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Chapter · January 2013

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Tuberculosis Control in Resource Limited settings:

Health Systems considerations

Juliet Nabyonga Orem
WHO Uganda Country Office
Health Systems and Services Cluster

Joy Belinda Nabukalu
WHO Uganda Country Office
Health Systems and Services Cluster

Abel Nkolo
Management Sciences for Health – Uganda

Miriam Nanyunja
WHO Uganda Country Office
Disease Prevention and Control Cluster

Introduction

Tuberculosis (TB) remains a significant public health problem globally, with higher incidence and prevalence in resource limited settings in sub-Saharan Africa and South East Asia (World Health Organization, 2012). This is compounded by the high Human Immunodeficiency Virus (HIV) prevalence in some of the resource limited countries, especially in sub-Saharan Africa where HIV is associated with increasing TB incidence of 5 – 10% annually (De Cock & Chaisson, 1999). Globally about 8.7 million new cases of TB occurred in 2011, with about 60% of cases in South East Asia and Western Pacific World Health Organization (WHO) regions, 24% of cases in Africa, and 13% co-infected with HIV (World Health Organisation, 2012). About 1.4million deaths due to TB occurred in the same year, with about 430,000 of deaths co-infected with HIV (World Health Organisation, 2012). India and China together contribute about 40% of the global burden of TB while Africa has the highest rates of TB cases and deaths per capita (World Health Organisation, 2012). Resource limited settings in this chapter refers to low and medium income countries based on the World Bank classification of Gross National Income of US$1,035 or less and $1,036 - $4,085 respectively(World Bank, 2013,). In such settings, resources for health are quite limited and do not allow for access to the whole range of preventive and curative health care services for all their populations. These include Africa, South East Asia, Caribbeans, Eastern Europe, and some parts of Latin America, and Western Pacific region (World Bank, 2013,).

Efforts to control TB have been ongoing for centuries however; achieving global TB control remains a challenge. In 1993, WHO declared TB a global emergence and provided a five-point frame work for control of TB which included 1) political commitment, 2) diagnosing TB using sputum smear microscopy, 3) use of short course chemotherapy under direct observation, 4) regular supply of drugs and 5) a standardized recording and reporting system. In mid 1990s most countries had adopted this approach (World Health Organisation & Stop TB Partnership, 2006). However, with the emergence of new challenges like HIV and multi drug resistant TB (MDR-TB); some aspects of this framework, for example, the directly observed treatment, short-course (DOTS), where a patient is observed by a health worker or community member while swallowing medicines, was insufficient in controlling TB (De Cock & Chaisson, 1999; Harries, Hargreaves, Chimzizi, & Salaniponi, 2002). Currently the recommended strategy for TB care is the Stop TB Strategy which emphasizes expansion of quality DOTS, addressing HIV and MDR-TB, strengthening health systems, engaging all health care providers, empowering people with TB through partnerships and promoting research (World Health Organization, 2010). Although the 6thMillennium Development Goal (MDG 6) to halt and reverse the TB epidemic has been achieved at a global level with declining prevalence and incidence and a reduction in death rates (World Health Organisation, 2012), the burden of tuberculosis is still high. Furthermore, this global achievement conceals the picture in most sub-Saharan African countries which are not on track to achieve the global targets (World Health Organisation, 2012). Due to the inadequate coverage of TB control interventions, reductions in incidence of TB have been modest where they occurred with a global fall in incidence rate of about 2.2% documented between 2010 and 2011 (World Health Organization, 2012). In addition, inadequate coverage of effective treatment has resulted in emergence of multi-drug resistant (MDR) and extreme-drug resistant (XDR) TB in several countries, with India, China, Russian Federation, and South

Africa reporting the highest numbers of MDR-TB globally in 2011 (World Health Organization, 2012). Many resource limited countries especially in sub-Saharan Africa are not reporting MDR-TB and XDR-TB due to inability to undertake confirmatory tests; hence the reported cases are likely to be an under-estimate of the actual burden (World Health Organisation, 2012). Nevertheless, in the few sub-Saharan countries that have reported MDR and XDR TB, this poses special challenges where the second-line anti-TB drugs are largely not affordable, and the treatment lasts a long time (20 months) (World Health Organization, 2012).

Tuberculosis control in most countries has been guided and implemented by vertical national TB control programmes (World Health Organization, 2012).Although some successes have been achieved in some countries using the vertical approach (Atun, Bennett, & Duran, 2008) there is emerging evidence that without strong health systems, and a health systems integrated approach to TB control, meeting the TB control targets will remain a challenge, especially in the resource limited settings (Atun, Weil, Eang, & Mwakyusa, 2010). Several countries in the eastern part of the WHO European Region have noted the negative effects on effective management of TB posed by vertical programmes (Atun et al., 2008).Some researchers have advocated for vertical programs in special circumstances like the need for rapid response, focusing on special groups and delivery of complex interventions among others. They however, caution that such approaches should be time bound and, linkages between vertical and horizontal elements of the system worked out (Atun et al., 2008). A few resource limited countries have documented increased coverage through integrating TB interventions into primary health care, engaging non-governmental organizations, and the private sector in service provision (Atun et al., 2010).

Through review of both published and grey literature and, verification of reported findings with TB and Health Systems Strengthening (HSS) experts in sub-Saharan Africa, this chapter highlights the health systems bottle necks to TB control. It further proposes health systems considerations and possible solutions for overcoming these bottlenecks in order to achieve TB control targets. These will however need to be tailored to the country context given the level of development of the different HSS building blocks, the TB prevalence and existing partnerships with the private sector. The health systems considerations highlighted in this chapter could guide TB control programmes in resource limited settings to address key bottlenecks and ensure that their programmes are more effective.

The Health System

In this chapter, we adopt the definition of a health systems as provided by the WHO defined as "all organizations, people and actions whose *primary intent* is to promote, restore or maintain health" (World Health Organisation, 2000). Using the framework of the six building blocks as provided by WHO namely; Service delivery, Health workforce, Information, Medical products, vaccines & technologies, Financing, Leadership & governance (World Health Organisation, 2007) - see figure 1 - we examine how each of the building blocks impacts on TB control efforts with specific reference to resource limited settings. We also underscore specific HSS issues for consideration by TB control programmes in low resource settings to enhance TB control.

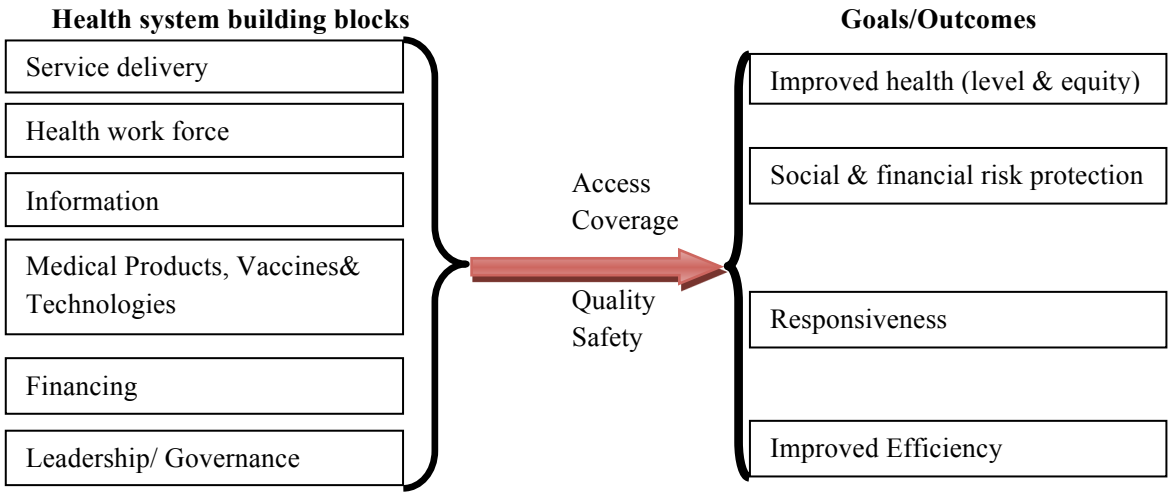

Figure 1: The WHO Health Systems Framework
Source: WHO: 2010, strengthening health systems: everybody's business(World Health Organisation, 2007)

Health Systems Considerations for Effective TB Control

Service Delivery

Good health services are defined as those that ensure delivery of effective, high quality, safe preventive, curative, and rehabilitation health care services to those that need them, when needed, with as minimal wastage as possible (World Health Organisation, 2007). These services may be delivered in health facilities, at home, at workplaces, or in the communities depending on the mode selected (Atun et al., 2010). Although there are no standard modes of delivery of health care services, the mode selected for different diseases and communities; should put into consideration the community as well as the treatment characteristics of a given disease and ensure equitable access, quality, safety, and continuum of care (Malmborg, Mann, Thomson, & Squire, 2006; World Health Organisation, 2007). Preventive and curative services for TB control are delivered using different modes in different countries; integrated into Primary Health Care (PHC) in most sub-Saharan African and South East Asian countries, and vertically delivered in some Eastern European countries (Atun et al., 2010). Furthermore, to ensure adherence, it is recommended that TB treatment is delivered as DOTS (Gabriel & Mercado, 2011; World Health Organization, 1994). To ensure DOTS, several modes of delivery have been adopted to deliver 1st and 2nd line anti-TB medicines by different countries including Health Facility-based DOTS (HF-DOTS), community-based DOTS (CB-DOTS), and a combination of the two. HF-DOTS is more effective where health facilities are within proximity, particularly for the poor and vulnerable patients (Malmborg et al., 2006). In several African countries, where access within 1km radius is still low, in addition to HF-DOTS, CB-DOTS was adopted that involves community health workers or treatment supporters observing patients' treatments daily (Adatu, et al., 2003; Mafigiri, McGrath, & Whalen, 2012). This ensures continuity of treatment once an admitted patient is discharged; and also avoids unnecessary admissions

for HF-DOTS (Adatu, et al., 2003). Where this has been implemented very well, treatment adherence and treatment success rates have been enhanced (Gabriel & Mercado, 2011; Shargie & Lindtjorn, 2005). CB DOTS has been shown to be cost effective compared to the conventional management of TB where the patient spends the initial two months in hospital further constraining the already weak health system (Wilkinson, Floyd, & Gilks, 1997).

Service Delivery Bottlenecks for TB Control

The effectiveness of DOTS is being compromised by the high prevalence of HIV/AIDS in many resource limited countries and, some researchers have raised the need for TB control programmes to adjust to the realities of the HIV/AID era, calling for integrated service delivery (Corbett, Marston, Churchyard, & De Cock, 2006; De Cock & Chaisson, 1999). Lack of universal access to effective preventive, diagnostic and treatment services remains a big bottleneck for TB control in resource limited settings (He, et al., 2011; Malmborg, et al., 2006; Parsons, et al., 2011). This results in delays in diagnosis and starting of treatment and, incomplete treatments following which drug resistance has been reported (World Health Organisation, 2012). Other factors contributing to limited access to effective TB prevention and control services include inadequate coverage of routine immunization with the BCG vaccine, Isoniazid prophylaxis and, limited numbers of diagnostic and treatment centres (Atun et al., 2010; Awofeso, Schelokova, & Dalhatu, 2008; Travis et al., 2004). Lack of adherence or defaulting from treatment remains a challenge in some countries due to cost, access, lack of continuity of treatment after discharge from health facility, and lack of information on the importance of adherence (World Health Organization, 2012). This has contributed to emergence of MDR-TB and XDR-TB (World Health Organisation, 2013a). Emergence of MDR-TB has posed additional challenges in service delivery; the facilities required for effective treatment of MDR-TB patients are not available in many resource limited settings and the treatment is much longer. In addition, MDR-TB treatment is associated with higher rates of adverse drug reactions hence requires active monitoring and patient checkups (World Health Organization, 2012).

Health Systems Considerations

Integration of services: In order to ensure universal access to effective preventive, diagnostic, and treatment services for TB, TB services in resource limited settings should be integrated into the package of services delivered at the different levels of the health systems (Atun et al., 2010). For example, at health facility level, BCG vaccination should be integrated into routine immunization services, TB diagnostics (laboratory and X-ray) should be delivered as part of the package of diagnostic services delivered by both private and public health facilities and, outreaches to communities from the health facilities should include TB services such as re-fill of the medicines of patients within the targeted communities (Atun et al., 2010; Awofeso et al., 2008). Tuberculosis services were being delivered integrated within primary health care in 20 of the 22 high-burden countries globally, and in 83% of 173 countries that were reporting progress in tuberculosis control to WHO in 2007 – 2008 (Atun et al., 2010).

TB-HIV integration: Given the high TB incidence in HIV infected patients, there is need to integrate TB and HIV services, to ensure every TB patient is tested for HIV and treated for both if necessary, and every HIV infected patient is regularly screened for TB to enable early detection and treatment of TB (De Cock & Chaisson, 1999; Harries, et al., 2002). This TB/HIV collaboration should be guided by appropriate policies and guidelines and, an environment favorable for integrated service delivery.

Supplies to enable delivery of TB/HIV integrated services should also be availed at all health facilities providing the services. If this is to be realized, both TB and HIV control programmes must re-think their approach, considering their similarities and potential synergies (Harries et al., 2010; Khan et al., 2010). Whereas integration of TB and HIV services has been challenging, this is slowly improving; Kenya and Rwanda are countries that have successfully integrated TB and HIV services and are performing very well, indicating that this is achievable in resource limited settings (World Health Organization, 2012).

Pro-poor services: TB diagnosis and treatment ought to be considered a public health good and provided free or highly subsidized by the Governments to ensure access and continuity of treatment for those that need it. However, governments in resource limited settings are often not in position to deliver effective anti-TB services single handedly; there is need for collaboration with the private sector and Non-Governmental Organizations in service delivery to achieve universal access. This should be guided by a relevant public-private-partnership policy and guidelines, with clear guidance on roles, reporting, and supply chain management. In order to subsidize the cost of TB treatment in the private sector and ensure treatment completion, the Governments could consider providing free anti-TB medicines to recognized private providers and regulate the costs charged for consultations and service delivery. However, governments would have to regulate and supervise the private for profit providers of TB services to ensure that standards and quality are maintained, and that TB treatment is not too costly to encourage high default rate (Malmborg, et al., 2006). In Myanmar, this model was implemented whereby Government signed a Memorandum of Understanding with Population Service International (PSI), and international non-governmental organization and the two agreed that in all private clinics affiliated to PSI, physician consultation fees would be $0.30 and anti-TB drugs would be provided free. The people that used the PSI affiliated clinics for TB treatment reported being very satisfied with the services (Saw, et al., 2009).In many resource limited settings, the first line of health care consultations is the private sector due to several reasons including ease of access, short waiting periods, better client care, and convenient opening hours (Malmborg, et al., 2006; Rutebemberwa, Pariyo, Peterson, Tomson, & Kallander, 2009). Effective TB control in the public health system will require adoption of some of these key factors that are attractive to the population.

Patient Tracking System: A system of follow up of patients started on anti-TB treatment to avoid defaulting should be established. Innovative technology such as mobile phone rapid short messaging service (SMS) could be used to remind patients of their re-fill and review dates. Ideally a multi-disciplinary approach involving physicians, nurses, social workers, and treatment buddies should be employed in anti-TB care initiation and follow up to enable them follow up on any person that is defaulting within 48hours of the appointment. This approach has been implemented in some research studies as well as anti-retroviral therapy clinics with success (World Health Organization, 2003). Cross notification between districts and between countries should also be done, supported by appropriate policy environment, to prevent international spread of TB, especially MDR-TB, in line with international health regulations. Active follow up of patients should be heightened when dealing with MDR-TB cases to avoid XDR-TB. The use of treatment buddies has enhanced adherence among patients on MDR TB treatment (World Health Organization, 2012).

Bottlenecks	Health Systems Considerations
High prevalence of HIV/AIDS compromising TB control, calling on interventions beyond DOTS	*TB-HIV integration* whereby HIV screening and treatment is fully integrated in TB care and TB screening and treatment fully integrated in HIV care. *Appropriate policy environment and guidelines* for TB-HIV integration
Lack of universal access to effective preventive, diagnostic, and treatment services remains	*Integration of effective TB preventive, diagnostic, and treatment services* in the package of services delivered at different levels of the health systems, and in primary health care *Pro-poor services whereby* TB diagnosis and treatment services are a public health good and provided free or highly subsidized by the Governments. *Partnership in TB control* with government subsidizing TB care in the private sector
Lack of adherence or defaulting from treatment	*Establishment of a patient tracking system* for follow up of patients started on anti-TB using innovative technology such as, mobile phone rapid short messaging service (SMS) to identify and follow up defaulters within 48 hours *Multi-disciplinary approach* involving physicians, nurses, social workers, and treatment buddies in anti-TB care initiation and follow up *Use of treatment buddies* to enhanced adherence. *Enhanced follow up MDR-TB cases* on treatment to avoid XDR-TB. *Cross-border notification of MDR-TB cases* that move across district and/or national borders

Table 1: Bottlenecks and health systems considerations in the Service delivery building block for TB control in resource limited settings

Health Workforce

Effective service delivery requires adequate, well-trained and motivated human resources for health (HRH), working in a conducive environment. Inadequate HRH has been highlighted as one of the major challenges to attainment of MDGs in sub-Saharan Africa (Travis et al., 2004).Globally, there are over 50 countries facing a human resource for health crisis and 36 of these are in the Africa Region. Other estimates show an average of 2.3 health workers per 1000 inhabitants in Africa (Awofeso et al., 2008). Health workers are essential in tuberculosis control given fact that they determine the quality and efficiency of provision of TB control interventions.

Human Resource for Health Bottlenecks for TB Control

National Tuberculosis Programme (NTP) managers from 18 of the 22 tuberculosis high-burden countries; ranked human resource as a major constraint to attainment of TB targets (Figueroa-Munoz et al., 2005). They highlighted challenges affecting performance of the health workforce as; inadequate and overworked staff, lack of carrier growth, low incentives and low morale. Health workers at various services levels lack skills to manage TB and this is coupled with high attrition rates (Figueroa-Munoz et al., 2005).Majority of low income countries also face additional challenges of mal-distribution where majority of qualified staff are in urban areas, migration to other countries as well as from the public to the private sector within the country (Nunn et al., 2002). Inefficiencies in HRH management have also been documented, for example, a study conducted in Uganda showed that the country lost close to US$12M per year due to health work absenteeism (World Bank, 2009).The need to enhance skills of health workers in TB control has been highlighted, however, investment by developing countries in this areas are suboptimal. NGOs have in the past taken up this role although in a disruptive way. Allowances and incentives provided to health workers while undertaking in-service training have tended to sidetrack large numbers of human resources away from front-line tuberculosis control duties for a substantial period of time (Figueroa-Munoz et al., 2005).

Health System Considerations

Addressing HRH gaps: The WHO HRH action framework for implementation of the Stop TB Strategy highlights several roles to be played by the National TB programs in improving HRH among which is resource mobilization; harmonization of donor support for HRH and ensuring linkages with relevant stakeholders involved in training, recruitment and deployment of HRH (World Health Organisation, 2013,).This however must within the overall HRH development plan of the country. The private sector is a significant player in health service provision in majority of countries in sub- Saharan Africa (Malmborg et al., 2006; Nabyonga-Orem, Mugisha, Kirunga, Macq, & Criel, 2011; Rutebemberwa et al., 2009). Forging partnerships with the private sector and provision of subsidies, including seconding of health workers, can alleviate the HRH crisis to some extent (Rangan et al., 2004; Ssengooba, Cruz, Yates, Murindwa, & McPake, 2006). This could be through formal agreements where user fee reductions are negotiated given subsidies received, to enable a higher percentage of the population access services from the private sector. Community health workers can also contribute significantly to improving access to TB care especially at village level but, these must have linkages with the formal health systems and need to be supervised by qualified health workers (Atun et al., 2010; Saw et al., 2009).

Enhancing health worker skills for TB control: Skills of health workers must be enhanced to provide TB services. This however calls for a coordinated way of skills enhancement through development and implementation of integrated in-service training strategies, whilst ensuring continued provision of services. Capacity building opportunities should be extended to the private sector as well. Strengthening pre-service curriculum should be implemented alongside to minimize the need for in-service training in the medium to long term.

Improving retention of health workers: Provision of incentives improves retention of health workers, however, this should not be programs based but incorporated in the overall remuneration package to minimize distortions in service delivery. Evidence has shown that health workers tend to concentrate on provision of services to which incentives are attached (Oxman & Fretheim, 2009). Other documented motivational factors include, good HRH management,career development, continuing education, and

recognition/appreciation and the TB program can contribute to these (Willis-Shattuck et al., 2008). Some countries have tried earmarking local and internationally funded tuberculosis training slots to applicants from geographical regions with high tuberculosis prevalence and after training, work in particular regions for a specified period (Awofeso et al., 2008).The decision as to which motivational package is adopted will be country specific given the context and resources available. The important issue to note is a mainstreamed approach where incentives are part of the overall HRH development as opposed to a program based approach.

Key Bottlenecks	**Health systems considerations**
Inadequate numbers of HRH to provide TB services	*Addressing HRH gaps* where the TB program supports resource mobilization; harmonization of donor support for HRH and ensuring linkages with relevant stakeholders involved in training, recruitment and deployment of HRH. *This must be within the broader HRH development.* *Partnerships with the private sector* where the government provides subsidies including seconding staff to the private sector. *This must be within a formal agreement framework.* Use of *community health workers* to extend TB services to the community level. *Need for linkages with the formal health systems and supervision by qualified health workers.*
Inadequate skills among health workers	*Enhancing health worker skills for TB control* through in-service training**.** *Must be implemented as part of an integrated in-service training strategy.* *Capacity building opportunities should be extended to the private sector as well.* *Strengthening pre-service curriculum* should be implemented alongside to minimize the need for in-service training in the medium to long term.
Attrition of HRH	*Improving retention of health workers* through **p**rovision of incentives. *Should however be incorporated in the overall remuneration package to minimize distortions in service delivery.* *Motivational packages adopted will be country specific given the context and resources available.*

Table 2: Bottlenecks and health systems considerations in the HRH building block for TB control in resource limited settings

Health Information

Generation and use of information is an integral component of a good health system and effective disease control programme. “A well-functioning health information system is one that ensures the production, analysis, dissemination and use of reliable and timely health information by decision-makers at different levels of the health system, both on a regular basis and in emergencies” (World Health Organisation, 2007).Data are needed to monitor the trends of TB cases and deaths, the population at risk, the prevalence, detection and cure rates of TB, the number requiring re-treatment, the number of MDR and XDR-TB cases, number co-infected with HIV, number on both anti-TB and antiretroviral drugs, among others(World Health Organisation, 2012a). In addition, these data are needed for monitoring performance and coverage of the programme, effect of the programme interventions, and progress towards national and international targets (World Health Organisation, 2012a). Generation of these data and related information routinely requires development of standardized tools, instruments, and guidelines; strengthening the health information and surveillance systems to collect and report the data; build capacity at different levels for analysis and use of the data to direct programme improvements where necessary (World Health Organisation, 2012a). In many countries TB data is collected vertically, and often with the programme and partners using parallel reporting systems (Atun et al., 2010). Standardized tools developed by WHO and adopted by most countries have enabled collection of comparable data from different countries (World Health Organisation, 2012a). Most resource limited settings use paper-based reporting, however a few have introduced electronic reporting of health information including TB and HIV data using computers or mobile telephones (World Health Organisation, 2012a). In Uganda, mobile telephone rapid SMS based reporting (mTrac) has been rolled out to all districts for immediate and weekly reporting of notifiable conditions including MDR-TB and tracer drugs consumption; and a computer based reporting system (DHIS 2) has been rolled out for monthly electronic reporting from all districts. In the African region, since the adoption of the integrated disease surveillance and response (IDSR) approach in 2007 (Perry et al., 2007), more countries are making efforts to integrate the TB data collection and reporting with national health information systems (Centers for Disease Control and Prevention (CDC), 2012,). Through IDSR, data is collected on different diseases of public health importance including TB, and more recently MDR-TB in an integrated manner, using integrated data collection tools, and is analyzed at different levels of the health system, and transmitted to the national level monthly where it is stored in a national data bank (World Health Organisation, 2012a). Different programmes can then access relevant data from the data bank as necessary, analyze and use it for monitoring programme performance and to inform programme planning. Globally the case notification rate and treatment success rate are being used as key programme indicators, with targets for good performing programmes being 75% and 80% respectively. Whereas global estimates are at 67% for case notification rate and 85% treatment success rate, the achievements in most resource limited countries are much lower than this (World Health Organisation, 2012).

Health Information System Bottlenecks for TB Control

One critical bottleneck for the TB programmes in many resource limited settings is the inaccuracy and poor quality of the data used to compute the programme monitoring indicators. The denominator of most of the indicators is inaccurate due to lack of prevalence surveys (De Cock & Chaisson, 1999). As a result, most countries use WHO estimates of burden of disease to compute their indicators. There is however

increased interest in TB prevalence surveys in many countries, with support from partners, although these are very resource intensive and their implementation challenging. Quality and completeness of data used to determine the numerators is also a bottleneck related to staff turnover, inadequate capacity, poor medical record keeping, and failure to collect data from the private sector (World Health Organisation, 2012a).Lack of or inadequate analysis and use of the data to inform programme management is another major challenge in resource limited settings. This is often due to lack of adequate skill in data analysis, lack of appreciation of its importance, and a weak culture of evidence-based planning (Orem et al., 2012). More data is now needed on HIV related indicators among TB patients; the TB programme has to make adjustments to ensure availability of this data (De Cock & Chaisson, 1999). Vertical reporting on TB interventions implemented by some resource limited countries has also faced challenges of sustainability and hence results in some gaps in data especially due to attrition of the responsible health worker in a facility (Nsubuga, Brown, et al., 2010; Nsubuga, Nwanyanwu, Nkengasong, Mukanga, & Trostle, 2010).

Health System Considerations

Integrated reporting systems: Strengthening integrated information systems such as IDSR should be prioritized as this would provide data not only on TB but also other related conditions e.g. HIV. Moreover such systems are more sustainable than vertical reporting systems (World Health Organisation, 2012b). Increasing funding for TB control could be used to strengthen the integrated national health information systems that will benefit the whole health system. The tools and instruments should likewise be integrated to minimize duplications in data collection that strains data collectors (World Health Organisation, 2012a). Some countries e.g. Russia still use vertical TB reporting systems, however most countries have now introduced TB variables and indicators in the integrated national health information systems with success; this has resulted in stronger and sustainable health information systems (Atun et al., 2010). A set of agreed, simple and clear indicators should be used for monitoring progress (Nsubuga, Brown, et al., 2010).

TB prevalence surveys: These are needed to generate more accurate data on the burden of disease (the denominator) (De Cock & Chaisson, 1999). There is increased interest in TB prevalence surveys in many countries, with support from partners, however these are very resource intensive and their implementation challenging (Atun et al., 2010). Capacity building in this area is critically needed in the resource limited countries to enable accurate determination of the burden of disease.

Capacity building: Training of health workers at all levels on the use of integrated data collection tools, data collection, validation, compilation and reporting using paper-based and/or electronic tools is important (World Health Organisation, 2012a). For effective TB control, the training should target several staff in every facility, integration of data from the private sector, use of standardized registers and other medical records. In addition, capacity for data analysis and use should be developed at all points of collection; it's at this point that it can be useful to inform programme improvements (World Health Organisation, 2012b).

Data quality assessments: Data quality assessments (DQA) and audits that aim at continuous improvement of data quality within the national health information system should be conducted periodically and, gaps identified systematically addressed. The DQA should be integrated, using indicators from different programmes as the tracer indicators. DQA should include TB indicators among the tracking indicators.

Electronic reporting systems: Electronic reporting using computers and/or mobile phones could improve greatly the quality, accuracy, completeness and timeliness of integrated reports including TB and HIV data among others (World Health Organisation, 2012a). However, this requires hands-on training of the people collecting the data on how to conduct the electronic reporting. Electronic reporting can also enhance data analysis and utilization given that an electronic database is easily available (World Health Organisation, 2012a).

Key Bottlenecks	**Health systems considerations**
Inaccuracy and incompleteness of the data used to compute the TB programme monitoring indicators	*Conduct TB prevalence surveys* to get more accurate data for denominators *Training of health workers* at all levels of the health systems on use of integrated tools for data collection. *Introduction of electronic reporting systems* where feasible,
Poor quality data Lack of or inadequate analysis and use of the data to inform programme management	*Capacity and skills building* in data analysis and use
Need for HIV related data among TB patients	*Strengthening integrated information systems* such Integrated Disease Surveillance and Response that collect data on more than one disease/condition.
Non-sustainability of TB vertical reporting systems	*Invest more in integrated reporting systems* that are more sustainable.

Table 3: Bottlenecks and health systems considerations in the Health Information building block for TB control in resource limited settings

Access to Essential Medicines, Vaccines, and Technologies

One of the pillars of effective TB control is early detection and effective treatment (World Health Organisation & Stop TB Partnership, 2006). To achieve this, access to good quality laboratory services and anti-TB medicines is critical (World Health Organisation & Stop TB Partnership, 2006). Access to good quality laboratory services requires trained laboratory workers with good diagnostics skills, availability of equipment and good quality reagents, materials and supplies for the laboratory testing, a system that ensures timely delivery of specimens to the laboratory, timely testing and appropriate feedback on the results (World Health Organisation & Stop TB Partnership, 2006). Microscopy has been the main stay of TB diagnosis for decades (World Health Organisation & Stop TB Partnership, 2006), however this is not very sensitive especially in patient co-infected with HIV and children, and misses out on detection of drug resistance (Parsons et al., 2011; World Health Organisation & Stop TB Partnership,

2006). In addition, accurate microscopy requires skilled technicians (Parsons, et al., 2011; World Health Organisation & Stop TB Partnership, 2006). Increasingly, culture and drug sensitivity testing facilities are becoming established in some resource limited settings. However, due to the costs involved in setting up and sustaining these, resource limited countries need to be very rational when making decisions on their deployment (World Health Organisation & Stop TB Partnership, 2006). There is increasing need for new, highly sensitive, point of care rapid tests to complement microcopy in diagnosis of TB; in addition the rapid tests should have capability for drug sensitivity testing so as to quickly detect MDR-TB cases (Parsons et al., 2011; Quezada et al., 2007; World Health Organisation & Stop TB Partnership, 2006).

Accurate quantification, timely procurement and distribution of good quality medicines to all health facilities where it is needed is requisite for effective TB treatment (World Health Organisation & Stop TB Partnership, 2006). Countries handle procurement and supply of the laboratory reagents, materials, and supplies as well as medicines differently; some procure vertically as the TB control programme whereas some use a centralized, integrated system of procurement; several countries procure anti-TB medicines through the Global Drug Facility (GDF), a facility that ensures competitive prices globally as well as high quality medicines whereas others procure directly from the manufacturers (Atun et al., 2010). Vertical procurement and distribution of anti-TB drugs and laboratory supplies is often supported by donor-funded projects in most resource limited settings while integrated procurement is mostly undertaken by governments through the national procurement systems or national medical stores (Khan et al., 2010).

Essential Medicines, Vaccines, and Technologies Bottlenecks for TB Control

Challenges faced in this area include inadequate numbers of good quality diagnostic centres due to lack of infrastructure, adequately trained laboratory technologists, and appropriate equipment in many health facilities, and irregular supply of reagents (Parsons et al., 2011). This contributes to low case notification rates that are common in most resource limited settings. Microscopy that is the main TB diagnostic used is not very sensitive in HIV infected people and children, and does not detect drug resistance (Parsons et al., 2011). In addition highly trained technicians are needed to run microscopy, yet these are not always available at health facilities, contributing to the limited numbers of inadequate diagnostic centres. Culture and drug sensitivity testing are resource intensive (Parsons et al., 2011).

Periodic anti-TB medicine stock outs, common in resource limited settings, result in treatment interruptions and emergence of multi-drug resistant TB (Parsons et al., 2011). On the other hand, over-stocking and mal-distribution of anti-TB medicines resulting in expiry of medicines is experienced in some areas alongside stock out of medicines in other areas are other challenges. Lack of consumption data and inaccurate quantifications contribute to the stock outs and mal-distribution of drugs (World Health Organisation & Stop TB Partnership, 2006). Whereas vertical procurement has resulted in timely distribution of medicines and supplies to health facilities in several countries, its sustainability remains an issue of concern. It often faces challenges when there are delays in release of funding from donors and when the projects come to an end (Atun et al., 2010). On the other hand national integrated procurement and supply chain management systems though more sustainable, are weak in many resource limited settings and significant wastage has been documented (Harmonisation for Health in Africa, 2010).

Health Systems Considerations

Integrating procurement of anti-TB drugs into national procurement systems: In order to ensure availability of anti-TB medicines, procurement of anti-TB medicines and supplies should be integrated into national procurement systems for health products to ensure sustainability (Atun et al., 2010). Where national procurement systems are still weak, concerted efforts by TB and other programmes should be put on supporting and strengthening the systems, with special focus on supply chain management to ensure accurate forecasting and; timely and accurate procurement, distribution and orders from the health facilities. This requires capacity building at different levels of the health system, which should be put into consideration when planning for TB and other disease control programmes, in collaboration with the national procurement entity, which in many countries is the National Medical Stores (Atun et al., 2010). Integrated procurement systems have worked with success in Cambodia and India (Saw et al., 2009). In Cambodia the National TB programme also supported capacity building at sub-national level to ensure accurate forecasting and ordering (Uchiyama et al., 2006). Furthermore, to ensure high quality of medicines procured, the GDF should be used by countries without appropriate quality control mechanisms (World Health Organisation & Stop TB Partnership, 2006). Several countries including Tanzania and Uganda have been procuring anti-TB medicines through the GDF and have not reported quality issues (Atun et al., 2010).

Bundling of medicines and diagnostic supplies: To ensure that diagnostic reagents, supplies and anti-TB medicines are readily available at the health facilities, orders from health facilities should include well quantified needs, and bundling of medicines and laboratory supplies during distribution should be considered.

Increasing funding for Medicines, vaccines and technologies: National governments should work towards funding all procurement of first line anti-TB medicines, second line medicines, and laboratory reagents and supplies requirements to minimize the stock out challenges created by projectized donor-funded vertical procurements (Atun et al., 2010). India has taken positive action in this aspect whereby the government procurement system procures anti-TB drugs with government funds but has a back-up emergency procurement system financed donors to bridge gaps in case of any delays in government procurements (Atun et al., 2010).

Monitoring drug consumption and stocks: Mechanisms for monitoring medicine consumption rates and innovative methods of tracking stocks of medicines should be established in all countries to ensure adequate amounts of medicines are available in health facilities at all times. In Uganda, a mobile phone rapid SMS based system has been established to monitor and report on medicine stocks weekly. This ensures quick identification of facilities that have minimum stocks of medicines and informs distribution plans within in the district where there is overstocking in some facilities, or from central to district levels when this is needed. In order to curb the increasing prevalence of MDR-TB, and the increasing expenditures on second line medicines, countries should have zero tolerance for anti-TB drug stock outs.

Integrated training of laboratory workers: Integrated training of laboratory workers should be done to enhance accuracy of diagnosis of TB as well as other common diseases in the locality instead of training them on only TB diagnosis as has been done in some countries. An example is Uganda where TB microscopists have been trained (Awofeso et al., 2008; World Health Organisation & Stop TB Partnership, 2006). This ensures that the laboratory workers keep busy when there are no TB specimens and thus do not lose skills.

Develop point of care rapid tests to complement microcopy in diagnosis of TB: Such tests should be highly sensitive and fairly easy to use. In addition the rapid tests should have capability for drug sensitivity testing so as to quickly detect MDR-TB cases (Parsons et al., 2011; Quezada et al., 2007; World Health Organisation & Stop TB Partnership, 2006).

Innovative specimen referral mechanisms: Where building of TB diagnostic capacity is not possible within a short distance (<5km), innovative specimen referral systems should be established. For example, only a few, or none of the laboratories in resource limited settings may be able to confirm MDR or XDR-TB (World Health Organisation & Stop TB Partnership, 2006); but with effective specimen referral mechanisms specimens could be referred for testing at the one laboratory in the country or in a neighboring country with the diagnostic capacity as is happening in some African countries. Uganda has one national reference laboratory for TB that provides diagnostic facilities for MDR-TB. A specimen referral mechanism has been established country-wide that ensures that specimens referred for testing to this laboratory reach it within 1 – 2 days. The laboratory also provides diagnostic services for some of the countries within the African region.

Integrating routine immunization services into maternity services: BCG vaccines have been integrated into the routine immunization system in all countries. Considerations should be on supporting and strengthening the immunization systems to ensure very high coverage of vaccines, including BCG vaccine soon after birth. To ensure this, vaccination services should be available at all maternity centers either as static or outreach sites; this will minimize missed opportunities for vaccination. Quality of vaccines should be ensured and national systems for monitoring severe adverse reactions, which in most countries are managed by the national medicines regulatory authorities, be strengthened to monitor adverse reactions following immunization.

Bottlenecks	**Health Systems Considerations**
Inadequate numbers of diagnostic centres due to lack of infrastructure, adequately trained laboratory technologists, appropriate equipment, and irregular supply of reagents in many health facilities	*Integrated training* of laboratory workers *Bundling laboratory supplies and reagents with anti-TB drugs* Development and introduction of easy to use *point of care TB rapid diagnostic tests*
Microscopy not very sensitive in HIV infected people and children, and does not detect drug resistance	*Establishment of culture and drug sensitivity testing facilities* *Innovative specimen referral mechanisms* to the few facilities established
Lack of consumption data and inaccurate quantifications of drug needs resulting into stock outs and mal-distribution	*Innovative drug consumption and stock monitoring mechanisms*
Non-sustainability of vertical procurement systems that are mainly donor-driven	*Integrating procurement of anti-TB drugs into national procurement systems* *Increasing government funding* for Medicines, vaccines and technologies

Table 4: Bottlenecks and health systems considerations in medicines, vaccines, and technologies building block for TB control in resource limited settings.

Health Financing

Financing for health services in sub-Saharan Africa falls below recommended investments and as a result, majority of countries cannot ensure access to health services for the whole population. For example, by 2010, over a third of African Union countries had not reached the recommended level of health expenditure per capita to fund a minimum package of health services estimated at US$ 44, while only five countries were allocating 15% of their national budget to health a target set in the Abuja declaration (Musango, Orem, Elovainio, & Kirigia, 2012).

Global efforts have tried to cover funding shortages in low income countries and among these is the Global Fund, UNITAID, bilateral agencies and philanthropic sources. Funding from these sources for the 22 TB high-burden countries increased from approximately $1.84 billion in 2006 to almost $2.64 billion in 2010 (Atun et al., 2010). The Global fund alone provides around 63% of all international financing for tuberculosis control globally (Lal et al., 2011). Returns on these investments have been realized to varying levels due to a number of challenges among which is weak financial management, weak accountability, low absorption capacity and weak procurement mechanisms (Kapiriri & Martin, 2006).

In an effort to improve access to health services, several countries provide health services free at the point of use. Financial barriers to patients' access to tuberculosis health services are still eminent despite tuberculosis services having been included in the free basic health package. This is due to gaps in service delivery partly as a result of under-investment in health (Atun et al., 2010; World Health Organisation, 2012). Current estimate show that, in the case of WHO Africa Region member states, available funding for TB control is only 55% and 47% of estimated requirement in 2012 and 2013 respectively and, over 50% is being funded by the Global fund (World Health Organisation, 2012). A call for increasing domestic funding for health has been made in the several health financing panels held between ministers of health and finance but progress remains slow (Musango et al., 2012). Effective TB control calls for increased investment in health alongside improving effectiveness of donor aid.

Bottlenecks in Health Financing for TB Control

Overall under-investment in health has implications on implementation of TB control strategies as evidenced by suboptimal coverage of TB interventions, and poor quality of TB services in several resource limited settings (World Health Organisation, 2012). Although investments in TB falls short of estimated requirements on the one hand, in 2005, expenditures were less than available funding in two WHO regions, particularly Africa and the Eastern Mediterranean, pointing to low absorption capacity issues (Floyd, Pantoja, & Dye, 2007).

As a results of inadequate investment and suboptimal coverage with TB control interventions, case detection rate in the WHO African Regions stands at 61% while TB success treatment rate stands at 82% falling short of targets set at 70% and 85% respectively (World Health Organisation, 2012). Public sector expenditure on medicines for countries in the WHO Africa Region is far inadequate below US$2 percapita in several countries (WHO Africa Regional Office, 2013). As a result, some countries are

experiencing emergence of MDR and XDR alongside a worsening TB epidemic with implications of higher cost of service delivery (World Health Organisation, 2012). The significant reliance of donor funding to finance TB programme poses several challenges. In the recent past, the economic crisis affecting several of the developed economies, who make significant investments in health, has had negative implications on funding for health services in low income countries (Kirigia, Nganda, Mwikisa, & Cardoso, 2011). This has raised concerns on suitability of funding for programme implementation and sustaining achievements made. This is further compounded by the rising costs of providing TB services largely driven by MDR TB and XR TB emergence (World Health Organization, 2012). Furthermore, aligning donor funding to government priorities and ensuring predictability are long standing challenges (Nabyonga-Orem, Ssengooba, & Okuonzi, 2009).

Inefficient use of available resources has also been highlighted. A study in Rwanda documented a significant cost saving by changing the service delivery model from General Practitioner clinics to the public sector (Kirigia et al., 2011). A loss of close to US$ 12 million in the health sector was estimated in health worker absenteeism in Uganda (World Bank, 2009). The WHO, World health report estimated that 20% - 40% of health resources are wasted mainly in drug procurement (World Health Organisation, 2010a). Although this is a global estimate, the picture in African countries is close given the fact that African governments pay 2.5 to 6.5 times higher than international reference prices (United Nations (UN), 2012)).

Health systems considerations

Financing for TB programs: Augments have been made for countries in SSA to wean themselves off donor funding and among the strategies suggested is; reduction in economic inefficiencies; reprioritizing public expenditures; raising additional tax revenues; increased private sector involvement in health development; and fighting corruption (Kirigia & Diarra-Nama, 2008). The call to increasing domestic funding by low income countries has been made repeatedly which needs to be implemented (Hafidz, & Rostina, 2013; Musango et al., 2012) . Some countries have taken bold steps to raise more funding for health through collecting earmarked taxes for health for example, a 2.5% of VAT in the case of Ghana. Earmarked taxes for health have been imposed on tobacco and alcohol in the case of Benin and Mobile companies and Money gram in the case of Gabon (WHO Africa Regional Office, 2013). These innovative mechanisms provide opportunities to raise more funding for health.

Improved alignment of donor funding: Donor funding provides an opportunity to strengthen the health system but efforts have to be made to address identified challenges. The poor alignment could be reduced through ensuring strong government leadership and governance, comprehensive and participatory planning processes and, monitoring. The principles of the International Health Partnerships (iHP+) which emphasize increased alignment behind one plan, joint approaches, greater use of country systems especially financial management and one platform for monitoring and accountability for results offer enormous opportunities for improving effectiveness of donor aid (International Health Partnerships, n.d.).

Improving efficiency in resource allocation and use: Strengthening medicines procurement mechanisms will minimize losses and subsequently reduce medicines stock outs. Regionally based procurement arrangements named “voluntary pooled procurement”; where a number of countries negotiate with a given supplier as a block, offer stringent quality standards and better negotiation opportunities and these need to be further explored (i+Solutions, n.d.). Financial management

mechanisms need to be strengthened and among the suggested options is training MoH staff in accountability processes (Musango, et al., 2012). Other measures include linking money to results under result/performance based financing mechanisms that have shown good results in several countries. They offer opportunities for system wide improvements depending on how they are implemented (Meessen, Soucat, & Sekabaraga, 2011)

Key Bottlenecks	**Health systems considerations**
Inadequate financing for TB control	*Increase domestic funding for TB control* through allocating more funds from available government budget and reprioritizing public expenditures. *Raise more funding* from innovative financing mechanisms to finance TB programmes.
Alignment of donor aid to government plans	*Improved alignment of donor funding by* ensuring strong government leadership and governance, comprehensive and participatory planning processes and, monitoring. Greater use of country systems especially financial management.
Inefficiency in the use of resources	*Improving efficiency in resource allocation and use through s*trengthening medicines procurement mechanisms and financial management systems. Explore mechanisms that link funding to results.

Table 6: Bottlenecks and health systems considerations in the financing building block for TB control in resource limited settings.

Leadership and Governance

The importance of good leadership and management, for effective health program implementation is already documented (Keugoung, Macq, Buve, Meli, & Criel, 2013). Decentralization of governance and financing for service delivery occurred in many low and middle income countries in the 1990s aimed at improving access, equity and efficiency in the health sector among others. However, inadequate financing, low planning capacity and political conflicts weakened these reforms and hindered fulfillment of their mandates (Atun et al., 2010). In some instances decentralization of governance and financing led to reduced programmatic financing, poor monitoring of programme performance, interrupted drug supplies as a result of disrupted supply chain systems, impaired case reporting further compromising effective service delivery (Atun et al., 2010).

Leadership and Governance Bottlenecks for TB Control

Weak management of HRH at the decentralized level has led to low retention, reduced morale of health workers and further compromising quality of health services (Figueroa-Munoz et al., 2005). In an effort to respond to the several managerial challenges at decentralized levels, vertical programmes have attempted to designate focal points for specific diseases at the decentralized level. This has not been

successful in several cases where the designated person lacks clout to engage within the overall decentralized leadership set up. In addition, due to staffing constraints, designated officers also do have other responsibilities, which limit the amount of time they can commit to a given disease. On the other hand however, incentive mechanisms accompanying such designations have led to reduced attention being paid to other programmes. The ability to improve quality of tuberculosis services depends crucially on the good practice of the managers at the level of the basic management unit. Decentralization of treatment to peripheral health centers and the community has been undertaken but this requires strong managerial capacity to ensure the logistics for DOTS, drug security, supervision, monitoring and recording in the community are in place. These are however not in place in majority of countries (Maher, Harries, & Getahun, 2005).

Health System Considerations

Strengthening leadership and management especially at the decentralized and service delivery level is essential. This could be through provision of management short courses as part of in-service training and, undertaking supervision visits to offer mentorship and problem solving. Pre-service curriculum for schools of public health should also be strengthened on management aspects as a medium to long term measure. The environment within which managers work must be supportive for them to be effective, the institutional set up must be strengthened, policies and guidelines put in place and roles and responsibilities spelt out.

Managerial constraints in tuberculosis control at decentralized levels cannot be resolved by NTPs in isolation and it is therefore essential strengthen overall management for health services at the decentralized level (Figueroa-Munoz et al., 2005).

Key Bottlenecks	Health systems considerations
Weak leadership and management capacities especially at the decentralized and service delivery levels	*Strengthening leadership and management* through provision of management short courses as part of in-service training. *Supportive supervision visits* to offer mentorship and problem solving. *Pre service curriculum for schools of public health should also be strengthened* on management aspects as a medium to long term measure. *Put in place a supportive environment*, polices and guidelines including spelling out roles and responsibilities. *Leadership and managerial skills should be strengthened as part of the overall management for health services at the decentralized level.*

Table 6: Bottlenecks and health systems considerations in the financing building block for TB control in resource limited settings.

Conclusion

Efforts to control TB require strengthened HSS able to deliver needed intervention to the whole population in a timely manner. The HSS functions as a whole and efforts to strengthen it should

undertake evidence based prioritized actions in each of the six building blocks. This will involve undertaking an assessment of the current status of a given HSS following which prioritized strategies will be identified. Improving coverage of interventions for a given diseases has implication on all the six HSS building blocks and this should be factored in the planning, implementation and evaluation of any disease programme. We do not attempt to suggest which building block is more important or where does one lay more emphasis; instead we emphasize a country specific approach based on evidence.

We also emphasize a holistic approach to HSS strengthening underpinned by robust national health policies and sector strategic plans developed a participatory and inclusive manner, bringing together all relevant stakeholders. The stewardship role of government needs to be strengthened at the national and decentralized levels to be able to harness the contribution of all actors, align all available resources to agreed priorities, regulate the private sector and oversee implementation of agreed strategies. Where vertical governance, funding and service delivery systems exist, integration will be difficult and changes must be underpinned by legal and regulatory adjustments aimed at linking the governance, organization and funding of vertical programmes with mainstream health systems.

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