setting	Population	Intervention	Comparator	Key results for contact tracing
						OR: 3.00 (95% CI 0.98 – 9.20; p=0.055)
Hall et al, 2010 (–)	Before and after	Community in London, UK	7 peer educators recruited 3200 hard-to-reach people	Peer educators (former TB patients with previous drug use/homelessness history)	Presumably before peer educators but no detail given	Active case finding increased from 44% to 75%
Verma et al, 2011 (+)	Retrospective cohort	Leicester TB service	588 patients accessing the TB service between 2007-9	Rapid access TB clinic in radiology	Other pathways to diagnosis	Average duration of symptoms was statistically significantly less with rapid access for non-pulmonary TB (78.4 v 122.1 days (p=0.03) and smear positive pulmonary TB 60.2 v 95.9 (p=0.03), compared with other pathways to diagnosis. There was a non-significant reduction in the duration of symptoms in smear negative pulmonary TB (80.4 v 100.1 days; p>0.05).
Treatment completion (5 studies)						
Jit et al, 2011 (++)	Economic evaluation alongside a cohort study	Community, including hostels and shelters, London	668 underserved people at risk of TB	Find and Treat service	Passive case finding	Treatment completion rates increased from 46% to 55% in the first year of treatment NB Diagnostic delay outcomes were also reported.
King et al, 2009 (+)	Before and after study linked to cost impact	Community based TB service in Bristol, UK	147 people referred to TB service	Community-based TB nurse-led service	Monthly clinic visit	Treatment completion increased from 84% to 94%.
Munsiff et al, 2006 [a] (+)	Retrospective cohort	NYC TB service	1039 TB cases	NYC cohort review process in 2004	Cohort review in 1999	Treatment success: 83% v 81% At least 90% of patients completed treatment in one year: 86.5% v 85.7% At least 90% of patients had appropriate contact investigation: 95.3% v 90.5% Mean contact investigation index: 8.3 v 5.0
Munsiff et al, 2006 [b]	Retrospective cohort	NYC TB service	856 TB patients with MDR-TB	MDR-TB treatment co-ordinator	Before MDR-TB co-ordinator	Treatment completion increased significantly from 11.6% before MDR-TB co-ordinator to 43.5% after its introduction.

Study (quality)	Type of study	Setting	Population	Intervention	Comparator	Key results for contact tracing
(+)						
Pursnani et al, 2014 (+)	Retrospective cohort	Bellevue hospital, NYC	149 TB patients	Involuntary detention because of non-adherence	Court ordered outpatient DOT	95% of detained patients completed therapy compared with 89% undergoing DOT

Many of these studies report on several outcomes; thus this table is an oversimplification.

Box 1 Cohort review of all cases

Evidence statement 1: Cohort review can improve contact tracing in TB patients

There is moderate evidence from one London UK study[1] (+) that cohort review can increase contact tracing of at least one contact identified (86% v 77%; p<0.001), compared with before cohort review was implemented. There was no difference in treatment completion (86% v87%; p=0.6). Other outcomes, such as increased DOT refusal (30% v 10%; p=0.001) were identified as something to address and monitor in future cohort review. Overall, the process was seen as identifying problems and allowing whole system improvement.

There is moderate evidence from one NYC study[2] (+) that continuous cohort review can increase contact tracing over time (at least 90% of patients with appropriate contact investigation: 2004: 95.3% v 1999: 90.5%). Treatment completion rates were similar (86.5% v 85.7%), whilst treatment success was slightly lower over time (2004: 81% v 1999: 83%), compared with previous cohort review. Again a large benefit of the process was seen as identifying problems that could then be addressed.

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because there are no obvious differences in the delivery of cohort review in the included studies compared to how it could be delivered in the UK.

1 Anderson et al, 2014 (+)
2 Munsiff et al, 2006 (+)

Outcome	Negative or no effect (study quality)	Non-significant positive effect (study quality)	Significant positive effect (study quality)
Contact tracing		1 (+) 2 (+)	1 (+)
Diagnostic delay			
Treatment completion	1 (+) 2 (+)		
Other outcomes	1 (+) 2 (+)	1 (+) 2 (+)	1 (+)

Summary of component studies

Study code	Study detail	Intervention / Comparator	Population / Setting	Outcomes (intervention v comparator)
1	Anderson et al, 2014 (+) (Linked to White 2011 and Anderson, 2010) Before and after study London, UK Total=1309 I=752 C=557	**Intervention:** Cohort review was implemented in 2010 which involved a brief, structured review of the management, contact investigation, and treatment outcome for each TB case within a service. Cohort review was reported to take under 3 minutes per case. **Comparator:** Before cohort review (2009)	**Population:** People attending North Central London TB service **Setting:** North Central London TB service	**All TB cases with contacts identified** At least 1 contact identified: 86% v 77%; p<0.001 At least 3 contact identified: 57% v 51%; p=0.024 At least 5 contacts identified: 30% v 29%; p=0.38 **Pulmonary TB cases with contacts identified** At least 1 contact identified: 88% v 78%; p=0.001 At least 3 contact identified: 64% v 55%; p=0.01 At least 5 contacts identified: 37% v 33%; p=0.27 **Contacts assessed for all TB cases** 81% v 74%; p<0.001 **Treatment completion at 12 months** 86% v 87%; p=0.6 **Other outcomes** Cases lost to follow-up

				3.4% v 2.2%; p=0.201 Patients requiring DOT 21% v 16%; p=0.049 Patients receiving DOT 63% v 84%; p=0.003 Patients refusing DOT 30% v 10%; p=0.001#
2	Munsiff et al, 2006, (+) Retrospective cohort study NYC, USA Total=NR I=906 C=1433	**Intervention:** Cohort review in 2004. This included a review of epidemiology, individual patient history and treatment, and assessment against national targets. As each case is presented cases are documented. Meetings are quarterly and results are sent to managers. Many issues were to do with missing data. **Comparator:** cohort review in1999. Limited details provided	**Population:** TB cases in NYC **Setting:** NYC TB service	**At least 90% of patients completed treatment in one year** 86.5% v 85.7% **At least 90% of patients had appropriate contact investigation** 95.3% v 90.5% **Mean contact investigation index** 8.3 v 5.0 **Other outcomes** At least 70% of eligible patients assessed for DOT 72.2% v 66.1% Treatment success 81% v 83%

please note that Anderson et al identified the high refusal rate for DOT as an issue to do with how DOT was delivered and the support available (particularly around the service's ability to provide it) which they then planned to overcome and monitor in future cohort review

Box 2 Nurse-led TB service

Evidence statement 2: Nurse led service can improve treatment completion in TB patients and reduce costs

There is moderate evidence from one Bristol UK study[1] (+) that a nurse led service can increase treatment completion rates compared with previous monthly clinics and cases notified to HPA in 2006 (94% v 84% v 55%; p<0.0001). Other outcomes, such as assessment for DOT were also improved compared with previous monthly clinics (92% v 5%; p<0.0001). The nurse led service was estimated to save £27,872 per year compared to monthly clinics, due to replacing 268 reviews (£104 each).

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because there are no obvious differences in the delivery of a nurse led service in the included study compared to how it could be delivered in the UK.

1 King et al, 2009 (+)

Outcome	Negative or no effect	Non-significant positive effect (study quality)	Significant positive effect (study quality)
Contact tracing			
Diagnostic delay			
Treatment completion			1 (+)
Other outcomes		1 (+)	1 (+)

Summary of component studies			
Study code	**Study detail**	**Intervention / Comparator**	**Population / Setting**
Outcomes (intervention v comparator)			

Study code	Study detail	Intervention / Comparator	Population / Setting	Outcomes (intervention v comparator)
1	King et al, 2009 (+) Before and after study with cost impact analysis, Bristol, UK Total=147 I=64 C1=22 (2006a) C2=58 (2006b)	**Intervention:** Two community-based TB nurses were appointed by the Bristol primary care trust (PCT) in 2008 **Comparator:** Previous monthly clinics in hospital in 2006a Cases referred to HPA (2006b)	**Population:** People with TB in Bristol **Setting:** Community v hospital	**Treatment completion** 2008: 94% (56/59) 2006a: 84% (16/19) 2006b: 55% (32/58) (p<0.0001) (3 way Fisher exact) **Other outcomes** Assessed for requiring DOT: 2008: 92% (59/64) 2006a: 5% (1/22) (p<.00001) Uninterrupted medication: 2008: 92% (59/64) 2006a: 15% (3/20) Cost savings 268 reviews replaced (£104 each), saving £27,872 in one year

Box 3 DNA surveillance of TB cases

Evidence statement 3: DNA surveillance of TB cases can support conventional contact tracing

There is moderate evidence from one Netherlands study[1] (+) that DNA surveillance can support conventional contact tracing by increasing epidemiological links based on documented exposure (35% increase; p<0.001), although only 1% of contact investigations were extended. It was seen as being particularly useful training mechanism for inexperienced TB nurses, a method of monitoring the effects of new control policies, and enabling institutional deficiencies to be detected.

Applicability
The evidence is partially applicable to TB service delivery in the UK. This is because this study was conducted in the Netherlands which may have different contact tracing policies from the UK, which means that the expected benefits of DNA surveillance in the UK could be different.

1 Lamberts-van Weezenbeek et al, 2003 (+)

Outcome	Negative or no effect	Non-significant positive effect (study quality)	Significant positive effect (study quality)
Contact tracing		1 (+)	1 (+)
Diagnostic delay			
Treatment completion			
Other outcomes			

Summary of component studies				
Study code	**Study detail**	**Intervention / Comparator**	**Population / Setting**	**Outcomes**
1	Lamberts-van Weezenbeek, 2003 (+) Cohort study Netherlands Total=3,602 I=2,206	**Intervention:** A national program involving voluntary collaboration between regional TB services standardised documentation of restriction fragment length polymorphism (RFLP) typing for all TB isolates. The epidemiological link was confirmed using RFLP patterns and clusters. **Comparator:** Conventional contact tracing before the RFLP result	**Population:** Patients with TB in the Netherlands **Setting:** Netherlands TB service	**Contact investigations re-opened** 0.9% (34/3602) Resulting in 71 contacts with LTBI Additional epi links based on documented exposure after RFLP result: 35% (193/550); p <0.001 Additional epi links established among clustered cases after RFLP result: 24% **Other results** It was seen as being particularly useful training mechanism for inexperienced TB nurses, a method of monitoring the effects of new control policies, and enabling institutional deficiencies to be detected. Estimated to cost 200,000 Euros.

Box 4 Educational outreach and incentives to screen for TB in primary care

Evidence statement 4: Educational outreach and incentives to GPs can increase TB screening and diagnosis of TB in people presenting at primary care

There is moderate evidence from one London UK study[1] (++) that education outreach visits by specialist TB nurses and academic GPs to GP practices, together with practice computer system prompts and a £7 incentive for TST administration, can increase the proportion of people screened for TB at registration health check, compared with usual practice (57% v 0.4%). This increased the diagnosis of active TB (47% v 34%; OR 1.68, 95% CI 1.05 – 2.68), and latent TB (19% v 9%; OR 3.00, 95% CI 0.98 – 9.20), compared with usual care. This may be inferred to reduce diagnostic delay.

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because there are no obvious differences in the delivery of this type of intervention in the included study compared to how it could be delivered in the UK. However, the study may only be applicable to high incidence TB areas; in areas of the UK with a lower incidence of TB, the rates of people presenting with TB in primary care may be much less.

1 Griffiths et al, 2007 (++)

Outcome	Negative or no effect	Non-significant positive effect (study quality)	Significant positive effect (study quality)
Contact tracing			
Diagnostic delay		1 (++)	1 (++)
Treatment completion			
Other outcomes			1 (++)

Summary of component studies				
Study code	**Study detail**	**Intervention / Comparator**	**Population / Setting**	**Outcomes (intervention v comparator)**
1	Griffiths et al, 2007 (++) Pragmatic RCT London, UK Total=93,970 I=44,968 C=48,984	**Intervention:** A specialist TB nurse and academic GP made an educational outreach visit to each intervention practice to promote TB screening and raise TB awareness. They distributed screening guidelines. Prompts were included into the practice computer system for registration health checks to remind clinicians to ask the screening questions. Equipment for TST was provided. Telephone support from a specialist TB nurse was available. A financial incentive of £7 was paid to the practice for each TST administered. **Comparator:** Patients at general practices randomised to the control group received usual care. These general practices received no contact. Some practices in the control group had already been administering TST and continued to do so.	**Population:** Persons registering as new patients at general practices in the City and Hackney Teaching Primary Care Trust (PCT) during 1 June, 2002 – 1 October, 2004 **Setting:** General practice.	**Diagnostic delay related outcomes:** **Proportion patients screened for TB at registration health check:** 57% (13,478/23,573) v 0.4% (84/23,051) **TST undertaken:** 8.5% (1996/23,573) v 0.4% (84/23,051) **Active TB Diagnosis** 47% (66/141) v 34% (54/157) OR:1.68 (95% CI1.05 – 2.68; p=0.03) **Latent TB Diagnosis** 19% (11/58) v 9% (5/68) OR: 3.00 (95% CI 0.98 – 9.20; p=0.055) **Other outcomes:** **BCG coverage:** Rate: 26.8 per 1000 v 3.8 per 1000 Rate ratio: 9.52 (95% CI 4.0 – 22.7; p<0.001)

Box 5 Cultural community health workers for immigrant communities

Evidence statement 5: Community health workers can increase contact tracing in immigrant communities

There is moderate evidence from one Barcelona study[1] (+) that community health workers from immigrant communities working alongside public health nurses can improve contact tracing performed in all TB cases (66% v 55%; p<0.001) and performed in smear positive cases (82% v 66%; p<0.001), compared with public health nurses alone.

Applicability
The evidence is partially applicable to TB service delivery in the UK. This is because the demographics of TB patients and contact tracing policies in the UK may vary from those in Barcelona. The results of the study may be most applicable to areas of the UK where there is a high incidence of TB in people from immigrant communities.

1 Ospina et al, 2012 (+)

Outcome	Negative or no effect	Non-significant positive effect (study quality)	Significant positive effect (study quality)
Contact tracing			1 (+)
Diagnostic delay			
Treatment completion			
Other outcomes			

Summary of component studies				
Study code	**Study detail**	**Intervention / Comparator**	**Population / Setting**	**Outcomes (intervention v comparator)**
1	Ospina et al, 2012 (+) Cohort Study Barcelona, Spain Total=960 I=388 C=572	**Intervention:** Contact tracing with public health nurses and five community health workers from different immigrant communities (Asia, North Africa, Sub-Saharan Africa, China, and Latin America). The community health worker was a community member of the immigrant community. **Comparator:** Contact tracing with public health nurse Limited detail of comparator but some mention that at this period in time the healthcare system was not set up to cope with the large amount of immigration that occurred from high TB endemic countries who did not speak Spanish	**Population:** Foreign born people with TB in Barcelona **Setting:** Community	**Contact tracing performed in all TB cases** 66.2% (257/388) v 55.4% (317/572) p <0.001 **Contact tracing performed in smear positive TB cases** 81.6% (124/152) v 65.7% (132/201) p <0.001 **Adjusted odds of not performing contact tracing in smear positive TB cases in the absence of community health workers** OR 2.4 (95% CI 1.3 to 4.3; p=0.005) The community health workers conducted active-follow up in 194 TB cases and contact census, 264 individualised and 97 group educational sessions about TB, 280 home visits, 70 hospital visits and 5,935 telephone calls.

Box 6 Mobile screening in underserved groups

Evidence statement 6: Mobile screening can improve treatment completion and active case finding in underserved people

There is strong evidence from two studies (London UK [++],[1] Netherlands [+][2]) that a community based mobile radiography unit can increase active case finding by between 23-30% in underserved groups in an urban setting, compared with passive case finding/before mobile screening was introduced.

The UK study [++] provides moderate evidence that when a mobile radiography unit is combined with case holding and support it can be used to improve treatment completion (54.6% v 46.2% in first year of treatment) compared with passive case finding. The UK study [++] also provides moderate evidence that the service can be cost-effective, with an ICER of less than £10,000 per QALY.

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because there are no obvious differences in the delivery of mobile screening in the included studies compared to how it could be delivered in the UK. However, the results of the study may be most applicable to areas of the UK where there is a high incidence of TB in underserved groups.

1 Jit et al, 2011 (++)
2 De Vries et al, 2007 (+)

Outcome	Negative or no effect	Non-significant positive effect (study quality)	Significant positive effect (study quality)
Contact tracing			
Diagnostic delay		1 (++)	2 (+)
Treatment completion		1 (++)	
Other outcomes		1 (++) 2 (+)	

Summary of component studies				
Study code	**Study detail**	**Intervention / Comparator**	**Population / Setting**	**Outcomes (intervention v comparator)**
1	Jit et al. 2011 (++) Economic evaluation alongside a cohort study London, UK Total=668 I=416 C=252	**Intervention:** Find and Treat service, comprised of a mobile radiography unit, awareness raising, case holding, and support to complete treatment **Comparator:** passively presenting TB cases	**Population:** Underserved groups defined as persons in drug treatment services, and hostels or day centres for homeless and impoverished people **Setting:** Community, including hostels, homeless shelters and day centres	**Treatment completion** Previously untreated cases referred for treatment after screening- If in first year of treatment: 54.6% v 46.2% If in subsequent year of treatment: 67.1% v 56.8% **Diagnostic delay/active case finding** Estimated proportion of patients with the longest delays between symptom onset and treatment presentation found by Find and Treat service who likely would not have presented for treatment otherwise: 22.9% **Other outcomes** Lost to follow-up after one year in previously untreated cases: 2.1% v 17.2% Lost to follow-up after one year in complex patients: 2.6% v 34.7% The cost-effectiveness of Find and Treat was estimated at £6,400-£10,000 per QALY.
2	De Vries (+) Before and	**Intervention:** A mobile screening unit	**Population:** Illicit drugs users with a registered address and homeless	**Diagnostic delay/active case finding** Proportion cases found with mobile screening v prior to program: 59.2% (42/71) v 29.5% (26/88) (p < 0.001)

| after, Rotterdam, Netherlands Total=1,811 I=206 C=NR | with digital X-ray unit. **Comparator:** Before mobile screening was introduced | persons living in Rotterdam **Setting:** Community, including hostels, homeless shelters and day centres | **Other outcomes** Proportion smear positive cases among illicit drug users/homeless persons: 2002 – 2005 (after screening): 47.9% (34/71) 1997 – 2001: 58.0% (51/88) 1993 – 1996: 55.3% (26/47) (p=.11) |

Box 7 Peer educators for underserved groups

Evidence statement 7: The impact of peer educators on TB testing uptake in under-served groups is mixed

There is mixed evidence from two London UK studies[1,2] ([–], [+]) that peer educators working alongside mobile x-ray units can increase uptake of TB testing. One study[1] found that introducing peer educators increased uptake of testing compared with no peer education support (75% v 44%). A subsequent study[2] found no difference in uptake of testing via the mobile x-ray units with or without peer educator support (RR 0.98%; 95% CI 0.80 to 1.20). However, the latter study may have been confounded by control hostels having received peer educator involvement prior to enrolment in this trial, which may have underestimated the effect of peers.

Applicability
The evidence is directly applicable to TB service delivery in the UK. However, the results of the study may be most applicable to areas of the UK where there is a high incidence of TB in underserved people.

1 Hall et al, 2010 (–)

2 Aldridge et al, 2014 (+)

Outcome	Negative or no effect	Non-significant positive effect (study quality)	Significant positive effect (study quality)
Contact tracing			
Diagnostic delay	2 (+)	1 (–)	
Treatment completion			
Other outcomes		1 (–)	

Summary of component studies				
Study code	**Study detail**	**Intervention / Comparator**	**Population / Setting**	**Outcomes (intervention v comparator)**
1	Hall et al, 2010 (–) (abstract) Before and after London, UK Total=7 peer educators I=7 peer educators C=NR (presumably 0)	**Intervention:** Former TB patients with a history of homelessness and drug/alcohol dependence were trained as peer educators to work alongside mobile screening units and TB clinics. **Comparator:** Presumably before the introduction of peer educators but no detail provided	**Population:** Underserved people (homeless or drug/alcohol dependence) in London **Setting:** Community	**TB screening uptake following peer educator training of hostels workers** 75% v 44% (p value not reported) **Other outcomes** Interviews with service users highlighted importance of peer educators in raising TB awareness and promoting service access. Peers recruited 3200 hard-to-reach clients at 101 screening sessions resulting in 45 hospital referrals.
2	Aldridge et al, 2014 (+) (abstract) Cluster RCT London, UK **Total=**46 hostels **I=**22 hostels **C=**24 hostels	**Intervention** Hostel staff encouraging screening with the addition of peer educators with direct experience of TB and/or homelessness. Peers encouraged screening by speaking and contacting residents. **Comparator** Current practice of hostel staff encouraging screening	**Population:** Residents in hostels in London that were not on active TB treatment and had not had a chest x-ray within last 6 months. **Setting:** Hostels	**Screening uptake (diagnostic delay)** **Poisson regression:** RR 0.98% (95% CI 0.80 to 1.20) **Screening rate** **Overall:** 44% uptake (IQR 26,59) **Intervention:** 45% uptake (IQR 33,55) **Control:** 40% (IQR 25,61)

Box 8 Rapid radiology referral for suspected TB patients

Evidence statement 8: Rapid access referral triggered by radiology coding of abnormal chest x-rays can reduce diagnostic delay in TB patients

There is moderate evidence from one Leicester UK study[1] (+) that rapid access referral triggered by radiology coding of abnormal chest x-rays statistically significantly reduces the duration of symptoms in non-pulmonary TB (78.4 v 122.1 days; p=0.03) and smear positive pulmonary TB (60.2 v 95.9 days; p=0.03). There was a non-significant reduction in the duration of symptoms in smear negative pulmonary TB (80.4 v 100.1 days; p>0.05). There was a non-significant lower rate of contact tracing with radiology referral compared with other diagnostic pathways (mean number of contacts 4.57 v 4.91; p>0.05).

Applicability
The evidence is directly applicable to TB service delivery in the UK. However, the results may be most applicable to areas of the UK where there is a high incidence of TB.

1 Verma et al, 2011 (+)

Outcome	Negative or no effect	Non-significant positive effect (study quality)	Significant positive effect (study quality)
Contact tracing	1 (+)		
Diagnostic delay		1 (+)	1 (+)
Treatment completion			
Other outcomes			

Summary of component studies				
Study code	**Study detail**	**Intervention / Comparator**	**Population / Setting**	**Outcomes** (intervention v comparator)
1	Verma et al, 2011 (+) (abstract) Retrospective cohort Leicester, UK Total=588 I=288 C=300	**Intervention:** Rapid access which is triggered by appropriate coding of abnormal chest x-rays by the reporting radiologist and/or a list of red flag symptoms on a proforma **Comparator:** 'Other pathways to diagnosis'	**Population:** People diagnosed with TB in Leicester **Setting:** Health service	**Diagnostic delay** Average duration of symptoms non-pulmonary TB (days) 78.4 v 122.1 (p=0.03) Average duration of symptoms smear positive pulmonary TB (days) 60.2 v 95.9 (p=0.03) Average duration of symptoms smear negative pulmonary TB (days) 80.4 v 100.1 (p>0.05) **Contact tracing** % associated with contacts 81.6 v 90 (p>0.05) Mean number of contacts 4.57 v 4.91 (p>0.05)

Box 9 MDR-TB control programme for MDR-TB patients

Evidence statement 8: Comprehensive MDR-TB control programme can improve treatment completion in MDR-TB patients

There is moderate evidence from one NYC study[1] (+) that a comprehensive MDR-TB control programme can improve treatment completion in MDR-TB patients (44% v 12%; p<0.001) and reduce death prior to treatment completion (39% v 69%; p<0.001, compared with outcomes reported at the start of the programme.

Applicability
The evidence is partially applicable to TB service delivery in the UK. This is because the demographics and management of MDR-TB patients in the UK may vary from those in NYC.

1 Munsiff et al, 2006 (+)

Outcome	Negative or no effect	Non-significant positive effect (study quality)	Significant positive effect (study quality)
Contact tracing			
Diagnostic delay			
Treatment completion			1 (+)
Other outcomes			1 (+)

Summary of component studies				
Study code	**Study detail**	**Intervention / Comparator**	**Population / Setting**	**Outcomes (intervention v comparator)**
1	Munsiff et al, 2006 (+) Retrospective cohort NYC, USA Total=856 I=46 (1997) C=303 (1992)	**Intervention:** A comprehensive MDR-TB programme. This involved, a central MDR-TB Surveillance Coordinator who oversaw regional MDR-TB coordinators assigned to the 5 NYC boroughs. There were multiple providers. **Comparator:** A comparison was made with outcomes in 1992, the start of the programme, with outcomes achieved in 1997.	**Population:** Patients with TB who are resistant to at least isoniazid and rifampin, and who had ≤30 days of anti-tuberculosis treatment prior to the collection of the first MDR-TB specimen. **Setting:** NYC TB service	**Treatment completion** 43.5% v 11.6% (p<0.001) **Death prior to treatment completion** 39.1% v 69.0% (p<0.001) **Started on MDR-TB treatment** 78% v 56% (p<0.001)

Box 10 Involuntary detention for non-compliant TB patients

Evidence statement 9: Involuntary detention can improve treatment completion in non-compliant TB patients

There is moderate evidence from one NYC study[1] (+) that involuntary detention followed by court-ordered DOT improves treatment completion in non-compliant patients compared with standard DOT (95% v 89%).

Applicability
The evidence is partially applicable to TB service delivery in the UK. This is because the demographics and management of non-compliant TB patients in the UK may vary from those in NYC.

1 Pursnami et al, 2014 (+)

Outcome	Negative or no effect	Non-significant positive effect (study quality)	Significant positive effect (study quality)
Contact tracing			
Diagnostic delay			
Treatment completion		1 (+)	
Other outcomes			

Summary of component studies				
Study code	**Study detail**	**Intervention / Comparator**	**Population / Setting**	**Outcomes** (intervention v comparator)
1	Pursnami et al, 2014 (+) Retrospective cohort NYC, USA Total=149 I=79 C=70	**Intervention:** Involuntary detention of patients with TB for completion of TB treatment because of non-adherence, followed by court-ordered DOT as necessary. **Comparator:** Outpatient DOT TB treatment at Bellevue Hospital Chest Centre.	**Population:** Patients undergoing TB treatment in the Bellevue Hospital Chest Service, NYC, between January 1st 2002 and December 31st 2009. **Setting:** Hospital	**Treatment completion** 95% v 89% **Other results – correlations** Multivariate analysis Independent predictors of detention (when controlling for other variables): Presence of substance abuse: OR 9.25 (95% CI 2.81-30.39, p<0.001) Mental illness: OR 5.80 (95% CI 1.18-28.51, p=0.03) NB: The authors called for greater co-ordination between mental health service, drug services and TB services.

Summary

The results of the effectiveness review provide evidence of a range of service delivery models/interventions that can be used to improve contact tracing, diagnostic delay and treatment completion at the whole system level and for specific sub-groups, such as underserved individuals, immigrant communities and people with MDR-TB. However, there is no single intervention that appears to be able to address all three outcomes, and much of the evidence of specific interventions is limited to one or two studies.

5. Economic review

This chapter explores the literature on the economics of service delivery models for the delivery of TB services. The aim of this review was to identify any economic studies, including cost-utility, cost-effectiveness, cost-benefit, cost-consequence, and cost-impact analyses, that captured the economic impact of changes to TB service delivery with a priority focus (but not limited) to reducing diagnostic delay, contact tracing and improving treatment completion. There was no limit on the perspective or time horizon of the evaluation. See the Methods section for further details.

Included studies

Four economic studies were included: one full economic evaluation and three cost impact studies. See the Methods section for further details of the evidence flow and identification of studies.

Critical appraisal of included studies

The critical appraisal of the included studies is presented in Table 10. One study was graded as having minor limitations (++), two studies as having moderate limitations (+), and one study as having major limitations (–). The critical appraisal of each study is discussed below in the relevant section.

Characteristics of the included studies

An overview of the four included studies is presented in Table 9. Full evidence tables are presented in Table 13. A discussion of the methods and results of each of the studies is presented below, split into cost-utility and costing studies, to aid interpretation.

Please note that two of the studies were also included in the effectiveness review (Jit et al, 2011; King et al, 2009). However, in the effectiveness review the main focus was on the clinical outcomes data; this section focuses primarily on the economic data available.

Table 9 Characteristics of the included economic studies

Study (QA)	Type of analysis	Location	Population	Intervention	Comparator	Economic outcome	Key clinical outcomes in study	Estimated rate of TB Per 100,000 [a]
Brian, 2009 (–)	Cost impact analysis	Leeds, UK	HIV patients	TB testing in HIV clinic	No TB testing	Costs of TB testing	• Latent TB testing in HIV patients	16.8 [b]
Jit et al, 2011 (++)	Cost utility analysis	London, UK	Underserved individuals at risk of pulmonary TB	Find and Treat service	Passive case finding combined with ad hoc outreach	Cost/QALY	• Treatment completion • Lost to follow-up	41 [c]
King et al, 2009 (+)	Cost impact analysis	Bristol, UK	Patients referred to TB nurses	Community-based TB nurse-led service	Monthly clinic visit	Cost savings	• Treatment completion • Uninterrupted medication • Assessment for DOT • HIV counselling • Monthly reviews	18 [d]
Li, 2007 (++)	Cost impact analysis	NYC, USA	Close contacts of pulmonary TB patients	HIV counselling, testing and referral (CTR)	No HIV testing	Costs of CTR	• Knowledge of HIV status • Patients offered HIV information and CTR	12 [e]

a These rates were taken from other sources to try and give an indication of the rate of TB being experienced in that area at the time the study was conducted

b Estimates based on 2009 data taken from http://www.leeds.gov.uk/docs/Public%20Health%20Annual%20Report.pdf

c Estimates based on 2012 data taken from http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317140109893

d Estimates based on 2006 data taken from http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1203928719558

e Estimates based on 2007 data taken from http://www.nyc.gov/html/doh/html/pr2013/pr007-13.shtml

Table 10 Critical appraisal of the economic studies

Reference	Applicability								Overall judgement	Study limitations											Overall assessment
	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8		2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	2.11	
Brian et al, 2009 (abstract)	++	++	++	?	+	NA	NA	NA	Directly applicable	NA	NA	+	+	?	?	?	?	NA	NA	?	Major limitations
Jit et al, 2011	++	++	++	++	++	++	++	++	Directly applicable	++	++	++	++	+	++	+	++	++	++	-	Minor limitations
King et al, 2009 (abstract)	++	++	++	?	++	NA	NA	NA	Directly applicable	NA	NA	+	++	++	?	+	?	NA	NA	?	Moderate limitations
Li et al, 2007	++	++	?	-	-	NA	NA	NA	Partially applicable	NA	NA	+	++	++	?	++	++	NA	NA	?	Moderate limitations

++ Yes; + Partly; - No; NA Not applicable; ? Unclear

Key to questions:
1.1 Is the study population appropriate for the topic being evaluated?
1.2 Are the interventions appropriate for the topic being evaluated?
1.3 Is the system in which the study was conducted sufficiently similar to the current UK context?
1.4 Was/were the perspective(s) clearly stated and what were they?
1.5 Are all direct health effects on individuals included, and are all other effects included where they are material?
1.6 Are all future costs and outcomes discounted appropriately?
1.7 Is the value of health effects expressed in terms of quality-adjusted life years (QALYs)?
1.8 Are costs and outcomes from other sectors fully and appropriately measured and valued?
2.1 Does the model structure adequately reflect the nature of the topic under evaluation?
2.2 Is the time horizon sufficiently long to reflect all important differences in costs and outcomes?
2.3 Are all important and relevant outcomes included?
2.4 Are the estimates of baseline outcomes from the best available source?
2.5 Are the estimates of relative 'treatment' effects from the best available source?
2.6 Are all important and relevant costs included?
2.7 Are the estimates of resource use from the best available source?
2.8 Are the unit costs of resources from the best available source?
2.9 Is an appropriate incremental analysis presented or can it be calculated from the data?
2.10 Are all important parameters whose values are uncertain subjected to appropriate sensitivity analysis?
2.11 Is there any potential conflict of interest?

Cost utility study

Only one cost utility study was identified (Jit et al, 2011). This study was conducted in underserved individuals at risk of TB. Jit et al, 2011 undertook a patient level evaluation of the Find and Treat service over a life-time time horizon compared with passive case finding of active pulmonary TB in underserved people in London (for a definition of what Find and Treat entails see Table 9 below). At the time the study was conducted, London was considered a high incidence area of the UK – see Table 9 (which is still the case in London in 2014). The study used a discrete, multiple age cohort, compartmental model with four health states. The study found that the base case incremental cost-effectiveness ratio (ICER) for the service as a whole was £6,400; for the screening component was £18,000, and for the case management component was £4,100. Even under the most unfavourable assumption tested in the model the ICER never increased above a willingness to pay threshold of £10,000 for the service as a whole, and £26,000 for the screening component. As such, the authors concluded that the London Find and Treat service was a cost-effective service. A brief overview of the key results of the study is presented in Table 11 and Table 12

The critical appraisal of this study is presented in Table 10. Overall the quality of this study was high, and the study was likely to have minor limitations. The main limitation with the internal validity of the study was due to the non-randomised study design potentially biasing the outcomes. The authors deemed that this bias was likely to underestimate the benefit of the Find and Treat service.

Overall, the results from Jit et al, 2011 indicate that a Find and Treat service is likely to be cost-effective compared with passive case finding. The study was high quality and generalisable to the UK as a whole, although may only be directly applicable to high TB incidence areas.

The evidence statement derived from this study is available in Box 6 in the Effectiveness Review chapter.

Table 11 Results of the Find and Treat Service

	Find and treat	**Passive case finding**	**Difference**
Costs at the service level*			
Find and Treat service	£1,000,000[#]	£0	£1,000,000
Diagnostic tests	£730	£330	£400
Treatment	£690,000	£310,000	£400,000
TOTAL	£1,700,000	£310,000	£1,400,000
QALYs at the service level*			
QALYs gained	1100	920	220
Incremental cost-utility ratio			**£6,400**

* Data were taken directly from the paper and reported as being rounded to two significant figures.

Comprised of both the mobile screening unit (£530,024) and the case management (£512,825).

Table 12 Cost-effectiveness of the Find and Treat service under various scenarios

	Find and treat (as a whole)	Mobile screening alone	Case management alone
Costs at the service level*			
Base case	£6,400	£18,000	£4,100
Most unfavourable scenario to Find and Treat (multi-way SA)	£10,000	£26,000	£6,800

* Data were taken directly from the paper and reported as being rounded to two significant figures.

Cost impact studies

Three cost impact studies of actual or possible changes to TB service delivery or configuration were identified: two conducted in the UK and one in NYC. None of these areas were considered high TB incidence areas at the time that the studies were undertaken; furthermore, the rates of TB being experienced are quite similar across the studies (12-18%, see Table 9 above). As such it seems reasonable to discuss these studies in terms of the service being implemented, rather than the geographic location.

Using a nurse led TB service (one study)

One cost impact study was conducted in Bristol, UK which compared a nurse-led TB service with the previous system of monthly hospital clinic visits (King et al, 2009). The study was only available as an abstract; thus only limited information was available. The study looked at the costs of implementing the new service as well as the benefits of the service in terms of key outcomes such as treatment completion. The study estimated that the nurse-led service saved £27,872 due to 268 reviews being replaced by nurses at a saving of £104 per review. The outcomes reported were as follows (previous clinic service versus nurse-led service): treatment completion: 84% v 94%; uninterrupted medication: 15% v 92%; assessment for need for DOT: 5% v 92%; monthly reviews: 59% v 86%; monthly reviews not attended: 17% v 6%; HIV counselling: 32% v 69%.

The critical appraisal of King et al, 2009 is presented in Table 10. The quality of this study was moderate. For an abstract the study was well reported although certain details were not available, which makes is difficult to validate the results. However, the study is directly applicable to the UK and provides an indication that a nurse-led service can improve important clinical outcomes and reduce costs.

The evidence statement derived from this study is available in Box 2 in the Effectiveness review chapter.

Testing for latent TB in a HIV service (one study)

Brian, 2009 was conducted in Leeds, UK and assessed the feasibility of how screening for latent TB can be implemented for newly diagnosed HIV patients. This study was only available as an abstract; hence, limited details were available. The study estimated that if a new screening programme was introduced the costs would be £12,760 to £23,720 per year (latent TB rate 20-30%), which was less than the estimated £14,776 to £53,194 for treating

active TB cases (progression rate of latent to active TB 20-40%). The process outcomes reported were as follows: of the 101 HIV patients, 24 patients were screened for latent TB: 3 patients were screened at time of diagnosis, and 21 were screened later. Of the 24 screened, four tests were found to be abnormal and three patients received treatment for latent TB.

The critical appraisal of Brian, 2009 is presented in Table 10. The quality of this study was weak (–) and the study was likely to have very serious limitations. The main limitations with the internal validity of the study were potentially due to the poor reporting of the study methodology, which made it difficult to determine the reliability of costs estimates.

The evidence statement derived from this study is available in Box 11 below, together with a visual representation of the evidence.

Box 11 Testing for latent TB in a HIV service

Evidence statement 10: Testing for latent TB in a HIV service can increase diagnosis of latent TB in HIV patients

There is weak evidence from one Leeds UK study[1] (–) that testing for latent TB in a HIV clinic can identify cases of latent TB (24/101 people tested, of which 4 tests were abnormal). This could be inferred to reduce diagnostic delay. The costs were estimated to be £12,760-£23,720 per year, compared with £14,776 to £53,194 for treating active cases.

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because the demographics of HIV-TB patients and HIV-TB screening policies in this study are likely to be the same as in the rest of the UK.

1 Brian et al, 2009 (–)

Outcome	Negative or no effect	Non-significant positive effect (study quality)	Significant positive effect (study quality)
Contact tracing			
Diagnostic delay		1 (–)	
Treatment completion			
Other outcomes		1 (–)	

Summary of component studies				
Study code	**Study detail**	**Intervention / Comparator**	**Population / Setting**	**Outcomes (intervention v comparator)**
1	Brian et al, 2009 (–) Cost impact analysis alongside a feasibility study Leeds, UK Total=101 I=NA C=NA	**Intervention:** Hypothetical scenario where screening for latent TB in a HIV clinic using Quantiferon TB Gold **Comparator:** No TB testing	**Population:** Newly diagnosed HIV patients **Setting:** Leeds HIV clinic	**Diagnostic delay** Of the 101 HIV patients, 24 patients were screened for latent TB: 3 patients were screened at time of diagnosis, and 21 were screened later. Of the 24 screened, 4 tests were found to be abnormal and three patients received treatment for latent TB. **Costs** If a new screening programme was introduced the costs would be £12,760-£23,720 per year (latent TB rate 20-30%), which compares with £14,776 to £53,194 for treating active cases (progression rate of latent to active TB 20-40%)

Testing for HIV in a TB service (one study)

Li et al, 2007 was conducted in NYC, USA and assessed how HIV counselling, testing, referral (CTR) could be implemented as part of the routine contact tracing of TB patients. The average cost of providing HIV CTR was estimated at $18 per contact. However, this was based on the variable total costs of $10,361 for the service and did not include the fixed costs, such as $286,000 for administration. The process outcomes reported were as follows: 93% provided HIV information; 29% newly tested. The knowledge of HIV status was 39% with HIV CTR versus 2% previously. However, no new cases of HIV were identified, although the study authors felt this was due to under powering of the study (N=569) without providing clear evidence to substantiate this.

The critical appraisal of Li, 2007 is presented in Table 10. The quality of this study was moderate, with the potential for serious limitations. The main limitation with the study was the heavy focus on variable costs (fixed costs were presented separately), which made it difficult to determine the true costs of setting up the service.

This study did not provide any results related to the review's key outcomes of reducing TB diagnostic delay, TB treatment completion or TB contact tracing. As such, it is presented here for information but does not form part of an evidence statement.

Summary

The results of the economic review provide evidence of the costs and benefits of several different service delivery interventions/models. However, all of the evidence of specific interventions is limited to one study; two of which were only available in abstract form. All of the studies focussed on individual aspects of TB service delivery. Only one study was a cost-utility analysis and presented economic data in terms of incremental cost effectiveness ratios.

Table 13 Data extraction of economic studies

Study Details	Population and setting	Intervention / comparator	Outcomes and methods of analysis	Results	Notes
Authors: Brian R, Stewart C, Okpaluba U, and Evans A **Year:** 2009 **Citation:** Introducing a protocol for diagnosing and treating latent TB in newly diagnosed HIV patients: feasibility and cost-effectiveness. *HIV Medicine 10* (sup 1), P72, p31 (Abstract) **Aim of study:** To assess the potential impact of introducing latent TB screening for newly diagnosed HIV patients **Type of economic analysis:** Cost impact analysis alongside a feasibility study **Economic perspective:** Although not explicitly stated, it appeared to be NHS. Unclear what cost year was used – presumably 2007 **Quality score:** - (abstract) **Applicability:** ++	**Source population/s:** Newly diagnosed HIV patients **Setting:** HIV clinic in Leeds **Data sources:** Retrospective audit of a HIV clinical cross-referenced with data from TB clinic **Sample characteristics:** Newly diagnosed HIV patients; 70% born in Africa and 18% in UK	**Intervention description:** Hypothetical scenario where screening for latent TB in a HIV clinic using Quantiferon TB Gold **Comparator Description:** No testing **Sample sizes:** **Total:** N=101 **Intervention:** NA **Comparator:** N=101	**Outcomes:** Costs of screening Number of patients currently being screened **Time horizon:** NA **Discount rates:** NA **Perspective:** Although not explicitly stated, it appeared to be NHS **Measures of uncertainty:** NA **Modelling method:** NA	**Primary economic analysis:** If a new screening programme was introduced the costs would be £12,760-£23,720 per year (latent TB rate 20-30%), which compares with £14,776 to £53,194 for treating active cases (progression rate of latent to active TB 20-40%) **Secondary analysis:** Of the 101 HIV patients, 24 patients were screened for latent TB: 3 patients were screened at time of diagnosis, and 21 were screened later. Of the 24 screened, four tests were found to be abnormal and three patients received treatment for latent TB. **Sensitivity analysis:** NA	**Limitations identified by author:** • Quantiferon TB Gold has limitations in patients with low CD4 cell counts • The burden of polypharmacy • The need to avoid delays in initiation of antiretrovirals • The importance of excluding atypical TB cases **Limitations identified by review team:** • Very limited detail provided in abstract so difficult to judge **Evidence gaps and/or recommendations for future research:** NR **Study source of funding:** NR

Study Details	Population and setting	Intervention / comparator	Outcomes and methods of analysis	Results	Notes
Authors: Jit M, Stagg HR, Aldridge RW, White PJ, and Abubakar I **Year:** 2011 **Citation:** Dedicated outreach service for underserved patients with tuberculosis in London: observational study and economic evaluation. *BMJ 343*:d5376 **Aim of study:** To evaluate the cost-effectiveness of the Find and Treat service from September 2007 to July 2010 in London **Type of economic analysis:** Cost-utility using individual patient data from a cohort study **Economic perspective:** Although not explicitly stated, it appeared to be NHS and social service. All costs were inflated to 2009-10 prices **Quality score:** ++ **Applicability:** ++	**Source population/s:** Hard to treat individuals with active pulmonary tuberculosis screened or managed by the service **Setting:** Community **Data sources:** Retrospective data from Find and Treat database/records; HPA enhanced tuberculosis surveillance system; hospital and community health services pay and prices index; literature; utility scores were based on published EQ-5D scores **Sample characteristics:** Excluded cases: extrapulmonary tuberculosis, latent tuberculosis, and suspected tuberculosis; cases merely receiving	**Intervention/s description:** Find and Treat service including (1) mobile radiography unit which visits drug treatment centres, homeless shelters etc., and provides voluntary screening (2) enhanced case management service to support treatment completion (including home visits and accompanying clients to services, and links with other services e.g. drug support, criminal justice), and awareness raising **Comparator/control/s description:** London's enhanced surveillance service system which utilised a passive case finding approach combined with ad hoc outreach in some PCTs **Sample sizes:** **Total:** N=668 **Intervention:** N=416 (including N=48 identified by mobile screening unit, N=188	**Outcomes:** Cost per QALY **Time horizon:** Life time **Discount rates:** 3.5% **Perspective:** Although not explicitly stated, it appeared to be NHS and social service **Measures of uncertainty:** One-way sensitivity analyses on a range of conditions that are unfavourable to Find and Treat: • improved quality of life for untreated TB (0.68 to 0.76), and poor quality of life for TB cases on treatment (0.79 to 0.76); • asymptomatic cases detected by mobile screening unit do not always progress to symptomatic disease (50% of original); • increased costs for mobile screening unit (£530,024 to £600,000); • increased cost of TB treatment (drug sensitive and MDR-TB rise from £5,522 and £31,329, to £8,300 and £75,000	**Primary economic analysis:** Find and Treat as a whole: £6,400 per QALY (net cost of £1.4 million and gains 220 QALYs) **Key clinical outcomes: Find and Treat v control for previously untreated cases** Treatment completion in 1st year: 54.6 v 46.2% Lost to follow-up: 2.1% v 17.2% **Secondary analysis:** • Mobile screening unit alone: £18,000/QALY • Case management alone: £4,100/QALY **Sensitivity analysis:** The most unfavourable scenario, based on a combination of all most unfavourable one-way sensitivity analyses: • Find and Treat as a whole: £10,000/QALY • Mobile screening alone: £26,000 • Case management alone: £6,800 The range of individual one-way sensitivity analyses produced ICERs ranging from: • £6,500 to £7,600/QALY for Find and Treat as a whole	**Limitations identified by author:** The lack of an RCT and use of an observational comparator means that outcomes are uncertain. Methods used for modelling do not fully capture the benefits of the Find and Treat service as transmission was not taken into account. Did not measure the effect of the Find and Treat service on reducing the likelihood of patients developing and transmitting acquired drug resistance due to poor treatment adherence **Limitations identified by review team:** • The comparator of 'passive case finding' may not be the only relevant comparator and more effective comparators may exist; • the study is highly applicable to London, albeit with the issue of 'passive case finding' being only one possible comparator, but it is unclear how generalisable the study is to other high TB incidence UK areas which may have different service configurations and patient demographics; • the generalisability of this study to low TB incidence areas of the UK is doubtful

Study Details	Population and setting	Intervention / comparator	Outcomes and methods of analysis	Results	Notes
	prophylaxis (and hence unlikely to have active tuberculosis); cases for which the diagnostic delay could not be calculated; and cases younger than 16 years	referred to Find and Treat for case management support, N=180 referred to Find and Treat for loss to follow-up). All evaluated between September 2007 and September 2010. **Control:** N=252 evaluated between January 2009 and August 2010	respectively); • cases referred to Find and Treat service for enhanced case management have a reduced loss to follow-up rate in the absence of the service (34.7% to 17.2%); • cases referred to Find and Treat service for loss to follow-up could still passively re-engage with treatment (51%) **Modelling method:** A discrete, multiple age cohort, compartmental model with four health states: active untreated TB; active treated TB with upto 125 days of treatment; active treated TB with more than 125 days of treatment; lost to follow-up. Four final (absorbing) outcomes were modelled: completion of treatment; death due to TB; death due to other causes; other outcomes which Find and Treat is not anticipated to change	• £18,000 to £22,000 for mobile screening alone • £4,100 to £5,600 for case management alone	**Evidence gaps and/or recommendations for future research:** • Point of care testing within community outreach settings, such as mobile screening units; • the role of community treatment delivery; • a randomised trial of the Find and Treat service **Study source of funding:** English Department of Health

Study Details	Population and setting	Intervention / comparator	Outcomes and methods of analysis	Results	Notes
Authors: King R, Carter M, Mungall SB, and Hetzel MR **Year:** 2009 **Citation:** Does a specialist TB nurse service improve outcome? *Thorax; 64* (sup IV), P110, A121(Abstract) **Aim of study:** To assess whether a specialist TB nurse service improves outcomes **Type of economic analysis:** Cost impact analysis of a service change following guideline implementation **Economic perspective:** Although not explicitly stated, it appeared to be NHS. Unclear what cost year was used – presumably 2006 and 2008 **Quality score:** + (Abstract) **Applicability:** ++	**Source population/s:** All patients referred to TB service **Setting:** TB service in Bristol **Data sources:** Retrospective audit of TB service in 2008 compared with audit conducted in 2006 and HPA notifications in 2006 **Sample characteristics:** Patients referred to Tb service Excluded patients: • partially treated before referral • given chemoprophylaxis • changed diagnosis • died	**Intervention description:** Nurse led TB service **Comparator Description:** Previous system of monthly hospital clinic visits **Sample sizes:** **Total:** N=136 **Intervention:** N=59 **Comparators:** Audit cases (2006a): N=19 HPA notification cases (2006b): N=58	**Outcomes:** Costs savings of new service Treatment completion and a range of other clinical outcomes **Time horizon:** NA **Discount rates:** NA **Perspective:** Although not explicitly stated, it appeared to be NHS **Measures of uncertainty:** NA **Modelling method:** NA	**Primary economic analysis:** • Costs saved due to replacing outpatient clinic reviews= £27,872 (based on 268 reviews replaced by nurses at a cost of £104 per review) **Secondary analysis 2006 service v 2008 nurse-led service:** • Treatment completion: 84% v 94% • Uninterrupted medication: 15% v 92% • Assessment for DOT: 5% v 92% • Monthly reviews: 59% v 86% • Monthly reviews not attended: 17% v 6% • HIV counselling: 32% v 69% **Additional outcomes associated with nurse-led service:** • 97% of patients were given nurse contact details within 2 working days • TB nurses undertook 771 additional face-to-face or telephone contacts (mean =15 per patient) **Sensitivity analysis:** NA	**Limitations identified by author:** NR **Limitations identified by review team:** • Very limited detail provided in abstract so difficult to judge **Evidence gaps and/or recommendations for future research:** NR **Study source of funding:** NR

Study Details	Population and setting	Intervention / comparator	Outcomes and methods of analysis	Results	Notes
Authors: Li J, Marks M, Driver C, et al **Year:** 2007 **Citation:** Human immunodeficiency virus counselling, testing, and referral of close contacts to patients with pulmonary tuberculosis: feasibility and costs *J Public Health Management Practice; 13* (3), 252-62 **Aim of study:** To increase HIV counselling, testing, referral (CTR) and knowledge of HIV status of close contacts of TB patients, and improve TB screening and treatment of HIV-infected contacts **Type of economic analysis:** Cost impact analysis of the implementation of HIV CTR into contact tracing **Economic perspective:** NR – presumably health system perspective. Cost year: 2003 **Quality score:** + **Applicability:** +	**Source population/s:** All close contacts of TB patients notified in Manhattan between December 2002 and November 2003 **Setting:** TB service in NYC **Data sources:** Data captured during the study **Sample characteristics:** Excluded patients: • Contacts younger than 13 years unless the biological mother was the index TB case and HIV infected	**Intervention description:** Contacts were provided with HV information and offered HIV counselling and testing **Comparator Description:** No testing **Sample sizes:** **Total:** N=569 **Intervention:** N=569 **Comparators:** NA	**Outcomes:** Costs of CTR Knowledge of HIV status **Time horizon:** NA **Discount rates:** NA **Perspective:** Although not explicitly stated, it appeared to be the health system perspective **Measures of uncertainty:** NA **Modelling method:** NA	**Primary economic analysis:** Variable costs: • Total variable cost to implement service = $10,361 • Average per contact cost for HIV information and CR: $18 per contact • Cost of providing HIV information: $1 per patient • Cost of CTR = $5 for not tested and $8 for those tested (as more attempted needed to ascertain refusal) • Cost of HIV pre-test counselling = $14 per patient • Cost of HIV testing = $24 per patient • Cost of HIV post-test counselling = $7 per patient • Cost of HIV results follow-up = $23 per patient Fixed costs • Total admin costs=$286,000 • Training = $1,735 • Transportation: $42 per HIV patient tested **Key clinical outcomes:** • Knowledge of HIV status 39% v 2% previously • 93% provided HIV info • 29% newly tested • 0% new HIV cases detected **Sensitivity analysis:** NA	**Limitations identified by author:** • The study was underpowered to detect HIV cases • Unable to use rapid HIV testing, thus no opportunity to compare HIV testing methods **Limitations identified by review team:** • The strong focus on variable costs underestimates the true costs of implementing the programme elsewhere, which also includes large fixed costs at initiation • The fact than no new cases of HIV were detected was not seen as indicating that patients with HIV are being identified in other ways and thus this is an unnecessary programme **Evidence gaps and/or recommendations for future research:** NR **Study source of funding:** CDC

6. Discussion

This report presented the findings of an evidence review on the organisation and delivery of TB services. The review focussed on evidence from the UK, together with evidence from New York City, Canada, Barcelona, and the Netherlands which could be used to inform service delivery in the UK. The review took a mixed-methods approach and presented case studies which described key aspects of service delivery, together with evidence on the effectiveness and cost-effectiveness/impact of service delivery models or interventions. A service delivery intervention/model was defined as any service adaptation, such as process changes, change in delivery setting or mode (including staff), change in structure, accountability or commissioning of a TB service.

Case studies

Overall, the case study profiles show that all of the included areas (UK and non-UK) have similar high risk population groups including foreign born people, people living with HIV, people who misuse substances, homeless people and prisoners (with the addition of the indigenous population in Canada), and broadly similar priorities and policy direction for example active case finding, targeting high risk groups, surveillance (including strain typing), improving treatment completion including enhanced case management and DOT, although the targeting and accountability for each element may have differed.

The findings from the case studies are summarised in the summary statements below.

Summary Statement 1: Service delivery and commissioning
In the UK, commissioning falls to the NHS and devolved across 200 area-based clinical commissioning groups (CCGs) working in partnership with Public Health England and local government to develop and deliver TB services. Public Health England provide some
Summary Statement 1: Service delivery and commissioning
In the UK, commissioning falls to the NHS devolved across 200 area-based clinical commissioning groups (CCGs) working in partnership with Public Health England and local government to develop and deliver TB services. Public Health England provide some national-level support (including surveillance and emergency response to outbreaks), but decisions about how services such as outreach programmes, nursing and DOT provision are commissioned rest at a local level with CCGs. This means that different areas, even neighbouring ones, or areas with similar profiles and incidence rates, may take very different approaches to service organisation and delivery.

The non-UK case studies organise the provision and delivery of TB services in different ways: New York City, Barcelona and the Netherlands all take a centralised approach, and although the lines of accountability may differ by place a centralised approach appears to help ensure clear responsibility for different elements of the service. In NYC, one body (the BTBC) is responsible for the whole system (NYC-DOHMH, 2013). In Barcelona the system is led by the Public Health Service with Public Health Nurses acting as the hub of the system supported by community health workers in high risk community settings and clinical unit nurse managers in the hospital sector (Cayla and Orcau, 2011). Similarly in the Netherlands MHS:GGD-NL specialist doctors, public health nurses and medical assistants have responsibility for providing diagnosis and treatment in the community in particular in those

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with complex social needs, whilst hospitals provide treatment for more clinically complex cases such as MDR-TB. The Canadian approach is perhaps more similar to the UK, with a mixture of national support and guidance from the national Public Health Agency with more regional decision making (territory or province) on how services are delivered. This appears to result in variation in service delivery, for example mobile clinics in Saskatchewan target a high risk indigenous population, but other areas with high risk groups do not provide this service (Government of Saskatchewan, 2012).

Summary Statement 2: Finance

Financial input appears to differ markedly with over $40,000 US dollars per notified case committed to TB in the Netherlands and Canada, $24,000 per case in NYC based on 2012 data to around $12,000 per case in London based on 2009 data, we were unable to identify a national picture for TB funding in the UK or funding data for Barcelona (WHO 'country profiles', 2013; Hayward et al, 2010; Menzies et al, 2008).

Summary Statement 3: Legislation

There are a wide range of legislative mechanisms and support for TB prevention and control in the case study areas, including pre-entry screening for immigrants and court ordered detention and treatment in NYC and Canada, and the recent launch of a pre-entry system (PHE, 2014d) and the power to detain and isolate but not treat non-compliant patients in the UK (Ohkado, 2005). The Netherlands take a preventative rather than enforcement approach with sanctions for screening immigrants and compulsory medical examination, but no detainment or enforced treatment, whilst Barcelona had no legislative control measures (Coker et al, 2007, Paolo, 2004; NYC-DOHMH, 2013).

Summary Statement 4: Contact Tracing

All areas included in this review deliver contact tracing using the same method (stone in the pond/concentric circle), with variation found in the staff who delivered it. In Barcelona community health workers recruited as 'peers' of the target group are involved in delivery of contact tracing. In the Netherlands, medical assistants support delivery of contact tracing and in NYC Public Health assistants deliver contact tracing: This may contribute to variations in the effectiveness of the contact tracing activity – see Effectiveness review. It may also impact on the capacity of specialist public health nurses to deliver other elements of services such as DOT or case reviews, where non-clinical staff take on specific tasks and free up clinical time for other activities (Cayla and Orcau, 2011; Ospina, 2012; Boar and de Vries, 2012).

Summary Statement 5: Targeting high risk groups

All case study places actively target high risk groups, although the approaches used differ. Pre-entry screening is well established in NYC and Canada and has been very recently introduced to the UK. NYC, Rotterdam and London also make use of outreach and mobile x-ray units to diagnose underserved groups such as the homeless (de Vries et al, 2007 and 2014; Hayward et al, 2010). However, it is not clear whether MXU outreach activities occur across the Netherlands or only in Rotterdam. Furthermore, in the UK this aspect of the service is only widely used in London (de Vries et al, 2007 and 2014; Hayward et al, 2010). Similarly, mobile outreach clinics being delivered in Northern territories in Saskatchewan

(Canada) to high risk indigenous communities are not available in other areas (Government of Saskatchewan, 2012).

Summary Statement 6: Treatment completion

DOT is a core element of service provision to improve adherence and treatment completion in all case study areas, in particular in relation to vulnerable groups or those at risk of non-adherence. However, the availability of DOT appears to differ markedly. In NYC DOT is a core element of the TB service, and many studies have concluded that consistent use of DOT is responsible for much of the decline in TB over recent years (NYC-DOHMH, 2002). In 2012 it formed the basis of the majority of treatment (487 of 651 cases ~ 75%) and is considered the standard of care, in NYC 94% of cases completed treatment within 12 months during this time (NYC-DOHMH, 2013). In Canada, DOT is recommended as the minimum level of support for patients with risk factors for non-adherence (Pan Canadian Public Health network, 2012), although the levels of delivery of DOT are unknown. In Barcelona again the incorporation of DOT into methadone programs has been credited with the dramatic decline of TB in people who inject drugs (Cayla and Orcau, 2011). UK data on the provision of DOT is only partially available: between 1.7 and 32% of cases received DOT in London and 0% in Bradford (Bothamley et al, 2011). Given the epidemiological profile of TB in the UK, it is likely that far fewer people were offered DOT than would benefit from it however without data on the proportion of cases who had a risk assessment and were subsequently offered or provided with DOT it is difficult to draw further conclusions.

Summary Statement 7: Staffing

Staffing ratios of nurses (or other staff) differ across the case study areas from 1:12[8] in NYC; 1:18 in the Netherlands and 1:35-45 in Barcelona. There is no UK data available to provide a national picture of TB staff:case ratio (Boer and de Vries, 2011; Bothamley, 2011; Cayla and Orcau, 2011). It should also be noted that in the Netherlands medical assistants support public health nurses to deliver case management including DOT and contact tracing in clients with complex needs in community based clinics. In Barcelona Community Health Workers support contact tracing in culturally similar high risk immigrant groups (Ospina et al, 2012),and in NYC trained Public Health Assistants are responsible for most case management including DOT, active case finding and contact tracing activities as well as providing formal case review as part of the cohort review process. These support workers are likely to off-set the workload of specialist TB nurses in these areas, freeing up clinical time for other duties. In the UK these activities are almost exclusively provided by specialist TB nurses.

Summary Statement 8: Surveillance

Surveillance is consistently prioritised as an important element of service delivery approaches at a national level with national systems for enhanced surveillance and a mandate to report all notified cases in all case study areas. Surveillance is overseen by a national agency in all cases and includes geno-typing/DNA fingerprinting as standard. It should be noted reliance on surveillance to support service delivery in Barcelona significantly

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[8] NYC and Netherlands ratios were calculated based on information and data identified during the review process.

pre-dates the recent National Plan highlighting the need for a national surveillance system (Cayla and Orcau, 2011).

Summary Statement 9: Cohort Review

New York City and the UK are both reported to use Cohort Review as a way to systematically review the management of every case of TB on the basis of treatment completion, contact investigation and case management process (Bothamley, 2011; Munsiff et al, 2006). Case managers are responsible for presenting the review of their cohort, this process is considered one of the most important approaches to program evaluation, service improvement and ensuring accountability in NYC (Munsiff et al, 2006). Whilst a number of cities in the UK cited delivery of cohort review (London, Manchester, Leeds and Leicester), it is not clear how systematic this approach is across the UK (Bothamley, 2011).

Effectiveness and cost-effectiveness/impact

The results of the effectiveness review provide evidence of a range of service delivery models/interventions that can be used to improve contact tracing, diagnostic delay and treatment completion at the whole system level and for specific sub-groups. There is, however, limited information on the cost-effectiveness/impact of service delivery models and interventions.

The findings of the comparative data from the effectiveness and economic reviews are summarised in the evidence statements below.

Evidence statement 1: Cohort review can improve contact tracing in TB patients

There is moderate evidence from one London UK study[1] (+) that cohort review can increase contact tracing of at least one contact identified (86% v 77%; p<0.001), compared with before cohort review was implemented. There was no difference in treatment completion (86% v 87%; p=0.6). Other outcomes, such as increased DOT refusal (30% v 10%; p=0.001) were identified as something to address and monitor in future cohort review. Overall, the process was seen as identifying problems and allowing whole system improvement.

There is moderate evidence from one NYC study[2] (+) that continuous cohort review can increase contact tracing over time (at least 90% of patients with appropriate contact investigation: 2004: 95.3% v 1999: 90.5%). Treatment completion rates were similar (86.5% v 85.7%), whilst treatment success was slightly lower over time (2004: 81% v 1999: 83%), compared with previous cohort review. Again a large benefit of the process was seen as identifying problems that could then be addressed.

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because there are no obvious differences in the delivery of cohort review in the included studies compared to how it could be delivered in the UK.

1 Anderson et al, 2014 (+)
2 Munsiff et al, 2006 (+)

Evidence statement 2: Nurse led service to improve treatment completion in TB patients and reduce costs

There is moderate evidence from one Bristol UK study[1] (+) that a nurse led service can increase treatment completion rates compared with previous monthly clinics and cases notified to HPA (94% v 84 v 55%%; p<0.0001). Other outcomes, such as assessment for DOT were also improved, compared with previous monthly clinics (92% v 5%; p<0.0001). The nurse led service was estimated to save £27,872 per year compared to monthly clinics, due to replacing 268 reviews (£104 each).

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because there are no obvious differences in the delivery of a nurse led service in the included study compared to how it could be delivered in the UK.

1 King et al, 2009 (+)

Evidence statement 3: DNA surveillance of TB cases can support conventional contact tracing

There is moderate evidence from one Netherlands study[1] (+) that DNA surveillance can support conventional contact tracing by increasing epidemiological links based on documented exposure (35% increase; p<0.001), although only 1% of contact investigations were extended. It was seen as being particularly useful training mechanism for inexperienced TB nurses, a method of monitoring the effects of new control policies, and enabling institutional deficiencies to be detected.

Applicability
The evidence is partially applicable to TB service delivery in the UK. This is because this study was conducted in the Netherlands which may have different contact tracing policies than the UK, which means that the expected benefits of DNA surveillance in the UK could be different.

1 Lamberts-van Weezenbeek et al, 2003 (+)

Evidence statement 4: Educational outreach and incentives to GPs can increase TB screening and diagnosis of TB in people presenting at primary care

There is moderate evidence from one London UK study[1] (++) that education outreach visits by specialist TB nurses and academic GPs to GP practices, together with practice computer system prompts and a £7 incentive for TST administration, can increase the proportion of people screened for TB at registration health check, compared with usual practice (57% v 0.4%). This increased the diagnosis of active TB (47% v 34%; OR 1.68, 95% CI 1.05 – 2.68), and latent TB (19% v 9%; OR 3.00, 95% CI 0.98 – 9.20), compared with usual care.

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because there are no obvious differences in the delivery of this type of intervention in the included study compared to how it could be delivered in the UK. However, the study may only be applicable to high incidence TB areas; in areas of the UK with a lower incidence of TB, the rates of people presenting with TB in primary care may be much less.

1 Griffiths et al, 2007 (+)

Evidence statement 5: Community health workers can increase contact tracing in immigrant communities

There is moderate evidence from one Barcelona study[1] (+) that community health workers from immigrant communities working alongside public health nurses can improve contact tracing performed in all TB cases (66% v 55%; p<0.001) and performed in smear positive cases (82% v 66%; p<0.001), compared with public health nurses alone.

Applicability
The evidence is partially applicable to TB service delivery in the UK. This is because the demographics of TB patients and contact tracing policies in the UK may vary from that in Barcelona. The results of the study may be most applicable to areas of the UK where there is a high incidence of TB in people from immigrant communities.

1 Ospina et al, 2012 (+)

Evidence statement 6: Mobile screening can improve treatment completion and active case finding in underserved people

There is strong evidence from two studies (London UK (++),[1] Netherlands (+)[2]) that a community based mobile radiography unit can increase active case finding by between 23-30% in underserved groups in an urban setting, compared with passive case finding/before mobile screening was introduced. This may be inferred to reduce diagnostic delay in this group.

The UK study (++) provides moderate evidence that when a mobile radiography unit is combined with case holding and support it can be used to improve treatment completion (54.6% v 46.2% in first year of treatment), compared with passive case finding. The UK study (++) also provides moderate evidence that the service can be cost-effective, with an ICER of less than £10,000 per QALY.

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because there are no obvious differences in the delivery of mobile screening in the included studies compared to how it could be delivered in the UK. However, the results of the study may be most applicable to areas of the UK where there is a high incidence of TB in underserved groups.

1 Jit et al, 2011 (++)
2 De Vries et al, 2007 (+)

Evidence statement 7: The impact of peer educators on TB testing uptake in under-served groups is mixed

There is mixed evidence from two London UK studies[1,2] ([–], [+]) that peer educators working alongside mobile x-ray units can increase uptake of TB testing. One study[1] found that introducing peer educators increased uptake of testing compared with no peer education support (75% v 44%). A subsequent study[2] found no difference in uptake of testing via the mobile x-ray units with or without peer educator support (RR 0.98%; 95% CI 0.80 to 1.20). However, the latter study may have been confounded by control hostels having received peer educator involvement prior to enrolment in this trial, which may have underestimated the effect of peers.

Applicability

The evidence is directly applicable to TB service delivery in the UK. However, the results of the study may be most applicable to areas of the UK where there is a high incidence of TB in underserved people.

1 Hall et al, 2010 (–)

2 Aldridge et al, 2014 (+)

Evidence statement 8: Rapid access referral triggered by radiology coding of abnormal chest x-rays can reduce diagnostic delay in TB patients

There is moderate evidence from one Leicester UK study[1] (+) that rapid access referral triggered by radiology coding of abnormal chest x-rays statistically significantly reduces the duration of symptoms in non-pulmonary TB (78.4 v 122.1 days; p=0.03) and smear positive pulmonary TB (60.2 v 95.9 days; p=0.03), compared with other diagnostic pathways. There was a non-significant reduction in the duration of symptoms in smear negative pulmonary TB (80.4 v 100.1 days; p>0.05). There was a non-significant lower rate of contact tracing with radiology referral compared with other diagnostic pathways (mean number of contacts 4.57 v 4.91; p>0.05).

Applicability
The evidence is directly applicable to TB service delivery in the UK. However, the results may be most applicable to areas of the UK where there is a high incidence of TB.

1 Verma et al, 2011 (+)

Evidence statement 9: Comprehensive MDR-TB control programme can improve treatment completion in MDR-TB patients

There is moderate evidence from one NYC study[1] (+) that a comprehensive MDR-TB control programme can improve treatment completion in MDR-TB patients (44% v 12%; p<0.001) and reduce death prior to treatment completion (39% v 69%; p<0.001, compared with outcomes reported at the start of the programme.

Applicability
The evidence is partially applicable to TB service delivery in the UK. This is because the demographics and management of MDR-TB patients in the UK may vary from that in NYC.

1 Munsiff et al, 2006 (+)

Evidence statement 10: Involuntary detention can improve treatment completion in non-compliant TB patients

There is moderate evidence from one NYC study[1] (+) that involuntary detention improves treatment completion in MDR-TB patients compared with court ordered DOT (95% v 89%).

Applicability
The evidence is partially applicable to TB service delivery in the UK. This is because the demographics and management of non-compliant TB patients in the UK may vary from that in NYC.

1 Pursnami et al, 2014 (+)

Evidence statement 11: Testing for latent TB in a HIV service can increase diagnosis of latent TB in HIV patients

There is weak evidence from one Leeds UK study[1] (–) that testing for latent TB in a HIV clinic can improve rates of identification of cases of latent TB (24/101 people tested, of which 4 tests were abnormal). The cost was estimated to be £12,760-£23,720 per year, compared with £14,776 to £53,194 for treating active cases.

Applicability
The evidence is directly applicable to TB service delivery in the UK. This is because the demographics of HIV-TB patients and HIV-TB screening policies in this study are likely to be the same as the UK.

1 Brian et al, 2009 (–)

Limitations

This review took a broad mixed methods approach, including a wide range of study designs, across several settings, populations and countries. A formal search strategy was designed to capture published studies. In addition to this, an extensive grey literature search was conducted, along with a call for evidence, to capture unpublished studies. However, with any systematic searching process there is always the potential that relevant studies will be missed, as the time and resources needed to identify every single study of relevance would be extensive (McGowan and Sampson, 2005).

A further limitation of this review is the fact that many service delivery and organisation interventions and models are not formally evaluated. Hence, there may be additional interventions and models that are effective in controlling TB, but which have never been evaluated. The case study approach did attempt to allow us to make broader inferences of models and interventions that authors have speculated work but may not have been subject to formal evaluations. This more contextual information can then be linked back to the effectiveness and cost effectiveness chapters, which describe interventions that have been formally evaluated.

We excluded studies published before 2003. While this helps to make the evidence in the review more relevant to current practice, it means that a body of older evidence was excluded. The review was also limited to English language only articles.

The review of case studies was limited to the UK, New York City, Barcelona, the Netherlands and Canada. These were all areas identified by the SDG as being of high relevance to this work. Whilst this provides a focus on the places that the SDG considered applicable to the UK, there may be other places that can offer valuable insights on how to configure TB services. In particular, it may have been useful to include places that were doing less well in controlling TB.

All of the studies included in the effectiveness review only assessed the effectiveness of individual components of the TB service in isolation. As such, it is not possible to provide evidence of the effectiveness of the service as a whole. Thus it will be important for the SDG to triangulate this evidence with other sources of evidence.

There is very little cost-effectiveness or cost-impact evidence on the service delivery interventions covered by this review; we located only a four studies, two of which were abstracts, and as such provide limited details of the service delivery interventions being evaluated. All of the studies focussed on individual aspects of TB service delivery. Only one study was a cost-utility analysis and presented economic data in terms of incremental cost effectiveness ratios.

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