TB Modelling and Analysis Consortium (TB MAC)

Country-level economic modelling

London, UK - virtual meeting
02 June and 07 July 2020

Meeting Report

www.tb-mac.org

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Executive summary

The TB Modelling and Analysis Consortium (TB MAC) is an initiative to improve global tuberculosis (TB) control by coordinating and promoting mathematical modelling and other quantitative research activities. At our **meeting held virtually on 2nd June and 7th July 2020**, we brought together representatives from TB modelling groups engaged in country-level economic analyses, including support to priority setting and resource allocation exercises, to discuss this body of work and shape the direction of future efforts in this area. Our **aims** were twofold. The first was for each modelling group to present their methods, highlighting any challenges and lessons learned. Our second aim was to collate this information, looking for patterns and key differences across groups, and create a forum to facilitate discussions on how to improve current efforts.

The **rationale** for convening this meeting is the lack of commonly-agreed approaches for (a) creating cost and budget forecasts based on TB modelling; and (b) translating modelling evidence into discussions on resource needs and allocative efficiency. The meeting was intended to develop a common understanding of the various approaches used, how these might produce different results or be applicable in different situations, and learn from the collective experience that has developed around TB costing and budgeting. Moreover, TB program planning does not occur in a vacuum, and it is important to understand how these approaches align with the broader work on health technology assessment and health system-level priority setting and financing.

The meeting was organized as two sessions, held a month apart. Session 1 centred around presentations contributed by modelling groups representatives describing their current approaches for economic analysis, followed by guided discussions that saw significant engagement from all present, culminating in a number of questions and suggestions for further exploration in Session 2. Session 2 was open to a larger number of participants, including health economists and other experts and practitioners involved in country-level priority setting and resource allocation. Through the two sessions, items were identified as possible areas for collective action in the future. These items were grouped into broad **thematic areas**, and **options for short-term action** identified.

Generation and use of economic data inputs

1. Understanding/resolving differences in the scope and comprehensiveness of unit costs and how they are used and represented in models.
2. Need for greater adherence to the formats specified by unit costing guidelines such as GHCC.
3. Utility of defining a hierarchy of cost data sources, and describing approaches to deal with potential bias for different sources and to ensure consistency and standardisation.
4. Need for a review of methods for transferring costs, both across countries and within countries, and from trials to real world settings.
5. Need for better data on the impact of health system constraints on intervention quality and coverage, and the ability to scale up new services.
6. Evidence on the cost and outcomes of efforts to relieve health system constraints.
7. Guidance on how to deal with data gaps on the links between costs and effectiveness of activities and interventions to improve service quality and/or coverage, and the potential need for better evidence in this area.
8. Need for guidance on formal methods to elicit assumptions from expert/stakeholder groups, and to validate cost inputs.

Modelling the relationship between services, costs, and health outcomes

9. Lack of clarity on how and when to use cost functions (including economies of scale and scope), and appropriate data for constructing these functions.
10. Further discussion of methods for modelling the impact of health system constraints.
11. Standard approaches for selecting cost-effectiveness thresholds and considering decision rules for national priority setting and budgetary constraints.
12. Standard approaches for DALYs and life years calculations (including disability weights and utilities for TB and post-TB), and to selecting time horizons.
13. Guidance on applying and estimating other decision criteria for priority setting (e.g. equity, feasibility) for TB.
14. Guidance supporting the use of societal perspectives.

Presenting results, country engagement and capacity building

15. Improving collaboration between international modelling technical assistance groups to identify and involve local health economists (often not embedded within National TB Programmes).
16. Need for approaches for communicating and discussing joint economic and epidemiological uncertainty in the decision/priority-setting process with stakeholders (in terms of processes).
17. Guidance on how to (and whether to) estimate and report costs for scenarios that are 'uncostable', such as intervention scenarios projected too far into the future, or where almost no local data are available, or where health systems are severely constrained.
18. Clarity on how to adapt economic methods for different purposes (e.g. advocacy, broad strategy development, program budgeting).
19. How to best ensure engagement at the sub-national level, which might be necessary to get the full picture of real-world implementation.

Several of the issues highlighted above are not new to economic evaluation and priority setting, but it was considered important to ensure that TB modellers were clear on current guidance; and some may need specific guidance to ensure they are correctly and consistently applied to TB.

Options for short-term action

- *Develop a mechanism for maintaining a consolidated database of existing TB cost estimates with periodic updates. Global Fund Strategic Initiatives is a potential source of initial funding.*
- *Develop a mechanism to collate evidence to link between the direct epidemiological impact of interventions and the resource needs to achieve that impact.*
- *Encourage more systematic documentation of unit costs used as inputs to modelling exercises - NSP costing reports and modelling reports could have appendices detailing data sources, assumptions and any adjustments made. BRR modelling review mechanism could include cost assumptions.*
- *Targeted research to fill evidence gaps identified above.*

1. TB Modelling and Analysis Consortium (TB MAC)

1.1 Background on TB MAC

The complex natural history of TB, range of possible interventions and great variation in epidemiological settings, mean that TB policy-makers and donors face great uncertainty when prioritising TB control activities. This uncertainty can be reduced and quantified, and the cost-effectiveness of different strategies compared, using mathematical modelling and other quantitative research activities. Historically, several groups of modellers worked separately on issues such as the impact of new diagnostics, drugs and vaccines, but although this work has contributed greatly to understanding the transmission and control of TB, the influence of the work was weakened by a lack of coordination, information-sharing, consensus building and prioritisation. This led to critical research gaps and conflicting policy recommendations that served TB control poorly.

Policy making and resource allocation must be based on scientific consensus derived from optimal analytic inputs, which draw on data and models in epidemiology, economics, demography and related disciplines. Over recent years, the TB Modelling and Analysis Consortium (TB MAC, www.tb-mac.org) has worked to improve the interaction between quantitative researchers, policy makers, TB programmes and donors, in order to increase the effectiveness and efficiency of TB control policy and practice at global and country level, and thereby accelerate reductions in global TB burden. TB MAC pursues these goals by (1) improving coordination, knowledge sharing and management within the TB community, (2) creating new high-quality modelling guidelines and resources, and (3) developing better informed technical assistance/decision making communities and modellers. A first meeting of TB MAC focussed on TB control in high HIV settings. TB MAC's focus then shifted to diagnostics and drugs, followed by a multi-model comparison exercise (over three meetings, see here, here and here) to evaluate the feasibility of the End TB Strategy targets in China, India and South Africa, and subsequently a consideration of the socio-economic determinants of TB. Recent work has included the development of guidance and a benchmarking, reporting and review process for country-level TB modelling, as well as modelling of TB case detection and prevention, diagnostics and vaccines.

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2.1 Background to meeting

Forecasting the budget needs and economic impacts of country-level TB policy change is both difficult and important. Useful forecasts must (i) accurately estimate the magnitude and timing of resources (financial or non-financial) needed to implement a new program or policy, (ii) estimate the costs or cost-savings for other related services that result from the policy change, and (iii) account for a range of contextual factors (capacity constraints, secular trends in unit costs and health burden, related policy changes) that will impact projections. The results of these projections will be used to develop National Strategic Plans, funding applications, and investment cases. When paired with estimates of the health effects of policy change, these estimates are also used to assess allocative efficiency and prioritize across a set of possible policy choices.

Given the complexity of estimating future health and economic outcomes, mathematical models are increasingly used to synthesize available evidence and provide internally-consistent estimates of policy effects for use in decision-making. Several of these 'health policy models' are in active use to support country-level TB policy-making. These models are commonly developed by international technical assistance groups (academic institutions, consulting organizations), and an individual modelling application involves a team of external experts working with country stakeholders to undertake analyses. These analyses typically employ a base programming code that gets tailored to country conditions using local data on epidemiological trends, programme quality and coverage indicators, and cost data. Models are used to simulate future health and economic outcomes of scenarios describing a range of policy options, and these results are used to create budget forecasts, and inform deliberations about which policy options should be prioritized.

2.2 Motivation and objectives

There is not a commonly-agreed approach for creating cost and budget forecasts from TB modelling. There is also a variety of approaches that are used to translate modelling evidence into discussions on resource needs and allocative efficiency, and it is not clear when specific methods are or are not appropriate. While there are few data to empirically assess the relative validity of different approaches, it would be useful to develop a common understanding of the various approaches used, how these approaches might produce different results or be applicable in different situations, and learn from the collective experience that has developed around TB costing and budgeting. Moreover, TB program planning does not occur in a vacuum, and it is important to understand how these approaches align with the broader work on health technology assessment and health system-level priority setting and financing.

In this meeting, TB MAC convened experts on the economics and financial analysis of TB policies employing disease models, with the following objectives:

i. Share current practices and past experience in producing cost and budget forecasts, as part of country-level TB policy modelling.
ii. Share current practices and past experience in using economic results for country-level resource allocation and policy prioritization.

iii. Discuss how these approaches might produce different results or be applicable in different situations.
iv. Discuss the utility of standardization around methods, analytic assumptions, and/or the reporting of results.
v. Propose next steps for acting on these issues (collectively and individually).

2.3 Structure and process of meeting

Given the logistical difficulties on an in-person meeting during the COVID-19 pandemic, the 2020 TB MAC economics meeting was organized as two 3-hour sessions:

Session 1

Session 1 focussed on the economic approaches employed by TB modelling groups, and included modelling group representatives as well as TB MAC. It covered the following topics:

1) Questions answered by country-level TB economic modelling
    - *Introduction, Tuesday 2nd June*

   An orientation on recent efforts to support country-level TB economic modelling by reviewing common approaches and addressing challenges

2) Description of current approaches to country-level TB economics
    - *12:30-14:30 Tuesday 2nd June*

   Presentations by 6 TB modelling groups describing their economic analysis methods, covering evaluation questions, data sources, cost model structure and analytic approaches, and technical assistance process

3) Identification of methodological areas for discussion with expert panel
    - *14:30-15:00 Tuesday 2nd June*

   A discussion of the strengths and challenges of current economic analysis approaches, highlighting areas for intervention and improvement

Session 2

Session 2 elicited additional input from external economic experts, and included a discussion of issues raised in both Session 1 and 2. The session included the Session 1 attendees as well as several economic experts working in areas relevant to TB decision-making and budgeting. It covered the following topics:

4) Reflections on country-level TB economics by expert panel
    - *12:30-13:30 Tuesday 3rd July*

   Short presentations by selected experts on novel approaches and resources for country-level TB modelling and common challenges in the field.

5) Conclusions and way forward
    - *13:45 -15:00 Tuesday 3rd July*

   A discussion of the areas for improvement identified in session 1, culminating in practical suggestions and plans for future work.

3. Current approaches for country-level TB economic modelling (Session 1)

3.1 Summary of economic approaches

The meeting began with a summary of written descriptions provided by each modelling group, based on questionnaires completed before the session. These questionnaires covered the objectives, data inputs, analytic approaches, challenges, and future directions for the country-level economic analyses the modelling groups undertake (full survey responses are provided in Appendix 2.3). Survey responses were received from AuTuMN, TIME Economics, IDM, SEARO, Liverpool and Optima TB, and the summary was prepared by Fiammetta Bozzani.

The main types of country-level economic analyses included the selection of interventions to include in National Strategic Plans (NSPs) for TB, Global Fund applications, and assessment of new health technologies. Specific objectives included carrying out cost-effectiveness analyses, for example of the interventions being considered for inclusion in NSPs, and estimation of resource requirements to implement them, including gap analyses. The objectives of these analyses and the comparators to include were most often selected in consultation with countries' National TB Programmes (NTPs), donors and other experts. Typically, workshops and/or small group consultations are held at several stages throughout projects to define the scope of work, select interventions, and to collect and validate model parameters. A crucial step in the expert elicitation of model parameters includes collecting information on the effects of interventions on health outcomes, which often complements literature reviews.

All modelling groups reported using linear cost functions, with constant unit costs attached to model outputs defining the size of the population receiving a TB service or intervention. Approaches to costing involved a mix of methods, with some primary data collection, usually alongside data from trials or from WHO patient cost surveys, some collation of available unit costs from the literature and from repositories (One Health, Global Health Costing Consortium, Stop TB Partnership Global Drug Facility etc.) and some expert consultation, for example to collect prices and quantities from NTP procurement records. Only one group made explicit use of health systems data in their operational model. Two groups made use of economic data on TB budgets and expenditure, such as costed NSPs and funding request breakdowns, to estimate budget impact and requirements of new interventions. In the absence of new data collection exercises or other setting-specific data, 'default' cost estimates from costing repositories were used to fill gaps, followed by expert consultation (for example to estimate resource quantities per unit of output) and by published literature from comparable countries.

The main results reported included incremental cost-effectiveness ratios (ICERs), TB outcomes (prevalence, incidence) over time under different intervention or resource allocation scenarios, and total costs or resource needs by scenario. Uncertainty around key model parameters was most often communicated using graphics showing ranges produced by repeated model runs, as well as user interfaces such as dashboards allowing stakeholders to vary parameters and observe the effects on estimates. Most groups engaged in both in-country and remote training activities on economic modelling theory and on how to run versions of the models independently for national strategic planning, with some user-friendly tools being developed (or advocated) for this purpose.

3.2 Economic approaches by each modelling group

AuTuMN

The first presentation was by Emma McBride, representing the Australian Tuberculosis Modelling Network (AuTuMN). Their country-level analyses primarily support strategic planning, usually 5-year National Strategic Plans (NSPs), by comparing the cost-effectiveness of alternative policy options being considered by National Tuberculosis Programmes (NTPs). The objectives and scope of the analyses are usually decided in consultation with the NTP, with support from funding partners. Data on TB programme spending and on the quantities and costs of resource items required to implement the interventions are requested from the NTP, most often with the aim of carrying out an incremental costing rather than costing current services under the TB programme. Depending on data availability, a combination of micro- and macro-costing approaches are undertaken with the aim of defining the cost-coverage curve for the specific services, which shows how variable costs change as coverage expands. Data gaps are frequent, particularly for determining indirect costs. These are filled using published evidence from comparable countries, where possible, or using data from repositories such as One Health, the Global Health Costing Consortium (GHCC) or the Stop TB Partnership's Global Drug Facility (GDF). A societal perspective is preferred and key economic outputs include incremental cost-effectiveness ratios (ICERs), estimated investments or cost savings for different intervention scenarios. These are presented using online interactive visual tools that allow end-users (policymakers and other stakeholders), to explore uncertainty and the effects of varying key model parameters on the final outputs.

Following the presentation, Anna Vassall asked whether there are any specific interventions whose costs are particularly difficult to elicit compared to others. Emma McBride responded that most NTP stakeholders have an idea about treatment costs, particularly in the context of specific interventions such as improving patient support. However, it is more difficult to estimate costs and effects of more complex interventions such as active case finding (ACF), comprising numerous activities. Less common interventions, such as those tackling latent TB, are also difficult to cost. Nick Menzies asked how cost coverage curves were estimated. These were obtained outside the model, using cost data for the desired scenario to estimate the possible coverage given the available budget (or vice versa, the financial resource requirements at the desired coverage level). Richard White asked whether the cost coverage curves are communicated to stakeholders only, or also presented in publications. Usually, curves are produced for all interventions analysed and are included in online appendices.

TIME Economics

The second presentation was by Rachel Sanders, from Avenir Health, describing TIME Economics. TIME is currently used in a number of countries, usually to estimate the cost-effectiveness of packages of interventions considered for inclusion in NSPs and funding requests to the Global Fund. The aims of these analyses usually include demonstrating the benefits and costs of new intervention strategies by comparing between the strategies and the status quo. For each intervention in the model, the target population is multiplied by the population in need and the coverage level to calculate the number of services provided under each strategy. This number is then attached to the unit cost to calculate total intervention costs. The data sources to parametrise the model are usually country- and context-dependent. The provider perspective is taken in analyses using TIME Economics.

Following the presentation, the team was asked whether opportunity cost thresholds other than those put forward by WHO CHOICE had been considered. Rachel responded that there is certainly a need to expand to other thresholds but there is uncertainty at the moment over which ones would be best. It was observed that TIME Economics uses linear cost functions such that unit costs do not vary with coverage or service volume. What would then be the approach if countries asked to model a drastic, rapid increase in coverage? This is not uncommon, and the approach is to try to think beyond costs, about other resource requirements such as health provider time & capital equipment. By looking at availability of physical inputs, it is possible to have a discussion with stakeholders about whether the proposed policy option and timeline are viable.

IDM

The third presentation was by Bradley Wagner, discussing IDM's modelling approach. IDM's economic work includes cost-effectiveness and willingness-to-pay analyses, typically to support the refinement of Target Product Profiles (for example for new vaccines or diagnostics) and investment cases. Costing is done incrementally compared to baseline, from the provider perspective, and parameters are sought in the published literature or in available repositories (GHCC), without collecting primary data. The final product of these analyses is usually a ranking of the interventions being considered, based on ICERs. These are presented visually through graphs and uncertainty is communicated by showing possible variations in the ranking order. The biggest challenge at the moment lies in the lack of setting-specific cost data and in the heterogeneity in sub-national costing data, which makes discussion of the cost-effectiveness of locally-targeted interventions challenging.

Following the presentation, more information was requested on how uncertainty is analysed to assess how it can change study conclusions. This can be done using partial rank correlation coefficients, which is a non-parametric approach that can be used to identify which variables are the most important (although this is not always presented to stakeholders). Another option is to look at whether individual parameters may change the relative ranking of interventions. It was observed that sometimes bounds for uncertainty are clearly defined, but in some areas uncertainty is too broad (e.g. when costs are only available from a single region, but might not apply to the whole country) and a method is required to deal with these cases. This is particularly relevant to TB modelling as there are often new intervention areas for which very little data are available and best practices might be unknown. Brad agreed that this might pose difficulties, and a way of dealing with it would be to include an upper and lower bound just to give an idea of whether rank is sensitive to the parameter. This situation is however unusual for IDM's economic work, as it usually layers new interventions on top of an existing platform for which information is available.

SEARO

The fourth presentation was by Vineet Bhatia, outlining the economic analyses aimed at defining a package of services required to end TB in WHO's South-East Asia region. The study, initially undertaken for high-level advocacy during a Regional ministerial-level meeting in March 2017, was subsequently used for supporting national and regional planning and resource allocation. Its components included a cost-effectiveness analysis of interventions considered, an estimation of resources required for implementation, and a gap analysis compared to current spending and available financing. The study was conducted for each of the 11 countries in the Region, and involved a combination of interventions including rapid

expansion of newer technologies like molecular tests for diagnosis, scale-up of non-NTP sector engagement, and intensified case finding covering a large proportion of contacts. Costs were collected from published sources and validated with country experts, taking a societal perspective. The main challenge with this analysis was to parametrise scenarios modelling the effects of novel interventions, for which there is as yet little clarity on the details of implementation and little cost data is available.

Following the presentation, there was a question on how the modelling group extrapolates costs from different countries. This is usually done by adjusting data from the literature using proportions of GNI per capita, particularly for the costs of labour time as these were not usually available. The discussion also expanded on the issues with parametrising novel interventions. ACF in particular was a struggle, as there is still very little information on what the intervention might look like and relatively few trials of ACF strategies. Data collection is now ongoing alongside some of these trials. Another question was on the approach taken for modelling 'aspirational' scenarios looking at TB elimination. Population preventive therapy is one example, where the approach was to look at the potential impact of aspirational coverage with the caveat for population based preventive treatment that no specific intervention was modelled or costed, as there is as yet no information on what inputs would be required.

Liverpool School of Tropical Medicine

The next presentation was by Laura Rosu and Ewan Tomeny, who presented two pieces of work by the Liverpool School of Tropical Medicine. The first was the group's operational modelling, which allows for analysing health system constraints and bottlenecks affecting intervention delivery. The main aim of this work is to support the rollout of new diagnostic technologies. Costs are analysed from the societal perspective using local published and unpublished sources, including WHO patient surveys for patient costs. Results are communicated using ICERs as well as data on health system resources, bottlenecks and resource requirements, such as numbers of machines needed to achieve diagnostic targets. The model includes an interface that can be run with stakeholders to visualise results and communicate uncertainty. The second piece of work is the STREAM trial, which includes an economic evaluation of MDR-TB drug regimens alongside the RCT.

Following the presentation, challenges with defining which of the costs incurred in the STREAM trial would translate to real world implementation were discussed. This was addressed by costing the patient pathways based on the standard clinical guidelines rather than the trial protocol, modelling actual input counts rather than trial counts, and excluding any research costs. The STREAM trial also had to deal with changes in treatment protocols mid-point, this was done by dropping a trial arm due to changes in the treatment regimen recommended by WHO.

Optima TB

The last presentation was by Rowan Martin-Hughes, describing the economic analyses performed with the Optima TB model. Country analyses typically aim to assess the impact of different spending allocations, including the optimization of additional resources, on TB outcomes. These analyses are used to inform NSPs, support funding applications and highlight evidence gaps for future work. Intervention definitions in the model are customizable and model parameters include program spending, coverage, unit costs per person, per year, maximum saturation and capacity constraints, defined as a fixed upper and/or lower limit to

the number or proportion of people receiving a service or intervention in a given year. Provider costs are estimated from primary data collection (both top-down and bottom-up) and/or from repositories (GHCC and others).

Following the presentation, it was observed that AuTuMN tried an approach including optimisation but found that it did not add many insights. The Optima team reported that they had found that, even when results are mathematically evident (such as findings to prioritize a given program modality as it is both less expensive and more effective than another modality), working through the optimization process with a national team, and communicating the impact of optimized spending, had helped country experts enact change with policymakers. The Optima team share several measures of the uncertainty around results with national teams, stakeholders, and policymakers but, in any case, optimisation results are primarily about the relative ranking of options rather than exact numbers. Lori Bollinger asked for more information on the use of cost functions and their non-linear approaches to estimate costs in the model. The Optima team reported that optimisation works starting from the current budget and assessing a variety of possible ways of reallocating spending based on the objective function, which is usually to minimise deaths (as well as allowing to minimize infections, DALYs, or a combination). A cost-coverage curve describes the relationship between costs and coverage, and coverage and outcomes, much like the one shown by AuTuMN. Then, within the model, linear costs are adjusted to the coverage function. The exact shape of the cost function is defined by a formula (https://atomica.tools/docs/master/general/programs/Programs.html). Saturation level is defined by most recent or historical evidence and in-country experts (e.g. ACF programme can reach max 20% of the population). It was then asked if the functional form of the cost functions ultimately impacts results. The Optima team reported that headline results (e.g. what programmes to prioritise) do not change, but the process modelled is more realistic because saturation is not immediately reached, and programme scale-up looks more gradual.

3.3 Outcomes and next steps

A productive discussion among all participants followed the presentations. Points raised during the meeting (either through the survey responses, presentations, or discussion) were collated and organized for further discussion in Session 2.

4. Reflections on country-level TB economics, strengths and weaknesses, and the path forward (Session 2)

The first half of Session 2, chaired by Anna Vassall, featured short presentations by selected experts on novel approaches and resources for country-level TB modelling. The second half, chaired by Nick Menzies, was structured as an open discussion between the expert panel and other participants, going through the areas for improvement identified during Session 1 to propose practical solutions.

4.1 Reflections on country-level TB economics by expert panel

WHO tools

The first presentation was by Ines Garcia-Baena and Melanie Bertram, from WHO. Ines provided an overview of recent updates to the OneHealth tool. As budgets for national strategic planning often cannot depend on TB modelling due to scarce capacity for timely technical assistance, WHO supports the development of budgeting models for TB that can be used autonomously by countries. This is conceptualised as a stand-alone basic budgeting tool using a variety of impact modelling data. Use cases include regional and national investment cases.

The second presentation by Melanie Betrram was an introduction to the UHC Intervention Compendium. This aims to provide a standardised structure across interventions that can be used for priority setting exercises, for example to build unit costs. TB is being used as a pilot disease area.

Following the presentations, it was observed that, as part of defining interventions within GHCC, there were consultations with the modelling groups to define what can be modelled. Melanie explained that, as part of the UHC Intervention Compendium development, a modelling platform is being created to ensure there is alignment between the costing and modelling communities.

Clarifications were then sought around why budgeting for NSPs may not depend on TB transmission modelling given the scarcity of resources and tight timelines. However, Ines's presentation then showed that OneHealth links to the TIME model so modelling inputs can be used. Ines clarified that NSP budgeting needs to happen in all LMICs, including those that cannot access TB impact modelling on time or at all (i.e. need to be autonomous in projecting volume of cases to feed into "target populations" for interventions). WHO has requested Avenir to develop an interface that allows users to link any transmission model with the OneHealth TB costing module, not just TIME Estimates or TIME Impact, allowing more flexibility depending on the resources available. The Global Fund had expressed interest in funding this but there has not been a follow up yet.

WHO is also in the process of developing a report summarising models and tools for impact modelling and costing for TB. This should be available around August 2020. The tools are applied to the evaluation of the People-Centred Framework for NSP development in a number of countries - where the new NSPs developed using PCF principles will be evaluated against the traditional NSPs. It was explained that the evaluation is more of a landscape assessment of what is available at the moment, not really focussed on assessing usefulness of country-

level exercises but there are definitely some process questions in the evaluation that will then be publicly available. Aim is not to duplicate questions across countries as there are 4 evaluations going on already. Ines explained that there is still work to be done on defining best practices for some of the methods, for example measuring returns on investment. WHO has been summarising available modelling, costing and institutional context analyses to describe methods of estimating ROI, with the idea of going back to the countries in a couple years' time (post-covid) to apply the methodologies and put together implementation guides.

KNCV People Centered Framework for NSP development

The next presentation was by Kathy Fieckert from KNCV, introducing the people-centred framework approach. This is a new planning approach for TB, which also encompasses implementation and evaluation. The rationale for its development is the ever-increasing demands to be more ambitious with TB targets, and countries are struggling in response. We have more data and evidence than we ever had before, and new drugs and technologies, so optimising has become very important but the whole process is also now more complicated. The PCF framework is focused on the TB patients' journey along the care continuum, categorising patients based on access and retention in the system at different points. This helped identify data gaps. Involving economists earlier on is key to the process.

iDSI investment case

The fourth presentation was by Tommy Wilkinson from the University of Cape Town, going over the analyses to inform policy and the principles that underpinned the development of the iDSI reference case. A key question for framing the analyses is around TB exceptionalism - whether TB should be treated differently from other diseases. There are several examples of disease area exceptionalism (e.g. NICE in the UK will not consider HIV and vaccines) and TB is often treated in this way, with the objective of achieving efficiency within the individual programme. The case for TB exceptionalism is based on TB's high burden, donor interest and the established decision-making practice that treats infectious disease programmes independently (e.g. investment cases). The case against states that integrated approaches are more desirable, particularly under UHC when allocative efficiency is an objective and where it is important to be able to learn lessons from other areas. In this landscape, decisions based on models need to be embedded in the context and transparent. For this reason, the iDSI reference case was developed using the 'accountability for reasonableness' framework. It consists of 11 principles defining what needs to be reported in economic evaluations, helping countries think through the methodologies that are most appropriate to answer key questions.

Following the presentation, a discussion developed around whether TB would get enough prioritised funding if bundled together with other programmes. Even though there is a convincing investment case at global level, TB often does not make it onto the priority list among several health conditions. Hence, the question is how to prepare and present country-specific scenarios where different health interventions are compared in a country context. A number of TB interventions would certainly make it onto a priority list that was based on cost-effectiveness and equity, but there is a need to have a holistic view of intervention packages without using hard cost-effectiveness thresholds as decision criteria. A reasonable idea of the marginal productivity of the national health system would be necessary to make sure interventions are appropriately prioritised. It was added that this was considered by WHO-CHOICE, which covers approximately 400 interventions across 22 disease areas. Generally, TB interventions fall on the production possibility frontier so they would be included in high

priority packages, but ultimately their inclusion would depend on the local budget constraint.

Value TB

The last presentation was by Sedona Sweeney from LSHTM, presenting the costing data collated by the Value TB study. The project aimed to produce a comprehensive set of unit costs for TB services for the Philippines, Kenya, Ethiopia, India and Georgia, as well as a comprehensive framework (tools and processes) for TB cost data collection at country-level, for use in priority setting.

Following the presentation, there was a question on whether there is a process in place for modelling teams to access Value TB data yet. At the moment access is granted through the Value TB PI in each country. WHO GTB has published the syntheses of data across countries, but these do not include patient level disaggregated data. In the future, there will be lists of standardised, compatible interventions that can be used across countries.

4.2 Discussion on the strengths and weaknesses of current approaches

For this part of the meeting, chaired by Nick Menzies, the points for discussion raised in Session 1 were grouped by thematic area (either through the survey responses or through the presentations) to structure the consultation with panel members and other meeting participants.

4.2.1 Data sources

The purpose of this area is to define how, as the TB MAC community, we can ensure economic data is available (both in terms of quantity and quality) to assist country-level modelling efforts. Participants were asked to name activities that the modelling groups can undertake themselves, or that they need other stakeholders to undertake.

Hierarchy of costing data sources

Stephen Resch, from Harvard, described an ongoing project looking at some of the challenges that analysts come up against when using cost data that has already been collected (e.g. data is not from the study country, or it is from a different time period, or the intervention is slightly different to the one being costed). There might not be a formal hierarchy of cost data sources but there are definitely types of cost data that are better than others. The project aims to define the systematic process that analysts can go through to evaluate pieces of costing information for use in specific analyses - sort of like a checklist (e.g. is this from a comparable time period, from the same country, from a comparable intervention etc.), proposing systematic adjustments that can be considered for time, place etc.

Validating cost estimates

It was observed that there is an increasing availability of default values, which can be improved on through successfully engaging with country teams, but there is great variability across countries in terms of the extent that this is done. There are more rigorous and established methods for validating and adapting input costs, not so much for other intervention components, particularly above-service level costs. It was added that, from experience with HIV, where PEPFAR and Global Fund have been focussing on ‘expenditure reporting’, another possible step in a costing exercise might be to go through a process of reconciling expenditure per unit of output data with whatever unit costs have been estimated. While there are good reasons these might not be the same, this kind of triangulation could be a useful reality check

on unit cost assumptions. It was observed that expenditure data can also be used to triangulate with total costs to validate the underlying unit costs /numbers reached.

Transferring cost estimates
In the iDSI network there is a working group on transferability of data across countries (cost, effect and ICERs), that is hoping to come up with a framework on the transferability of economic data, with recommendations that should be aligned across similar efforts. It was added that it is important to have definitions of what is included in published and default cost estimates (what are the resources/activities costed, how is the intervention designed). Having standard definitions would help ensure that countries are able to provide standardised definitions for modellers. The UHC Compendium aims to fill this gap, providing standards for intervention components and resource quantities and allowing countries to enter their local price data. The Compendium will be launched in September and shared with the group as soon as it is available online.

Practical challenges
It was concluded that, ultimately, country-level analyses depend on the amount of funding, time and local capacity available, which are often limited. For example, an important constraint reported by the TIME team is in the ability to engage with country teams successfully. Many proposals are being prepared that do not get responses from countries because of too many competing requests and limited capacity.

Useful resources

- Selecting the appropriate data sources for informing benefit packages: https://www.cgdev.org/sites/default/files/whats-in-whats-out-designing-benefits-final.pdf
- GRADE recommendations on rating the quality of economic evidence: https://doi.org/10.1016/j.jclinepi.2012.04.012
- Assessing the appropriateness of existing model adaptation methods: https://whiterose.ac.uk/collaborationfunds/assessing-the-appropriateness-of-existing-model-adaptation-methods-to-the-context-of-middle-income-countries-a-case-study-on-taxanes-for-adjuvant-treatment-of-early-breast-cancer-in-south-africa/

4.2.2 Costs and effects modelling

This area, following discussions on the availability and quality of cost data sources, moves from the premise that there is a need for more systematic documentation of the structure of unit costs used as inputs to modelling exercises.

Modelling scale and scope
Advocates of using cost functions in models argue that the marginal cost of adding a new intervention/component to the health system is usually different from the average cost, so the unit costs currently used in modelling are of limited usefulness. It was observed that there is a need to define what the implementation of economies of scale and scope in models would look like in practice, as this would likely require data on the number of health facilities in a country providing a certain service as well as data on their capacity utilisation. Cost-coverage curves are probably easier to use in models, but create complications with modelling

economies of scale at the facility level. It was concluded that much of the existing work on cost functions is descriptive and focuses on site-level analyses, so there is no proof of causality and of what might be needed for programme-level changes.

Modelling analysis objectives
It was observed that approaches vary, depending on whether the objective is to advise NTPs or to make business cases to donors. The latter exercise would in principle require a full costing, but there is an incentive to cut corners and budget for fewer resources (e.g. volunteers) to make interventions look cheaper.

Modelling intervention effects
The importance of considering the health effects that interventions may have post-TB, where recipients are unlikely to return to full health, was pointed out, to avoid undervaluing prevention compared to treatment. It was also observed that it would be useful to list methods for incorporating indirect effects (i.e. averted infections and effects on labour / productivity) in models.

4.2.3 Presenting results, country engagement and capacity building

This area looked primarily at the modelling of health system complexity and how that complexity can be effectively communicated. The discussion also touched upon CEA threshold selection and other areas where methodological guidance would be useful and TB MAC can play a role in producing this.

Cost-effectiveness threshold selection
Cost-effectiveness thresholds are not usually influenced by a single disease area, so technical choices might not be a key aspect when looking at TB only. There was agreement that in many settings it is more important to understand where costs are falling and what is the budget impact of the interventions. However, cost-effectiveness does matter and there is a need to clarify a practical way forward around the use of thresholds. An attempt at producing some guidance in this space is forthcoming from iDSI.

Communicating uncertainty
Given the considerable uncertainty around key data highlighted during the course of the meeting, it is important to effectively communicate caveats to policymakers. It was suggested that modellers could produce a plan for the resources required to get models to generate a minimum level of uncertainty in their outputs. Another suggestion was to use Value of Information analysis to assess the value of further research to reduce information uncertainty. This also speaks to the appropriateness of alternative data sources, and the consequences for decision uncertainty. It also serves to highlight the need for targeted empirical research to reduce uncertainty.

Country engagement
WHO has been mapping people in-country who support priority setting processes to eventually produce a database of people who need to be linked up to the relevant networks.

Useful resources

- ISPOR report on Value of Information analysis good practices: https://www.sciencedirect.com/science/article/abs/pii/S1098301520300279

- Econometric estimation of York's cost-effectiveness thresholds for South Africa (first empirical data point for LMIC that is not an extrapolation from the UK): https://academic.oup.com/heapol/article/35/5/546/5775577
- Review and commentary on cost-effectiveness thresholds: https://link.springer.com/article/10.1007/s40273-017-0606-1
- Revill et al (2020) Global Health Economics: https://www.worldscientific.com/worldscibooks/10.1142/11045#t=toc
- Resources on distributional CEA: https://www.york.ac.uk/che/research/equity/economic_evaluation/

4.3 Outcomes and recommendations

Through the two sessions, several items were identified as possible areas for improvement or collective action in the future. These were consolidated through discussion and additional input provided after the two meetings. This consolidated list of issues is shown below, grouped into broad thematic areas.

4.3.1 Generation and use of economic data inputs

1. Understanding/resolving differences in the scope and comprehensiveness of unit costs and how they are used and represented in models.
2. Need for greater adherence to the formats specified by unit costing guidelines such as GHCC.
3. Utility of defining a hierarchy of cost data sources, and describing approaches to deal with potential bias for different sources and to ensure consistency and standardisation.
4. Need for a review of methods for transferring costs, both across countries and within countries, and from trials to real world settings.
5. Need for better data on the impact of health system constraints on intervention quality and coverage, and the ability to scale up new services.
6. Evidence on the cost and outcomes of efforts to relieve health system constraints.
7. Guidance on how to deal with data gaps on the links between costs and effectiveness of activities and interventions to improve service quality and/or coverage, and the potential need for better evidence in this area.
8. Need for guidance on formal methods to elicit assumptions from expert/stakeholder groups, and to validate cost inputs.

4.3.2 Modelling the relationship between services, costs, and health outcomes

9. Lack of clarity on how and when to use cost functions (including economies of scale and scope), and appropriate data for constructing these functions.
10. Further discussion of methods for modelling the impact of health system constraints.
11. Standard approaches for selecting cost-effectiveness thresholds and considering decision rules for national priority setting and budgetary constraints.

12. Standard approaches for DALYs and life years calculations (including disability weights and utilities for TB and post-TB), and to selecting time horizons.
13. Guidance on applying and estimating other decision criteria for priority setting (e.g. equity, feasibility) for TB.
14. Guidance supporting the use of societal perspectives.

4.3.3 Presenting results, country engagement and capacity building

15. Improving collaboration between international modelling technical assistance groups to identify and involve local health economists (often not embedded within National TB Programmes).
16. Need for approaches for communicating and discussing joint economic and epidemiological uncertainty in the decision/priority-setting process with stakeholders (in terms of processes).
17. Guidance on how to (and whether to) estimate and report costs for scenarios that are 'uncostable', such as intervention scenarios projected too far into the future, or where almost no local data are available, or where health systems are severely constrained.
18. Clarity on how to adapt economic methods for different purposes (e.g. advocacy, broad strategy development, program budgeting).
19. How to best ensure engagement at the sub-national level, which might be necessary to get the full picture of real-world implementation.

Several of the issues highlighted above are not new to economic evaluation and priority setting, but it was considered important to ensure that TB modellers were clear on current guidance; and some may need specific guidance to ensure they are correctly and consistently applied to TB.

4.3.4 Options for short-term action

Options for short-term action were identified based on the consolidated list of issues.

- Develop a mechanism for maintaining a consolidated database of existing TB cost estimates with periodic updates. Global Fund Strategic Initiatives is a potential source of initial funding.
- Develop a mechanism to collate evidence to link between the direct epidemiological impact of interventions and the resource needs to achieve that impact.
- Encourage more systematic documentation of unit costs used as inputs to modelling exercises - NSP costing reports and modelling reports could have appendices detailing data sources, assumptions and any adjustments made. BRR modelling review mechanism could include cost assumptions.
- Targeted funding to fill evidence gaps identified in 4.3.1-3.

APPENDICES

1. Participant List
2. Meeting Agenda

Appendix 1. Participant List

Session 1

Name	Organisation
Angela Kairu	KEMRI Wellcome Trust
Anna Vassall	London School of Hygiene and Tropical Medicine
Brad Wagner	Institute for Disease Modelling
Carel Pretorius	Avenir Health
Emma McBryde	James Cook University
Ewan Tomeny	Liverpool School of Tropical Medicine
Fiammetta Bozzani	London School of Hygiene and Tropical Medicine
Finn McQuaid	London School of Hygiene and Tropical Medicine
Hassan Haghparast-Bidgoli	University College London
Jamie Rudman	London School of Hygiene and Tropical Medicine
Laura Rosu	Liverpool School of Tropical Medicine
Lori Bollinger	Avenir Health
Madeleine Clarkson	London School of Hygiene and Tropical Medicine
Matthew Quaife	London School of Hygiene and Tropical Medicine
Nabila Shaikh	London School of Hygiene and Tropical Medicine
Nicolas Menzies	Harvard T.H. Chan School of Public Health
Nim Arinaminpathy	Imperial College London
Rachel Sanders	Avenir Health
Rein Houben	London School of Hygiene and Tropical Medicine
Richard White	London School of Hygiene and Tropical Medicine
Rowan Martin-Hughes	Burnet Institute
Sherrie Kelly	Burnet Institute
Thomas Palmer	University College London
Vineet Bhatia	WHO SEARO
SUPPORT & EVALUATION	
Christina Spencer	London School of Hygiene and Tropical Medicine

Session 2

Name	Organisation
Angela Kairu	KEMRI Wellcome Trust
Anna Vassall	London School of Hygiene and Tropical Medicine
Ashwin Mudaliar	Boston Consulting Group
Brad Wagner	Institute for Disease Modelling
Bridget Williams	Burnet Institute
Carel Pretorius	Avenir Health
Ewan Tomeny	Liverpool School of Tropical Medicine
Fiammetta Bozzani	London School of Hygiene and Tropical Medicine
Finn McQuaid	London School of Hygiene and Tropical Medicine
Francis Ruiz	iDSI/Imperial College London
Hassan Haghparast-Bidgoli	University College London
Ines Garcia-Baena	WHO
Jamie Rudman	London School of Hygiene and Tropical Medicine
Kathy Fiekert	KNCV
Laura Rosu	Liverpool School of Tropical Medicine
Lori Bollinger	Avenir Health
Lucy Cunnama	University of Cape Town
Madeleine Clarkson	London School of Hygiene and Tropical Medicine
Matthew Quaife	London School of Hygiene and Tropical Medicine
Melanie Bertram	WHO
Mukta Sharma	WHO
Nabila Shaikh	London School of Hygiene and Tropical Medicine
Nicolas Menzies	Harvard T.H. Chan School of Public Health
Nim Arinaminpathy	Imperial College London
Rachel Sanders	Avenir Health
Rein Houben	London School of Hygiene and Tropical Medicine
Richard White	London School of Hygiene and Tropical Medicine
Rowan Martin-Hughes	Burnet Institute
Sedona Sweeney	London School of Hygiene and Tropical Medicine
Sergio Torres-Rueda	London School of Hygiene and Tropical Medicine
Sherrie Kelly	Burnet Institute
Stephen Resch	Harvard T.H. Chan School of Public Health
Thomas Palmer	University College London
Tommy Wilkinson	iDSI/University of Witwatersrand
Vineet Bhatia	WHO SEARO
SUPPORT & EVALUATION	
Christina Spencer	London School of Hygiene and Tropical Medicine

Appendix 2. Meeting Agendas

Virtual TB MAC Meeting on TB Economics and Resource Allocation Modelling
Session 1, 2 June 2020, 12-3pm BST

Zoom video-conference details

Meeting ID: 964 6048 4819
Weblink: **https://lshtm.zoom.us/j/96460484819**
Dial-in: find your local number here https://lshtm.zoom.us/u/a57bEaDxX
Any problems during meeting: email tb-mac@lshtm.ac.uk

When	What	Who
		Chair: Anna Vassall
1200-1215	Orientation: questions answered by country-level TB economics	*Nick Menzies*
1215-1235	Summary of questionnaire responses	*Fiammetta Bozzani*
1235-1330	Description of current approaches to country-level TB economics, covering evaluation questions addressed, data sources / data collection, cost model structure and analytic approaches, technical assistance process. *All presentations: 10 minutes + 7 minutes question time*	
	Modelling group 1 (AuTuMN)	*Modelling group 1*
	Modelling group 2 (TIME LSHTM & Avenir)	*Modelling group 2*
	Modelling group 3 (IDM)	*Modelling group 3*
1330 -1340	Break (bring your own coffee!)	
1340-1435	Country-level modelling approaches *continued*	*Chair: Nick Menzies*
	Modelling group 4 (SEARO)	*Modelling group 4*
	Modelling group 5 (Liverpool)	*Modelling group 5*
	Modelling group 6 (OPTIMA)	*Modelling group 6*
1435-1450	Summary	*Anna Vassall*
1450-1500	Next steps and plan for session 2	*Nick Menzies*

Virtual TB MAC Meeting on TB Economics and Resource Allocation Modelling
Session 2, 7 July 2020, 12-3pm BST

Zoom video-conference details

Meeting ID: 964 6048 4819
Weblink: https://lshtm.zoom.us/j/95748948913?pwd=ODdUVUUwOHV3UUs0RWtscXpZb3Z3UT09
Password: TBMacEcon
Meeting ID: 957 4894 8913
Dial-in: find your local number here https://lshtm.zoom.us/u/a57bEaDxX
Any problems during meeting: email tb-mac@lshtm.ac.uk

When	What	Who
1200-1220	Introduction and plan for the session	*Chair: Anna Vassall* *Nick Menzies*
1220-1235	Summary of Session 1 on country-level economic modelling	*Fiammetta Bozzani*
1235-1335	Reflections on country-level TB economics *10 minutes for each presentation + 5 minutes questions* Melanie Bertram & Ines Garcia Baena, WHO Kathy Fieckert, KNCV Tommy Wilkinson, UCT Sedona Sweeney, LSHTM	
1335-1345	Break	
1345-1450	Discussion A: strengths and weaknesses of current approaches *Area 1: Costing data sources* *Area 2: Costs and effects modelling* *Area 3: Evaluation questions, and communicating results* *Area 4: Technical assistance process and capacity building*	*Chair: Nick Menzies* *Anna Vassall*
1450-1500	Next steps and meeting close	*Nick Menzies*