TB Modelling and Analysis Consortium (TB MAC) / World Health Organisation (WHO)

Annual meeting

Country-level modelling & UHC

Istanbul, Turkey
01-04 October 2019

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 tenth meeting, held in October 2019 in Istanbul, Turkey, our aims were twofold. The first of these was to discuss a variety of initiatives to support country-level TB modelling, including a benchmarking, reporting and review (BRR) process to support country-level TB modelling, activities to collate data linking intervention activities to their epidemiological impact, key economic challenges to supporting global and country-level decisions, a Key Performance Indicator of The Global Fund, and efforts led by the WHO to develop guidelines around methods for estimating subnational TB burden. Our second aim was to create a forum to facilitate discussions on how to improve current epidemiological and economic modeling efforts related to TB and Universal Health Coverage. We brought together experts from different fields, including social epidemiologists and epidemiological modellers, health economists, and representatives from stakeholder bodies, including GFATM, USAID, KNCV and WHO to discuss these bodies of work and shape the direction of future efforts in this area.

The meeting centred around presentations contributed by a range of participants, followed by whole- and small-group discussions that saw significant engagement from all present, culminating in a number of useful and concrete suggestions for the future direction of various pieces of work. Next steps include:
(1) incorporation of feedback into the final review of the BRR piloting,
(2) continuation of efforts to collate data linking intervention activities to their epidemiological impact,
(3) the need for better routine cost data collection and capacity building in economics, as well as characterization of uncertainty,
(4) an invitation from GFATM to TB MAC to coordinate the KPI4 re-evaluation work,
(5) follow up by WHO with members of the writing group to continue to develop guidance for subnational TB burden estimation,
(6) the need to prioritize setting-specific models of TB and UHC that can yield generalizable insight.

1.1 TB Modelling and Analysis Consortium (TB MAC)

Background

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 which 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. The TB Modelling and Analysis Consortium (TB MAC, www.tb-mac.org) aims to improve the interaction between quantitative researchers, policy makers, TB programmes and donors to improve global control. 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.

TB MAC Aim

To reduce the global burden of TB by increasing the effectiveness and efficiency of TB control policy and practice at global and country level.

TB MAC Objectives

1) Create improved coordination, knowledge sharing and management within the TB community
2) Create new high quality modelling guidelines and resources
3) Develop better informed technical assistance/decision making communities and modellers

1.2 TB MAC meeting 10: third TB MAC/WHO annual meeting

Background to meeting

In this third annual meeting with the World Health Organization (WHO), TB MAC sought to address each of its 3 main objectives, as well as continue to support the work of the WHO and the TB Country-Level Modelling Roadmap Steering Committee

In order to contribute towards TB MAC's objectives of sharing of knowledge (objective 1) and better informed communities (objective 3), the meeting brought together participants from a number of different viewpoints, including funding agencies, technical assistance organisations, country representatives, epidemiologists and modellers, as well as those outside the field of TB. These participants initially discussed key resources that TB MAC has been developing and piloting (objective 2), including a benchmarking, reporting and review process to improve quality and transparency of modelling to support country-level TB decision making, as well as a database linking active case finding activities to their epidemiological impact. This was followed by discussions of the key challenges in TB economics for global and country-level decision making, as well as the Global Fund's key performance indicator around intervention efficiency and different approaches to estimating subnational TB burden (objective 2).

In the second part of the meeting, as part of objective 2 the TB MAC Research Group identified modelling the epidemiological and economic interplay of TB with Universal Health Coverage (UHC) as a key area of interest to discuss during the annual meeting. A similar group of participants from a range of backgrounds, including a number with country-specific experience, was brought together to discuss the challenges and future direction of modelling TB and UHC from a range of perspectives.

Structure and process of meeting

The 2019 TB MAC/WHO annual meeting focused on 6 topics:

1) **Benchmarks, reporting and review of country-level models**
    - *09:00-15:00 Tuesday 1st October*

   An update and discussion of recent efforts to improve the quality and transparency of country-level TB modelling to support decision-making through external review

2) **Linking intervention activities to epidemiological impact**
    - *15:30-16:45 Tuesday 1st October*

   An update and discussion of data collation to fill the evidence gap between Active case finding (ACF) programme activities and epidemiological outcomes
3) **TB Economics of Global and Country-level Decisions**
    - *09:00-12:30 Wednesday 2nd October*

An update on the current state of the field and discussion around how the modelling and economic communities can jointly engage to address the key challenges and gaps remaining

4) **The Global Fund key performance indicators**
    - *13:30-15:00 Wednesday 2nd October*

A discussion of the Global Fund's key performance indicator on investment efficiency

5) **Subnational TB estimates**
    - *15:30-17:00 Wednesday 2nd October*

An update on different approaches to estimating subnational TB burden.

6) **Modeling TB and UHC**
    - *08:30 Thursday 3rd October to 16:00 Friday 4th October*

A discussion of model design, empirical needs, theoretical constructs and economic principles required to improve modelling of the epidemiological and economic interplay of TB and Universal Health Coverage.

1.3 Benchmarking, Reporting and Review of Country-level Modelling Applications: (DAY 1)

1.3.1 Background

At the request of the Country-level TB Modelling Roadmap Steering Committee, TB MAC is leading an initiative to promote the quality and transparency of country-level TB modelling. This initiative includes developing an approach for benchmarking, reporting and reviewing country-level modelling applications to support decision making - the BRR initiative. In the last TB MAC annual meeting a draft approach was discussed and suggested changes were made. Since then, TB MAC has been working with country-level modelling groups, independent reviewers and the Global Fund to Fight AIDS, Tuberculosis and Malaria to pilot this approach in specific country-level modelling applications. While these pilots are still underway, the aim of this meeting was to have an interim discussion of the information gathered from these pilots and the challenges reported by the stakeholders involved, as well as to suggest improvements and next steps.

1.3.2 Aims and objectives

Aim: report on the state of piloting of the BRR initiative

Objective 1: summarise rational and efforts thus far
Objective 2: discuss challenges faced and next steps to overcome these

1.3.3 Summary

Babis Sismanidis chaired the first session, which included an introduction to the overall meeting and the agenda by Richard White and Katherine Floyd. This was followed by a summary of the rationale for the BBR, and the plans and progress made on piloting this approach, provided by Nick Menzies. This was followed by input on personal experiences of the BRR process from modelling groups and reviewers involved in the piloting, as well as the wider country-level planning process from the Global Fund and KNCV Tuberculosis Foundation. After lunch, Finn McQuaid and Jason Madan (who chaired the second session) led a discussion on the key challenges faced during the BRR and potential next steps to resolve these.

In the introduction, Richard White and Katherine Floyd outlined some of TB MAC's outputs to date, as well as possibilities for the future in this potential renewal year. They then introduced the overall agenda, describing the expected areas of progress from the week, before handing over to Nick Menzies to focus on the first session in the agenda, country-level modelling. Nick then gave an overview of the benchmarking, reporting and review (BRR) framework that TB MAC has been developing and piloting. This included a rationale for the work and an update on current status, which was midway through piloting with selected modelling groups in Kenya, Indonesia, Mongolia, Bhutan and Myanmar. The aim of this framework is to improve the quality and transparency of country-level TB models through constructive feedback and review, with a focus on using models to support countries in making decisions.

After the break, Juan Vesga, Nim Pathy, Emma McBryde, Jamie Rudman and Sherrie Kelly each gave a brief account of their experience of piloting the BRR process from the modellers perspective, followed by Rachel Sanders and Anh Tuan Nguyen from the reviewer perspective. These accounts raised a number of important questions, including whether the BRR adds additional unnecessary burden to modelling groups and reviewers, whether it was seen to be an indefinite process or had a fixed timeline, the consequences if a model was seen to be completely incongruous with the benchmarks, whether there was enough involvement of country partners in the process, and the fact that the BRR still did not resolve the issue that different models have been known to produce different results using the same data in the same setting.

These accounts and the discussion surrounding them were followed by overviews from Shufang Zhang and Kathy Fiekart on the role of modelling and the BRR for country-level planning and the People-Centered Framework for National Strategic Planning respectively. These introduced the funder and policy perspective, locating the modelling (and review of it through the BRR) within the country decision-making process.

After lunch, Jason Madan chaired a discussion, led by Finn McQuaid, on challenges to the BRR that were raised both during the morning session and previously through evaluations of the BRR that TB MAC carried out after each piloted application was complete. The following points were raised during this session, either through feedback provided by participants in the pilot, or through discussion by the wider group of meeting attendees:

Firstly, it would be helpful to develop a clear description about what should happen if an application 'fails' the BRR review (i.e. the reviewers feel there remain major issues with using the modelling results as an input to TB programme budgeting or policy making). While the BRR process is designed to allow issues to be resolved before the final stage, there still needs to be clarity on what should happen if major issues remain.

As currently designed, the BRR is primarily a set of communications between modellers and reviewers, with some arms-length involvement from the funder and TB MAC. It is unclear the extent to which country stakeholders should be involved. While this might vary between applications for good reasons, there should be more thought on what level and type of engagement is useful, and how it should be structured.

Questions were raised about how frequently the BRR should be undertaken, and whether it should sunset at some point. Several participants made the point that this should be seen as an important quality improvement tool, and undertaken on an ongoing basis. This view was not unanimous, and further discussion on this point was suggested.

There was discussion as to whether the current review process was too burdensome. The consensus of current pilot participants was that the current process was not too burdensome. However, the point was also raised that the current level of review required of reviewers might restrict involvement of country-level programmatic staff, if the goal was to engage such individuals as reviewers.

There were suggestions that the review process could be made more flexible, allowing more interactive communication between reviewers and modelling team.

It was proposed that a draft TOR be developed that could be used to formalize the sharing of modelling results and data for the purpose of review, as the country stakeholder would likely want to approve the sharing of their modelling results and data for the review.

Given the interest in conducting the pilot expeditiously, some country applications had been included which were already underway. Meeting participants suggested that, while this was understandable for the pilot, future applications should ensure (i) all agreements to allow the review are in place prior to modelling, and (ii) communication between reviewers and modellers be initiated before modelling is advanced too far.

There was feedback provided that the current review approach was focussed more strongly on the modelling approach than on assessing the realism of scenarios being modeled. It was suggested that review by experienced in-country programmatic staff would be key to testing this part of the modelling, and it would be difficult to engage such individuals if review materials were lengthy.

The comments that have been included here do not necessarily represent a consensus view of meeting participants, but had at last some broader support in the discussion. Comments were also raised that may require solutions outside of the BRR process. These included the value generated by model comparison exercises, as a tool to both understand how and why models produce different results, and to allow mutual learning between modelling groups. The BRR does not provide opportunities for model comparison, but these may be valuable in the future, and could be coordinated by TB MAC. There is also less standardization and discussion of approaches to costing and cost modelling as part of country applications, and more comparison (and potentially standardization) in this area could be useful. Lastly, the BRR does not provide information on whether modeling is useful (or considered useful) by the stakeholders of the modelling. Efforts to answer these questions could be pursued outside of the BRR.

1.3.2 Outcomes and next steps

As the piloting is still underway there will be no immediate planned changes to BRR materials and process. However, this feedback will be incorporated into the final review of the pilot. In addition, new materials or processes suggested by this feedback (e.g. description of process following a review where major issues remain, ToR for sharing country data and modelling results for review) will be developed in anticipation of incorporating them into an updated BRR process after the pilot is completed. Feedback that relates to issues outside of the BRR will be brought to the TB MAC steering committee to suggest next steps.

1.4 Linking Intervention Activities to Epidemiological Impact: (DAY 1)

1.4.1 Background

TB Programme funders and governments are looking to optimise the returns on their investments, and therefore are placing greater emphasis on tools and programmes that demonstrate allocative efficiency. The TB MAC Targets exercise highlighted the severe lack of empirical evidence on suggested activities and their costs that might lead to intervention coverage increases. Efforts are ongoing to collect cost data on specific activities (e.g. Value TB). However, the link between activities and epidemiological impacts remains poorly evidenced. Without better evidence NTPs, TA agencies, and modelling groups, are forced to rely upon educated guess-work to inform policy decisions on resource allocation.

The 2018 TB MAC meeting focused on outlining this problem and developing a set of concrete steps to address it. In 2018 it was agreed that TB MAC's role would be to structure a database for evidence to identify, collate and summarise evidence on activities, by health outcomes and outputs, for all intervention areas along the prevention and care cascade, to better inform TB resource allocation.

Subsequent conversations with stakeholders in April 2019 refocussed TB MAC's efforts on a finite piece of work to evaluate whether collating data on one intervention area could generate information useful for TA support RA decision making. Active Case Finding (ACF) was identified as the intervention area because it has recently attracted large amounts of funding ($125 million from the Global Fund), modelling suggests it could be an important intervention, and yet there is little empirical evidence to support these predictions (Kranzer et al, 2013) introducing uncertainty around resource allocation decision-making.

1.4.2 Aims and objectives

Aim: to present progress and future plans on this piece of work, and seek feedback and input from key stakeholders and attendees

1.4.3 Summary

This session was a presentation and discussion led by Richard White and Madeleine Clarkson. Richard outlined the problem statement for this work and framed the need for a link between activities and evidence of their impact alongside other ongoing efforts to better inform decision-making. Madeleine then presented the database developed by TB MAC in response to last year's (2018) meeting and stakeholder meetings held in April (2019) to address this gap for ACF interventions.

The database was presented in 3 sections. The first section contained, for each relevant and identified paper, a subset of population and study characteristics. The second section contained a subset of health outcomes, identified as most important to modelling exercises, as well as a measure of quality. The final section provided binary (yes\no) information on whether the paper contained any information on activities in the following categories: health coverage measures, staffing and training resources, staffing activities (the role of staff in

intervention activities) and diagnostic algorithm. It was highlighted that, due to an inconsistency between the way activities were defined and recorded across different papers, collating data in more detail would not add value.

This presentation was followed by a discussion. Rein Houben was the first to share a modellers perspective on this work. He argued that the database would be useful as a reference. In general he agreed with the planned level of data collection being proposed, arguing that most modelling teams would refer back to the original papers to extract the information they need. He did request that as much detail as possible be collated on:

1) the diagnostic algorithm
2) the sensitivity and specificity of the diagnostic
3) health outcome data related to changes in transmission and incidence as well as measure to compare expert and x-ray type interventions.

Rein suggested the next potential area for this work to expand into would be preventative therapy. Rein finished by reiterating the value of having a range of epidemiologically evidenced ACF activities from which to choose and that we should consider what contextual factors are important to make these data generalisable.

Nick Menzies agreed that there is a utility in having a consistent framework across economic costing and epidemiology, and ideally this would match the structure of models and the care cascade. Nick made a few practical points, including a) that we should probably only include data in the database that was likely to be generalisable, and if the activities to change intervention coverage were not likely to generalise, then piloting each intervention in each setting would probably be necessary, b) different data would need to be collected for different interventions, and c) there was a balance to be achieved between using the most recent data versus data that had been cleaned and checked; he thought that this balance should probably err towards using only (hopefully higher quality) published data.

Babis Sismandidis provided a WHO perspective, and spoke about the importance of this work to promote the standardisation of indicators across countries and whether there might be emergent opportunities from ongoing epidemiological reviews and the People-Centered Framework for National Strategic Planning (PCF4NSP) work to standardise ACF information. He also expressed disappointment that the value of this work had not been recognised by funders, as demonstrated by the lack of funding support for these data collation activities.

The invited discussants concluded with Kathy Fiekert of KNCV, who provided a programmatic perspective. Kathy agreed with the importance of the work. However, she raised a number of country-level concerns around terminology and including appropriate perspective (district, country and patient) as ongoing issues. Kathy also drew attention to the tension between collecting data into the database and the related problems around country ownership and data being used to ‘judge’ countries in the past. Furthermore, Kathy responded to the earlier comment about only including published data; she felt that this might inhibit a timely response to programme learning and that a level of compromise should be considered. Her last remark was to remind the room that the priority should be to do good research and collect good data that a country would find useful.

The discussion was then opened for input from the wider meeting participants. Responding to Babis’ call for funding, Shufang Zhang agreed with the need for funding this work suggesting

that as a public good it would be suitable for a collaboration between funders (USAID, Global Fund and BMGF). In addition, Shufang agreed that joint advocacy is important and put forward the suggestion that the Country-level TB Modelling Roadmap Steering Committee (the RSC, of which she is the current chair) and TB MAC could coordinate the setup a process to ensure appropriate data collection for this work is undertaken. This prompted further discussion from Kathy, Francis, Hoojoon and Nick, which included: increasing efficiency across the whole care cascade; the need to characterise the cost of resource allocation uncertainty and whether routine data can be used; the importance of national and sub-national data; considerations of economies of scope (for example, the crossover between HIV and TB activities); and how a pragmatic trials may be used to fill these gaps. Concluding remarks from Sedona reminded us that now, in light of the Value TB data and PCF4NSP, was a good time to collaborate to progress this work.

The session ended with two comments from Nick. Firstly, a guidance point on modelling social responsibility; should we recommend that interventions for which there are no/insufficient evidence to inform decisions are not modelled? Secondly, will data collation fill these evidence gaps, or do we need pragmatic trials and pilot studies instead?

1.4.2 Outcomes and next steps

Outcomes from the discussion included demonstrations of strong support for the direction and finite task presented, encouragement to continue this work and grow it to other intervention areas, and opportunities to collaborate with ValueTB and KNCV.

As part of these outcomes discrete next steps were identified. Actions for the steering group were to ensure more detail on the diagnostic algorithm, the sensitivity and specificity of the diagnostic and health outcome data related to changes in transmission and incidence, as well as measures to compare Xpert and x-ray-type interventions, is included in the summary tables. Secondly, the group needs to decide if the database should only include published data (or not), as well as to explore appropriate joint sources of funding collaboration between funders, and to follow up with Sedona Sweeney regard collaboration opportunities and data collection efforts and (pre-print) sharing of the activity standardisation processes used in Value TB work. Lastly, TB MAC should recommend coordination and set up a process for appropriate data collection for the activity to impact work, and should decide if we should be providing explicit recommendations for interventions for which there is no/insufficient evidence to inform decisions.

1.5 TB Economics of Global and Country-level Decisions: (DAY 2)

1.5.1 Background

TB MAC and the broader economic and modelling community have invested in both economic analysis and data generation over the last 3 years to support improved priority setting for TB. Given that the current TB MAC grant is coming to an end, this session reflected on that work. The session, however, did not concentrate solely on work produced by TB MAC, as there are many actors in this space; the session instead provided a broader reflection by those economists currently working in TB and more generally. We hope that the session helped to inform the TB modelling community of key resources and current thinking, but also where gaps remain. At the same time, it provided an opportunity for those working in modelling to share their experience and questions around the economics of TB.

1.5.2 Aims and objectives

Objective 1: To reflect on the current state of the art of in priority setting and the economic evaluation of TB
Objective 2: To identify the key challenges in the coming 3 years
Objective 3: To discuss some of the solutions or actions the community can take to address these challenges

1.5.3 Summary

The session was split into two parts. The first part, before the break, focused on economic evaluation to support investment decisions in TB from a global perspective. The second part, after the break, focused on tools and data available for support at the country level.

Part 1 started off with a joint session from Hojoon Sohn and Jason Madan on economic analysis for investment in new technologies. Hojoon Sohn gave a presentation on the types of economic evidence that is being required by product developers. He described the complexity involved in determining costs all along the production pathway, and emphasised the need for wider contextualization of practices to inform cost-effectiveness analysis (eg. decentralization, adoption/implementation practices). Jason Madan then presented on the types of economic analysis being submitted to global guideline committees, and how HTA might influence the analyses required for investments in new TB interventions. He described various issues for economists to think about to help decision makers, such as different methods for outcome valuation and decision uncertainty. He also described areas of economics outside of economic evaluation that are becoming more relevant, such as consideration of affordability, game theory and decision-making ecology.

We then heard from Shufang Zhang about challenges that are being faced by the Global Fund. She described four key challenges, including: missing international guidelines on frameworks/methodologies/tools for economic evaluation, data gaps, a lack of coherent and well-coordinated planning processes, and inadequate technical and country capacity.

Finally, Francis Ruiz gave a discussion reflecting on the current state of economic evaluation to support investment decisions. He described the 'HTA process' of making resource allocation decisions within a political environment, highlighting that it is a long-term process involving multiple organizations and requiring heavy investment in capacity-building. He suggested that this process can be supported by improving routine data collection, acknowledging uncertainty and the limitations of models for decision-making, and respecting budgetary constraints.

After the tea break, Part 2 of the session started off with an introduction of key developments in economics models for TB. We had presentations from Rachel Sanders and Tom Palmer on the TIME Economics and Optima-TB models, respectively - both presentations covered the main developments of these models since the last TB MAC meeting, and what the key challenges are going forward. Both presentations highlighted a lack of data availability as a key challenge. Sedona Sweeney then presented the preliminary results from the Value TB project, which aimed to fill the cost data gap through collecting primary cost data in India, Kenya, Ethiopia, the Philippines, and Georgia, and designing standardized tools and guidelines to enable country-led data collection going forward. The data presented described a wide range of unit costs, and highlighted the substantial variation in practice, and hence costs within countries for the same technology. Finally, Kathy Fierkart reflected on how useful these tools and data are in country planning. She emphasised the importance of affordability in addition to cost-effectiveness, and understanding follow-on costs if practices change as a result of introducing a new technology.

1.5.4 Outcomes and next steps

A few key challenges emerged consistently throughout the session, including: uncertainty, data availability, and capacity. Discussions throughout the day focused on the need for routine cost data collection, efforts in capacity building in economics, and better characterization of uncertainty in economic analysis, to ensure transparency and better guide decisions.

1.6 The Global Fund Key Performance Indicators: (DAY 2)

1.6.1 Background

In June 2016, the Global Fund Board approved 12 Strategic KPIs designed to measure the Global Fund's progress towards achieving the four Strategic Objectives set out in the Global Fund's 2017-2022 Strategy, Investing to End Epidemics. These indicators link to the Global Fund's Performance Reporting Framework, and provide key stakeholders, both inside and outside of the Secretariat, with information to make decisions related to funding, program design, implementation and maximizing impact/results.

This session discussed the Global Fund's Key Performance Indicator on Investment Efficiency (KPI4), which is intended to describe how a country's national program design and implementation contributes to the efficiency of disease control investments, including those made available through the Global Fund.

1.6.2 Aims and objectives

Aim: to provide an overview of the KPI4 TB assessment methodology recommended by the Global Fund's Modelling Guidance Group (MGG), and review recent assessment results to obtain feedback on potential changes to the methodology to improve KPI4 assessment and reporting for TB for the Global Fund 2020-2022 allocation cycle

Objective 1: to review the current KPI4 assessment method for TB

Objective 2: to obtain feedback and suggestions on potential changes to KPI4 for TB as well as processes for further discussion of this KPI.

1.6.3 Summary

Shufang Zhang provided an update on what KPI4 is, how it is calculated, and described issues that have arisen whilst assessing KPI4 for TB during the Global Fund's current reporting round during its 2017-2019 allocation cycle.

KPI4 measures the overall investment efficiency of a country's disease program by incorporating both technical and allocative efficiency. Briefly, allocative efficiency increases when a country reallocates resources strategically across interventions, geographical areas and populations, in a way that increases impact. Technical efficiency increases when a country changes the ways in which health services are delivered so that a unit of health service output or health outcome is achieved at lower cost, while maintaining quality, for a given type of intervention or services.

The current KPI4 methodology was developed in consultation with MGG, which includes technical partners, epidemiological modellers, economists, epidemiologists and internal Global Fund teams. The three disease areas (HIV, TB, Malaria) each developed different methods to assess/operationalize KPI4 to respond to disease-specific concerns. In the approach used for TB, a simple method was adopted that only took account of differences in lives-saved through provision of TB treatment, summing the incremental change on survival

probabilities across treated individuals, and comparing these to investments made during the evaluation period (i.e. comparing unit cost per life saved of the current and previous allocation cycles). Previous input from the MGG had raised concerns about whether this indicator would be negative due to changes outside the control of a country's TB program (e.g., increases in price levels for program inputs), or in situations where countries were pursuing WHO-approved strategies whose benefits were not well captured through the current indicator. For this reason, a regression method was used to adjust initial KPI4 outputs and control for changes in price levels (proxied by per capita GDP change), and TB incidence. The resulting index was used to identify countries with possible inefficiency for further investigation. This method was applied in the most recent round, acknowledging the potential drawbacks it has such as the limited ability of controlling for other plausible explanations of a higher unit cost per life saved of a program as compared to its past.

Meeting participants recognized the utility of having an indicator to assess program efficiency to guide investment decision for greater impact. However, how to properly make such an assessment can be complex. Audience feedback raised a number of concerns about the formulation and operationalization of this KPI in the context of TB, where greater investment is needed yet would likely lead to a poor KPI4 result, and where current program strategies may not be appropriately valued by the current 'lives-saved' operationalization. It was suggested that further methodological work to be done to understand if a revised assessment methodology could be developed to resolve these issues, over the next year. Richard said that if GFATM would like TB MAC to coordinate this work, then it would help if the request could in the next month.

1.6.2 Outcomes and next steps

GFATM will consider if they would like TB MAC to coordinate the KPI4 re-evaluation work and if so, ideally make the request in the next month.

1.7 Subnational TB estimates: (DAY 2)

1.7.1 Background

There is increasing global demand for estimates of TB incidence at the subnational or subpopulation level in low and middle income countries, to better understand unmet needs for TB prevention and care services, improve TB programme planning, forecasting and budgeting, particularly in countries with decentralized programme budgeting. A number of different approaches show potential. Case notifications are the best source of information in countries with universal health coverage and high-performance TB surveillance. In other countries, case notifications cannot be expected to accurately mirror patterns in incidence as they suffer from varying levels of underreporting of detected cases, underdiagnosis or overreporting (including duplicated reporting). Inventory studies and appropriately-powered prevalence surveys represent additional sources of data on the distribution of TB burden, however there is currently no clear guidance on the variety of approaches available to generate subnational estimates of TB burden, including the reliability of these approaches.

1.7.2 Aims and objectives

Aim: To report on the status of different approaches to subnational TB burden estimation

Objective 1: To summarise approaches used so far
Objective 2: To discuss the pros and cons of different approaches presented

1.7.3 Summary

Ted Cohen chaired the session, which began with an overview of the field by Philippe Glaziou. After this, different groups outlined approaches that they have taken to produce subnational estimates of TB burden.

Fulvia Mecatti outlined the theory of Small Area Estimation Latent Markov models applied to estimating TB prevalence at subnational levels, illustrated using data from Pakistan. Melanie Chitwood outlined an approach to estimating subnational TB incidence taken in Brazil, using national vital registration data that are showing a large variability in mortality rates between municipalities. One limitation of the approach included fully addressing mortality amongst children. Rein Houben described a simplified approach used in Indonesia to estimated district level incidence using data from the last national TB prevalence surveys and external predictors such as living floor space and urbanisation. He emphasised the importance during the application of producing a simple, usable model that country partners could readily adapt, but a limitation was the lack of uncertainty documentation. Sandra Alba gave a first presentation of a geospatial model of case notification data in Bangladesh, with an attempt at validating predictions of high and low risk areas using results from the national TB prevalence survey. She then gave a second presentation on a TB “Hackathon” hosted by KIT Royal Tropical Institute, which invited different modelling groups to produce estimates of subnational TB burden for Pakistan using the national TB prevalence survey results and standard predictors including programmatic TB data. Six teams submitted their model reports, using a range of modelling approaches. The competition winner will be announced during the Union Conference in Hyderabad.

1.7.2 Outcomes and next steps

Philippe Glaziou at the WHO is leading efforts to develop guidance on different approaches to subnational TB burden estimation, and will follow up with members of the writing group to continue development of this guidance.

1.8 Modelling TB and UHC: (DAYS 3-4)

1.8.1 Background

The meeting took place over two days, and consisted of the following:

(i) Presentations and coordinated discussions around key topics pertaining to the interplay between TB and UHC.

(ii) Focused small group discussions within assigned groups, each oriented around a theme that reflected the structure of the modelling research group (MRG) and TB MAC's request for applications (RFA).

1.8.2 Aims and objectives

Objective 1: To update stakeholders on methods and evidence to address key questions in modeling the interplay of TB with UHC.
Objective 2: To prioritize tangible outputs (manuscripts, training programs, communications, etc.) that can lead to better models of TB and UHC in the future.
Objective 3: To increase networking and sharing of knowledge between modelers, epidemiologists and other stakeholders in TB and UHC.
Objective 4: To promote the opportunity to access $100k funding.

1.8.3 Summary

Day 1
The meeting started with a keynote presentation from Aamir Khan of Interactive Research and Development (IRD). He described implementation of TB prevention in Karachi and questions that local NTP officials face, including how to identify priority populations for preventive therapy and how to balance the cost of therapy against the risk of disease.

Session 1
This session was centred around the topic: *Examining the role of models to understand and measure the impact of UHC on TB.* The first part of this session was focused on *epidemiological and economic perspectives of the role of UHC on halting TB.*

The session started with a presentation from Delia Boccia from the London School of Hygiene and Tropical Medicine (LSHTM), who provided a global epidemiological perspective on the impact of UHC on TB. Her presentation focused on the role of social protection programs on TB, particularly TB outcomes and financial burden from TB-related costs, and highlighted evidence gaps. Fernando Rubinstein from Institute for Clinical Effectiveness and Health Policy (IECS) talked about social protection programs like conditional cash transfer, which has improved TB outcomes in Argentina, and emphasized the role of non-biomedical solutions in improving TB care. Hongjo Choi from the Korean Institute of Tuberculosis (KIT) presented on the public-private mix under the National Health Insurance Scheme in South Korea, highlighting structural changes within National TB Program in South Korea and the National Health System over the past decades, and discussing how a multisectoral approach can help address social determinants of TB. George Gotsatdze of Curatio International Foundation presented on UHC and TB services in Georgia. He highlighted challenges faced by countries

like Georgia that are undergoing financial transitions, having to replace donor funding with national budgetary outlays. Kritika Dixit from the Birat Nepal Medical Trust (BNMT) presented on perceived risk factors of TB and perceived barriers to accessing and engaging with TB treatment and care in Nepal, and how social protection packages can be developed to address these causes and barriers. Chu-Chang Ku from the University of Sheffield presented on the insights gained from analysis of individual patient pathway data in Taiwan (such as the amount of delay, and what part of the health system is contributing the delay), and how to develop models using these data to inform the epidemiological and economic impact of various interventions. Juan Vesga from Imperial College London presented on modeling work that has been developed to establish priorities for the Tuberculosis National Strategic Plan in Kenya, and highlighted the need for multiple sources of expertise needed to effectively model UHC and TB.

The second part of this session focused on *Methodological perspectives on how models can capture the impact of UHC on TB epidemiology*. Fiamma Bozzani of LSHTM presented on a review of methods to incorporate health systems in infectious disease modelling, giving us a perspective of how disease modeling (not exclusive to TB) has incorporated health systems. Sze-chuan Suen from the University of Southern California (USC) presented a suite of methods that can be used to optimize TB care (such as when to test, and how to design incentives to improve adherence). William Rudgard from Oxford University introduced a conceptual framework for modeling the impact of social protection on TB epidemiology, highlighting the role that models can play in assessing the role of social protection programs, including challenges with available data and methodology. And finally, Ozge Karanfil of Harvard University talked about how a system dynamics approach, which has been used in the context of other chronic diseases, can be leveraged to understand the impact of UHC on TB-related outcomes.

Session 2
This session aimed to delve into the topic: *Specific issues of relevance to models of UHC and impact on TB.* Nim Pathy of Imperial College London presented his work on modeling private sector engagement in India, highlighting how models can be used to understand the potential impact of various aspects of private sector engagement on TB outcomes, such as improvement in the accuracy of TB diagnosis and reduction in diagnostic delays. Krishna Reddy of Harvard University presented on how models can project programmatic outcomes and inform responses that complement trial data. His work illustrates one approach to assessing the impact of new diagnostics, empiric treatment and linkage to care. Laura Rosu of Liverpool School of Tropical Medicine and Dr. Jason Madan of Warwick University then presented their work on using models to extrapolate from TB trials, in particular a phase III randomized control trial to test the efficacy, safety and economic impact of the 9-month “Bangladesh” regimen for MDR TB.

Session 3
Presentations and discussion in this session focused around the topic: *Models for financing TB services in the context of UHC: key considerations.* Anna Vassall of LSHTM introduced the session by highlighting key issues related to financing TB, including evaluating the health benefits of TB interventions. Ivdity Chikovani from the Curatio International Foundation presented on the challenges of financing TB in Georgia in the context of UHC, which included considering TB services that are not costed, retention of services in the context of private

providers and identifying the appropriate mix of vertical and horizontal programming approaches. Averi Chakrabarti from Harvard University presented on estimating the non-health benefits of UHC for people with TB. She highlighted how the Extended Cost Effectiveness Analysis (ECEA) framework can be applied to incorporate equity and non-health benefits in the economic evaluation of policies. Sedona Sweeney of LSHTM presented on approaches to estimate catastrophic TB-related costs in South Africa. She compared a meta-analysis based approach with a regression analysis based approach in providing estimates of catastrophic costs. Dr. Sweeney also highlighted key data gaps, particularly on costs before receipt of diagnosis, and on individual and household income for people with TB.

Day 2
Session 4
Session 4 aimed to advance discussion around the topic: *How can models contribute to the broader discussion of UHC and TB? Perspectives on priorities, need, existing tools, and communication.* The first speaker in this session was Guy Marks from the University of New South Wales, who provided an epidemiologist's perspective on how models can contribute to UHC and TB. His presentation focused on the role of community-wide active case finding, how recent work in Vietnam has demonstrated the impact of such an intervention, and key questions that remain to be answered, including the long-term impact of active case-finding interventions and the criteria for active case finding to be cost saving. Philippe Glaziou from WHO provided the perspective of a global policy maker. In his presentation, Dr. Glaziou talked about the role that past modeling exercises have played in highlighting key data gaps and demonstrating the impact of TB policies including social protection. Evaline Kibuchi from the Stop TB Partnership in Kenya provided the perspective of an advocate. In her presentation, she emphasized the role that advocates and community organizers can play in advancing TB policy making, and the kinds of data and results that modelers can provide that can help for advocacy. David Collins from Management Sciences for Health (MSH) presented the perspective of a health economist. He presented MSH's approach to cost modeling, which provides country planners and managers with simple and open source models with minimal data needs. Emma McBryde from the Australian Institute of Tropical Health and Medicine provided a modeler's perspective on the role of models on the broader discussion of UHC and TB. She discussed the needs of the model, such as being able to translate UHC drivers into model parameters, as well as limitations of the modeling approach given current data availability. Finally, the session ended with a round-table discussion on the role of modeling in supporting UHC, using Kenya as a case study. The discussants were Ms. Evaline Kibuchi, Dr. Nim Pathy, Dr. Juan Vesga, Dr. Guys Marks, and Dr. Delia Boccia. The discussion, moderated by Dr. David Dowdy and Dr. Sourya Shrestha, included topics such as communication between modelers and policymakers, needs that must be met for models of TB and UHC to be relevant to decision-makers, the importance of focusing on questions that are both important and able to be answered with available data, and the need to engage advocates and other members of civil society from the beginning of any modeling effort that aims to influence policy.

The final presentation to conclude the meeting was given by Peter Small, where he argued that we need to use new technologies (and new ways of collecting and using data), which have revolutionized other parts of our lives, to guide new ways of addressing public health needs including TB control.

On Day 1, participants were assigned to five groups each oriented around a theme that reflected the structure of MRG and RFA. The five topics/themes were as follows: (1) incorporating local/country-level UHC plans or systems in epidemiological and/or economic models of TB interventions; (2) models to estimate the impact of UHC on TB outcomes; (3) models to improve the design, optimization, and implementation of primary care or UHC schemes; (4) models to inform financing of TB services in the context of UHC; and (5) models to evaluate and advance ethical and equity aspects of TB-focused interventions. On Day 2, participants were asked to discuss these topics within their assigned groups and were tasked to develop a two-slide presentation with 3 to 5 key questions/considerations for the topic, and one proposed approached to advance the modeling in that theme over the next 12 months. Groups presented their slides, respectively, and received feedback from the rest of the participants.

Finally, the RFA closing date is October 31, 2019. We encouraged participants to take the ideas from this meeting and work them into proposals for the RFA.

1.8.2 Outcomes and next steps

In summary, the TB Modeling Research Group meeting met all of its objectives. A broad variety of stakeholders were updated on the latest evidence and methods centred around key themes on the interplay between TB and UHC; five tangible approaches were identified for advancing models of TB and UHC; networking and sharing of information between modelers, epidemiologists, and other stakeholders was promoted; and participants were given the opportunity to develop specific proposals for the RFA. This meeting has sparked a conversation between individuals who usually do not interact with each other - including experienced TB modelers, advocates and other decision-makers, individuals with experience in specific country contexts of UHC, and junior investigators who will be critical for advancing the next generation of TB models.

The outcomes from the small group discussions also provide clear direction, in terms of practical guidance for improving models of TB and UHC in the coming 12 months. Specifically, we need to seek to prioritize models that are specific to particular settings yet can yield some generalizable insights, are calibrated to settings that have sufficient data to inform parameter values, and yield outputs that can be relevant to policymakers tasked with making specific decisions. Examples of how such models could be built in each of the five topic areas were provided. These will feed into the RFA applications and the groups' ongoing activities. The RFA will be awarded in mid November 2019.

APPENDICES

2.1 Participant List
2.2 Meeting Agenda

Appendix 2.1 Participant List

Name	Organisation
Aamir Khan	IRD Global
Adam MacNeil	Centers for Disease Control and Prevention
Anna Vassall	London School of Hygiene and Tropical Medicine
Anh Tuan Nguyen	Hanoi Medical University
Averi Chakrabarti	Harvard University
Babis Sismanidis	World Health Organization
Bobby Reiner	University of Washington
Brad Wagner	Institute for Disease Modelling
Chu-Chang Ku	University of Sheffield
David Collins	Management Sciences for Health & BUSPH
David Dowdy	Johns Hopkins School of Public Health
Delia Boccia	London School of Hygiene and Tropical Medicine
Emma McBryde	James Cook University
Evaline Kibuchi	Stop TB Partnership Kenya
Ewan Tomeny	Liverpool School of Tropical Medicine
Fernando Rubinstein	IECS
Fiammetta Bozzani	London School of Hygiene and Tropical Medicine
Finn McQuaid	London School of Hygiene and Tropical Medicine
Francis Ruiz	Imperial College London
Fulvia Mecatti	University of Milano-Bicocca
George Gotsadze	Curatio International Foundation
Guy Marks	University of New South Wales
Hojoon Sohn	Johns Hopkins School of Public Health

Hongjo Choi	Korean Institute of Tuberculosis
Hsien-Ho Lin	National Taiwan University
İlker Kayı	Koç University School of Medicine
Ivdity Chikovani	Curatio International Foundation
Jamie Rudman	London School of Hygiene and Tropical Medicine
Jason Madan	University of Warwick
Jens Levy	KNCV Tuberculosis Foundation
Juan Vesga	Imperial College London
Katharina Kranzer	London School of Hygiene and Tropical Medicine
Katherine Floyd	World Health Organization
Kathy Fiekert	KNCV Tuberculosis Foundation
Krishna Reddy	Harvard Medical School & Massachusetts General Hospital
Kritika Dixit	Birat Nepal Medical Trust
Laura Rosu	Liverpool School of Tropical Medicine
Lisa Koeppel	Centre of Infectious Diseases, University of Heidelberg
Lori Bollinger	Avenir Health
Madeleine Clarkson	London School of Hygiene and Tropical Medicine
Melanie Chitwood	Yale School of Public Health
Nichola Kitson	London School of Hygiene and Tropical Medicine
Nicholas Menzies	Harvard T.H. Chan School of Public Health
Nim Arinaminpathy	Imperial College London
Ozge Karanfil	Harvard School of Public Health, Koc University
Peter Small	Rockefeller Foundation
Philippe Glaziou	World Health Organization
Rachel Sanders	Avenir Health
Rein Houben	London School of Hygiene and Tropical Medicine
Richard White	London School of Hygiene and Tropical Medicine
Sandra Alba	KIT Royal Tropical Institute
Sedona Sweeney	London School of Hygiene and Tropical Medicine

Sevim Ahmedov	USAID
Sherrie Kelly	Burnet Insitute
Shufang Zhang	The Global Fund to Fight AIDS, TB and Malaria
Sourya Shrestha	Johns Hopkins School of Public Health
Sze Suan	University of Southern California
Ted Cohen	Yale School of Public Health
Thomas Palmer	University College London
Will Rudgard	University of Oxford
SUPPORT & EVALUATION	
Kristian Godfrey	London School of Hygiene and Tropical Medicine
Christina Spencer	London School of Hygiene and Tropical Medicine
David Collier	White Ox

Appendix 2.2 Meeting Agenda

TB MAC Annual Meeting
Old Town DoubleTree Hotel, Istanbul, 01-04 October
Fatih Function Hall (*unless otherwise specified*)

When	What	Who
Tuesday 1 October 2019 COUNTRY-LEVEL MODELLING		
0845-0900	Registration and coffee	*Morning Chair:* *Babis Sismanidis*
0900-0930	Meeting opening & agenda review	Richard White Katherine Floyd
0930-1000	Benchmark, reporting and review (BRR) scene setting	Nick Menzies
1000-1030	Break	
1030-1200	BRR piloting experience i. timing ii. data sharing iii. BRR material	Nim Pathy / Juan Vesga Emma McBryde Jamie Rudman Sherrie Kelly Rachel Sanders Anh Tuan Nguyen
1200-1215	The role of modelling and BRR for country-level planning processes	Shufang Zhang
1215-1230	The role of modelling and BRR for the PCF4NSP	Kathy Fiekert
1230-1330	Lunch	
1330-1345	Summary of feedback and possible changes	*Afternoon Chair:* *Jason Madan* Finn McQuaid
1345-1500	Discussion and planning for future of BRR	
1500-1530	Break	
1530-1600	Introduction to work linking activities to epi impact	Richard White Madeleine Clarkson
1600-1630	Perspective & discussion	Rein Houben Babis Sismanidis Kathy Fiekert Nick Menzies
1630-1645	Next steps	Madeleine Clarkson
1730-1830	Roadmap Steering Committee side-meeting (Laleli Room)	RSC members only
1900	Group meal - Byzantion Bistro Restaurant	

When	What	Who

Wednesday 2 October 2019 ECONOMICS OF TB GFATM KEY PERFORMANCE INDICATORS WHO SUBNATIONAL TB ESTIMATES		
0900-0910	Introduction to the day	*Morning Chair:* *Katherine Floyd*
0910-1030	Economics of TB: key remaining challenges and way forward *Part I: TB Economics for global decisions: how can they support and align with country level processes?*	Hojoon Sohn Jason Madan Shufang Zhang Francis Ruiz
1030-1100	Break	
1100-1230	*Part II: Supporting decisions at the country level*	Rachel Sanders Tom Palmer Sedona Sweeney Avidity Chikovani Kathy Fiekert
1230-1330	Lunch TB MAC Advisory Panel side-meeting (Laleli Room)	AP members only
1330-1500	KPI4 *Review of findings and suggestions for improvement*	*Afternoon Chair:* *Ted Cohen* Shufang Zhang
1500-1530	Break	
1530-1700	Subnational TB estimates	Philippe Glaziou Fulvia Mecatti Melanie Chitwood Rein Houben Sandra Alba
	Free evening time	

When	What	Who
Thursday 3 October 2019 MODELLING THE INTERPLAY OF TB WITH UHC		
0815-0830	Registration and coffee	
0830-0845	Introduction	David Dowdy
0845-0915	Keynote	Aamir Khan
0915-1045	Examining the role of models to understand and measure the impact of UHC on TB *Part I: Epidemiological/economic perspectives on the role of UHC in halting TB*	Delia Boccia Fernando Rubenstein Hongjo Choi George Gotsadtze Kritika Dixit Chu-Chang Ku Juan Vesga
1045-1115	Break	
1115-1230	*Part II: Methodological perspective on how models can capture the impact of UHC on TB epidemiology*	Fiamma Bozzani Sze-Chuan Suen William Rudgard Ozge Karanfil
1230-1245	Group discussion *Group formation*	
1245-1345	Lunch	
1345-1500	Specific issues of relevance to models of UHC and impact on TB	Nim Pathy Krishna Reddy Jason Madan Laura Rosu
1500-1530	Break	
1530-1650	Models for financing TB services in the context of UHC *Key considerations*	Anna Vassall Ivdity Chikovani Averi Chakrabarti Sedona Sweeney
1650-1700	Conclusions and introduction to final day	David Dowdy Sourya Shrestha
1715-1830	TB MAC Steering Committee side-meeting (Laleli Room)	SC members only
1900	Group meal - Venue to be confirmed	

When	What	Who
Friday 4 October 2019 MODELLING THE INTERPLAY OF TB WITH UHC		
0830-0900	Recap	David Dowdy Sourya Shrestha
0900-1030	How can models contribute to the broader discussion of UHC and TB? *Perspectives on priorities, needs, existing tools, and communication*	Guy Marks Philippe Glaziou Evaline Kibuchi David Collins Emma McBryde Geoff Garnett
1030-1100	Round-table discussion *Role of modelling in supporting UHC, using Kenya as a case study*	Evaline Kibuchi Nim Pathy Juan Vesga Shufang Zhang Guy Marks Delia Boccia Geoff Garnett
1100-1230	Group discussions (with tea) *Identifying key topics*	
1230-1330	Lunch	
1330-1500	Group discussions *Presentations and discussion*	
1500-1515	Break	
1515-1530	Summary	David Dowdy
1530-1600	Concluding remarks	Peter Small