



# EQUITY, ECONOMIC EVALUATION, AND DISEASE TRANSMISSION MODELLING

London, 26-27 March 2018

**Meeting report**

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## Executive summary

The 'Equity, economic evaluation, and disease transmission modelling' meeting, held in March 2018 in London (UK), aimed to create a forum to exchange methods and identify the opportunities and challenges faced in using infectious disease transmission models to evaluate the equity implications of global health interventions. We brought together representatives of two academic communities (mathematical modellers and economists) as well as representatives from funding, policy, and technical assistance organisations working in global health.

In preparation for this meeting, we reviewed concepts of equity and approaches economists have developed for the inclusion of equity in economic evaluations as well as advances in the representation of heterogeneity in transmission modelling. These reviews served as pre-meeting materials. The meeting then provided an opportunity for economists to present different approaches for the evaluation of equity in priority setting and for modellers to showcase the state of the art work in inclusion of heterogeneity in modelling for resource allocation. We aimed to provide discussion points from different disciplines, such as ethics, economics, policy, and mathematical modelling. We followed these presentations by group discussions both to consider further specifications to expand the reference case and to shape the future technical efforts needed in this area. The second day provided the opportunity to present further resources being developed (Equity Handbook) and reflections from funding and technical assistance organisations engaging with countries for useful and concrete suggestions for the future direction of various pieces of work. In this report, we summarise discussions and recommendations from the 'Equity, economic evaluation, and disease transmission modelling' meeting as well as next steps.

The meeting was co-organised by the TB Modelling and Analysis Consortium and the Centre for the Mathematical Modelling of Infectious Diseases at the London School of Hygiene and Tropical Medicine. This body of work has been funded by the International Decision Support Initiative.

## Background

Infectious diseases remain a priority in global health and policy makers in national governments and international donor organisations must make decisions about how best to allocate the resources available to them. Economic evaluations in general and those using disease transmission models are increasingly influential in the priority setting process. Mathematical modelling is being used both to understand and predict the spread of infectious diseases and to evaluate the impact of global health interventions. Yet differences in methodological approaches and reporting practices can make using these models in priority setting challenging.

The Reference Case (RC) for Economic Evaluation in Global Health (1), from the International Decision Support Initiative (iDSI), is intended to improve the quality of the economic evidence base informing priority setting decisions. The Reference Case is a principle-based approach for analysts to guide the planning, conduct, and reporting of economic evaluations. Traditional economic evaluation allows resources to be allocated efficiently, yet efficiency is not the only criterion for consideration during the decision-making process. Both countries and global funders are increasingly interested in assessing the equity impact of their health investments. As such, it is becoming increasingly necessary to consider the distributional effects and trade-offs that may arise from resource allocation decisions on health, healthcare utilisation, and healthcare

financing. This is reflected broadly in Principles 7 and 11 of the Reference Case which recommend that heterogeneity and equity should be represented and considered at all stages of an economic evaluation (see text box). However, the use of disease transmission models for economic evaluation presents specific conceptual and methodological challenges

### Box: Principles of the Reference case for Economic Evaluations (1).

- 1 An economic evaluation should be communicated clearly and transparently to enable the decision maker(s) to interpret the methods and results.
- 2 The comparator(s) against which costs and effects are measured should accurately reflect the decision problem.
- 3 An economic evaluation should consider all available evidence relevant to the decision problem.
- 4 The measure of health outcome should be appropriate to the decision problem, should capture positive and negative effects on length of life and quality of life, and should be generalizable across disease states.
- 5 All differences between the intervention and the comparator in expected resource use and costs of delivery to the target population(s) should be incorporated into the evaluation.
- 6 The time horizon used in an economic evaluation should be of sufficient length to capture all costs and effects relevant to the decision problem; an appropriate discount rate should be used to discount cost and effects to present values.
- 7 Nonhealth effects and costs associated with gaining or providing access to health interventions that do not accrue to the health budget should be identified when relevant to the decision problem. All costs and effects should be disaggregated, either by sector of the economy or to whom they accrue.
- 8 The cost and effects of the intervention on subpopulations within the decision problem should be explored and the implications appropriately characterized.
- 9 The uncertainty associated with an economic evaluation should be appropriately characterized.
- 10 The impact of implementing the intervention on the health budget and on other constraints should be identified clearly and separately.
- 11 An economic evaluation should explore the equity implications of implementing the intervention.

when applying these principles and these challenges are not currently addressed in the Reference Case. At the same time, economists are developing new approaches, techniques, and metrics to include equity into economic evaluation and priority setting.

The London School of Hygiene and Tropical Medicine (LSHTM) organised a meeting aimed to link academic and policy communities to exchange methods and identify the opportunities and challenges faced when using infectious disease transmission models to evaluate the equity of global health interventions. This meeting report summarised the presentations and discussions from the meeting that took place on the 26<sup>th</sup> and 27<sup>th</sup> March 2018, in London, UK. Before the end of 2018, the meeting report will be used to develop an outline of methodological considerations for applying Principles 7 and 11 to priority setting for infectious diseases.

## Meeting summary

TB Modelling and Analysis Consortium (TB MAC) and the Centre for the Mathematical Modelling of Infectious Diseases (CMMID) at the London School of Hygiene and Tropical Medicine convened a 1.5-day meeting bringing together economists, ethicists, and mathematical modellers with an interest in health economic evaluation and equity. In addition, we also invited representatives of global health funding organisations (The Bill and Melinda Gates Foundation, UK Department for International Development, Global Fund to Fight AIDS, Tuberculosis, and Malaria) and those involved in technical assistance and the development of normative guidance in global health (World Health Organisation, Avenir Health).

In advance of the meeting, the organising committee at LSHTM conducted a review of the theoretical foundations of equity, the variety of approaches for incorporating them in economic evaluations, and applications in the published literature. We circulated this review as pre-reading material together with an outline of methodological challenges to and opportunities for including equity considerations in model-based economic evaluations.

The meeting objectives were to:

- a) Create space for modellers and economists to connect and learn from each other's approaches to equity analysis and the inclusion of heterogeneity in modelling, economic evaluation, and priority setting;
- b) Generate discussion around the technical opportunities and challenges of evaluating equity in economic evaluations using mathematical modelling of infectious diseases;
- c) Inform guidance on applying the equity principle of the reference case when using transmission model based economic evaluations.

## Session 1: Economic approaches to equity in priority setting

### Equity concepts

After introductions (Francis Ruiz, iDSI; Richard White, TB-MAC) and an overview of the background and summary of issues to be covered in this workshop (Gabriela Gomez, LSHTM), Kara Hanson (LSHTM) provided an overview of equity concepts from an economic perspective. Kara outlined two essential considerations in the conceptualisation of equity:

- **Implied value judgement:** Equity often is defined in terms of systematic differences that are unjust or unfair. This implies a value judgement about the fairness or justice of observed differences in population health and thus invokes ethical frameworks and theories of social justice. Currently, there is no universal consensus as to what can be considered fair in systematic differences (a normative question), and we observe variations across countries (and analysts) related to differences in political attitudes and values.
- **Relevant outcomes:** Health economists have considered differences in health (outcomes), healthcare utilization (outputs), or healthcare financing (contributions).

Kara then described frameworks proposed to differentiate fair inequalities from unfair inequalities (inequities). Table 1.

Table 1. Equity concepts.

<b>Guiding principle</b>	<b>Summary</b>
<b>Equality</b>	Equal distribution of health outcome, access to healthcare or healthcare investment
<b>Distribution according to entitlement</b>	Individuals are entitled to wealth and if they choose to spend more on their health then this remains just.
<b>The 'decent minimum'</b>	While, in general, distribution might be according to entitlement, there should be a social safety net that enables access to basic services for individuals who would not otherwise have the means.
<b>Utilitarianism</b>	The aim is to achieve the greatest utility for the greatest number. Could be linked to the concept of Pareto efficiency where utilities are distributed in such a way that no one can be made better off without making someone else worse off.
<b>Rawlsian maximin</b>	Maximising benefits to the least well off. Unlike the decent minimum, the maximin principle would continually strive to improve welfare for the least advantaged, independently of the overall distribution of benefits.
<b>Envy-free allocations</b>	Fair inequalities may arise from differences in individual preferences. An optimal distribution is one in which there is no 'envy' of health/healthcare available to others.
<b>Equity as choice</b>	People should be allowed to make individual decisions from equal choice sets.

<p><b>Equality in capabilities</b></p>	<p>Freedoms or opportunities to be and do things that are valued. Recognises the importance of individual agency. For individuals to be able to make comparable choices they must have equality in basic capabilities. Health is an outcome dependent on the choices of individuals, or one of the basic capabilities necessary to make free choices.</p>
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Kara provided an illustration of how the choice of equity concept may influence the distribution of resources, using the Global Malaria Programme as an example (2). The equity considerations guiding allocations criteria were as follows:

- Equal amount of resources per person at risk – while following a principle of equality, does not consider ‘need’
- Allocating funds in proportion to disease burden e.g. number of deaths – follows a utilitarian principle in that it will maximize benefits
- Allocating funds according to capacity to benefit – to achieve universal coverage in countries with highest death rates and maximise lives saved
- Allocating funds to reduce and equalize the highest death rates – therefore maximizing benefits to the least well off (Rawlsian maximin)

Figure A. Resulting allocation patterns by country.

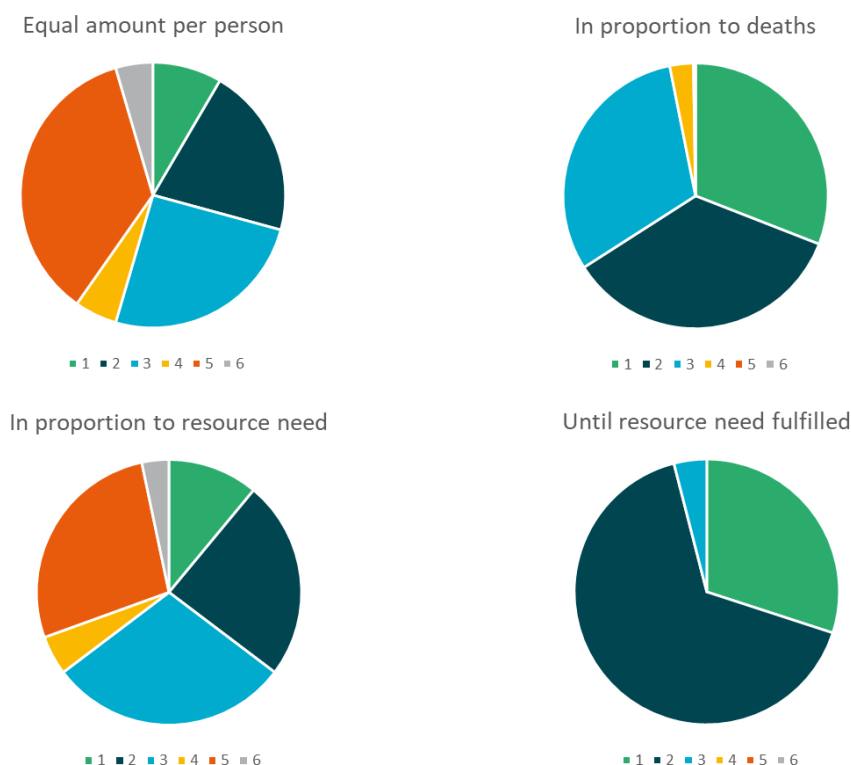


Figure A shows the varying resource allocation patterns depending on the choices made of equity concepts for a fixed amount of resources. Each pie represents a possible distribution of resources between countries. Each number represents a country with different



epidemiological and health systems characteristics. The area within each pie represents a proportion of the total resources allocated to each country.

Kara concluded that while economics itself cannot guide the choice of ethical framework, it can make the consequences of different choices explicit – and provides tools for measuring whether equity is being achieved, within the terms of the selected framework.

### Equity in public health ethics: Justice-Enhanced Cost-Effectiveness Analysis

Maria Merritt (Berman Institute of Bioethics and Bloomberg School of Public Health, Johns Hopkins University) provided an ethicist's response to Kara's presentation. She also reflected on two essential considerations in the conceptualisation of equity in public health ethics: what is meant by fairness in distribution? and what kinds of consequences matter?

Several principles of fairness in distributions apply to the question of equity(3). These concepts include:

- Maximization: “maximises what is available, irrespective of distribution”
- Prioritarianism: “assign[s] special importance to helping those at the bottom of a distribution”
- Egalitarianism: “aims to reduce inequalities in distribution”
- Sufficientarianism: “ensures that no one falls below a specified threshold”

The relevant consequences could be then grouped in three groups:

- Intended benefits: “good aggregate or collective health outcomes”(4), access to health-related services and resources, and protection against health-related financial risk;
- Impacts (may be intended or unintended) on capabilities (“freedoms to engage in various activities”) or functioning (“the activities individuals engage in”)(3);
- Impacts on multiple dimensions of well-being with health among other core dimensions of well-being all holding “fundamental ethical importance”(5).

It is in this frame of distributions and consequences that one can entertain two different views about the place of equity in public health ethics: equity as a constraint on the foundational goal of public health (presupposing that the foundational goal is to maximize welfare); or equity as part of the foundational goal of public health (presupposing that the foundational goal is to achieve social justice, understood in terms of “a broader commitment to secure a sufficient level of health for all and to narrow unjust inequalities”)(4). To illustrate how to integrate theories of social justice using multidimensional metrics of well-being into cost-effectiveness analysis after noting that a recent systematic review has canvassed potential methodological approaches(6), she presented a proof-of-concept on the Justice-Enhanced Cost-Effectiveness Analysis(6, 7) of MDR-TB treatment.

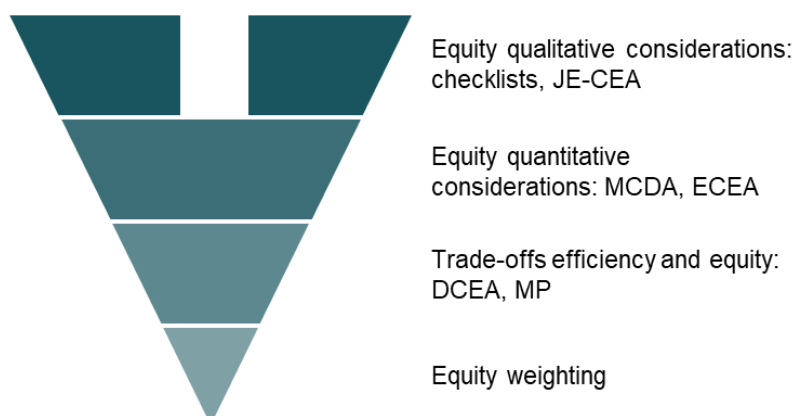
Justice-Enhanced Cost-Effectiveness Analysis (JE-CEA) is based on the ethical concern to protect and relieve people from severe societal disadvantage in multiple dimensions of well-being duty(5, 8-10). MDR-TB affects people already struggling with severe poverty and

social exclusion, in ways that people with MDR-TB are also very likely to experience prior clustering of disadvantage. The personal and social burdens of standard MDR-TB treatment, in the process of trying to restore patients' health, may set them back in other dimensions of well-being: specifically, agency, respect, and association(5). In JE-CEA, the analyst interprets specific types of expected patient experiences to assess social justice impact in terms of agency, respect, and association. In the case of MDR-TB, for example, one might interpret these experiences under treatment with standard and novel MDR-TB regimens. Formal social justice assessments can be made at “three composite levels: ‘expected not to worsen. . .’, ‘may worsen. . .’, and ‘expected to worsen clustering of disadvantage’” and “overlaid side-by-side with cost-effectiveness assessments corresponding to each branch pathway” on a decision tree(7).

The team is developing an extension of JE-CEA to dynamic transmission modelling with a completed CEA for a neglected tropical disease (NTD) elimination investment case(11). An observation from the group was that there is a consideration that personal experiences will need to be traded off with the benefits of future generations, especially in the case of eradication or elimination investment cases.

Following this discussion, three approaches to inclusion of equity in priority setting were described: 1) Distributional Cost Effectiveness Analysis, with a focus on quantifying the equity-efficiency trade-off(12); 2) Extended Cost-Effectiveness Analysis, with a focus on quantifying the equity impact per socioeconomic subgroup and financial protection impact (13); and 3) Multi-Criteria Decision Analysis, with a focus on equity as a criterium for priority setting, separate from value for money(14).

Figure B. Different levels of integration of equity and efficiency concepts.



### Distributional Cost-Effectiveness Analysis

Susan Griffin (University of York) presented the conceptual frame and application of distributional cost-effectiveness analysis (DCEA). DCEA was developed to extend cost-effectiveness analysis to estimate impacts on health inequality and the trade-off between equity and efficiency.

The first step in DCEA will be to estimate the costs and outcomes in subgroups of interest (e.g. socioeconomic) at baseline and for the intervention. This includes parameter estimates differing by equity relevant characteristics: uptake, adherence, efficacy, baseline risks, health related quality of life, costs. The analyst then converts total cost to a distribution of health opportunity cost across subgroups. Opportunity costs do not necessarily fall on intervention recipients, hence the population wide approach. We then calculate net health impact (health benefit - health opportunity cost) for all subgroups. The sum over subgroups provides same information as typical CEA. We then need to add net impacts to baseline distribution of lifetime health to calculate inequality measures on the pre- and post-intervention health distributions and summarise health inequality impact.

DCEA has been applied in high income countries across several interventions and diseases (examples in bowel cancer screening, smoking cessation, air pollution, rotavirus vaccination). Recently, the team has been working on approximations of the method based on aggregate and secondary data, applying DCEA to NICE public health guidelines.

There are important considerations when applying DCEA to low and middle-income country settings. These include:

- Data – comparability and availability
- Pattern of disease
- Relationships between social determinants and health
- Equity concern and priority can differ between countries
- Comparable data across countries
- Health statistics and socioeconomic characteristics defined in different ways
- Some countries lack resources and infrastructure to gather good quality data; data can be missing for certain populations

Two main challenges in global health applications of this approach were mentioned: 1) the definition of a global perspective, which entails multiple decision makers, and 2) the application of DCEA with costs falling across multiple sectors. While DCEA has been successfully applied to rotavirus in Ethiopia(15), it has not been applied to transmission modelling frames. Expected challenges are 1) infectious disease closely associated with poverty and low healthy life expectancy, simultaneous causality; 2) there are secondary effects and transmission by subgroup; 3) the distributions of burden and the equity characteristic of interest may overlap (i.e. epidemics to break out in pockets, often in most disadvantaged); 4) some equity relevant characteristics vary over time; and 5) how to conceptualise the aim of the policy: eliminating transmission vs minimising inequality vs minimising morbidity.

Discussion point: when calculating net health impact, we are considering all opportunity costs and their distribution across the population. In infectious diseases, one should also consider the distribution of secondary effects as part of the population level benefits in the calculation of health net benefit.

## Extended Cost-Effectiveness Analysis

Stéphane Verguet (Harvard T.H. Chan School of Public Health) presented a new approach to assess equity and poverty reduction benefits of health policies. The Extended Cost-Effectiveness Analysis (ECEA) methodology was developed as part of the *Disease Control Priorities 3<sup>rd</sup>* edition ([www.dcp-3.org](http://www.dcp-3.org)) initiative and has two objectives:

- 1) to estimate the distributional health and financial consequences across distinct strata of populations (e.g. socio-economic status, geographical setting, gender); and
- 2) to quantify household medical impoverishment (financial risk protection) averted by policy.

As described in detail in a tutorial(16), ECEA was developed to address health policy assessment, specifically to evaluate the health and financial consequences of public policies in four domains: 1) the health gains; 2) the financial risk protection benefits; 3) the total costs to the policy makers; and 4) the distributional benefits. Like CEA measures (e.g. cost per death averted), ECEA estimates efficient purchase of equity and financial risk protection in terms of say cost per per poverty case averted and cost per death averted among the poor. ECEA can be used in priority setting beyond the health sector (for inter-sectorial comparisons). ECEA has been applied across a variety of diseases and settings with about 30 published studies so far (complete repository of ECEAs available on Harvard's Center for Health Decision Science website: <https://chds.hsph.harvard.edu>)

ECEA case studies for infectious diseases presented were tuberculosis and vaccine-preventable diseases (17, 18). Data need is the main consideration for the continuous application of ECEA to infectious disease model-based CEA. These data needs related to out-of-pocket spending and household expenditures, distribution of burden of disease by key population subgroups, social mixing and transmission within and across subgroups, and the effect heterogeneity and herd immunity within and across subgroups.

## Multi-Criteria Decision Analysis

Rob Baltussen (Radboud University) presented on various approaches to multi-criteria decision analysis (MCDA) and emphasised the importance of fair and transparent decision-making processes. MCDA is a set of methods and approaches to aid decision-making, where decisions are based on more than one criterion, which make explicit the impact on the decision of all the criteria applied and the relative importance attached to them. There are two approaches to MCDA: 1) Deliberative MCDA where policy makers make judgement on the overall value of interventions through a process of argumentation; and 2) Algorithmic MCDA where the analyst replaces judgment by value measurement model. Eliciting weights, combined with scores to get overall score.

In his experience, deliberative MCDA provides an attractive alternative to policy makers as it provides a simple presentation of criteria and is embedded in a process for stakeholder deliberation. There was a discussion on the role of analysts and academics in the operationalisation of values in priority setting and how complex approaches like algorithmic MCDA or equity in CEA may ignore or mis-represent some qualitative and ethical dimensions of equity.

## Session 2: State-of-the-art in the modelling of heterogeneity

### Heterogeneity and modelling

In the afternoon, Graham Medley (LSHTM) discussed the role of heterogeneity in modelling equity using disease transmission models. In infectious diseases, interventions change the risk distribution in the whole population, not only those targeted/reached by the intervention. While to date virtually all transmission dynamic models have focussed on the mean/expected outcome of any intervention, it will be important to consider the distribution of these benefits when evaluating impact on equity.

Populations differ in multiple ways, and this is usually handled in transmission models by creating groups. Transmission is then modelled between groups, assuming homogeneity within the groups. Models have focussed on the heterogeneities of risk with some modifications for program logistics. Yet, when including equity considerations, there might be causal relationships between the two dimensions (risk and equity). For example, equity heterogeneity can be correlated with or create risk-heterogeneity. At the same time, risk-heterogeneity could contribute to equity variation.

In this case, the inclusion of equity in transmission models is a problem of dimensions, whereby we may have a minimum of three:

- 1) Risk of infection (~behaviour / group membership): this is required to capture the transmission dynamics. Inclusion allows targeting a “core group” which is expected to have the maximum impact on infection;
- 2) Risk of disease (given infection): this is required as infection and disease are not usually the same, and more vulnerable groups will have a greater health loss for the same degree of infection. Inclusion allows consideration of strategies with variation in access to treatment;
- 3) Equity: this is required to assess the impact of interventions on equity measures, which will be the outcome of interventions targeted at either risk groups or more vulnerable groups. Inclusion also allows consideration of targeting directly to different groups identified in terms of equity.

Because the “full” model is impossible to parameterize and we lack mechanistic descriptions of behavior, as modellers, we need to simplify the system dynamics and which simplification is the most appropriate will depend on the policy question.

Generally, these three dimensions are not independent. There are correlations between the distribution of people between groups and causality relations, where membership of groups is consequence and cause of risks and equity status. Intervention in this case are the best way of untangling causality.

In conclusion, the consideration of equity in priority setting process offers an opportunity for transmission modellers and health economists to properly collaborate. Current transmission dynamic frameworks are going to be stressed unless we change them. “Perverse” outcomes, such as increases of disease in those subgroups not vaccinated, are likely to be

more common if access to care, health services policy / behaviour are included as drivers of transmission / disease risk. Many interventions will also create additional heterogeneity.

In the brief discussion that followed, the potential for a temporal aspect to population stratification was explored further. That is, we can differentiate not only between population sub-groups in the present but between a population today and populations in the future. The example of elimination illustrates this with the population of today paying for benefits accrue to populations in the future.

## Heterogeneity, elimination, and NTDs

Déirdre Hollingsworth (University of Oxford) expanded on the special case of heterogeneity considerations in elimination examples. Neglected tropical diseases represent a large burden of chronic morbidity and mortality, while affecting the poorest populations. Thus, perpetuating a “cycle of poverty”. Control of neglected tropical diseases is based on two main strategies: mass drug administration and intensified disease management.

Heterogeneities can lead to different outcomes than expected from observing the mean. The presence of heterogeneities can be beneficial, as allow us an opportunity to exploit it, through a targeting of interventions. However, it is usually expected to undermine control. Heterogeneities are complex to measure and may only be observed as transmission levels fall. They will also affect the estimation of probability of elimination, which is crucial in elimination investment cases,

Currently, there is a timely discussion about whether to pursue control or elimination. This discussion is based on the balancing of costs and benefits of both approaches and the importance of uncertainties in models at low prevalence.

## Heterogeneity, control, and malaria

Pete Winskill (Imperial College London) discussed the modelling of geographical heterogeneity in disease burden and transmission when aiming to optimise funding allocation for global malaria control(19). This modelling exercise focused work at the first administrative unit (~ 1000 total). They characterised each transmission setting by vector bionomics, local climate, and baseline transmission intensity. The goal was to maximise the number of cases and deaths averted. They observed that allocation of resources shifts when trying to balance different global goals. Maximising burden reduction and focussing on elimination with a limited budget are competing objectives.

The afternoon session on heterogeneity in transmission models was closed by Nick Menzies (Harvard T.H. Chan School of Public Health). He provided a brief discussion on modelling for equity from an economist perspective. In one way of viewing things, mathematical modelling and concerns for equity in decision-making are separable tasks in policy-analysis:

- Mathematical modelling engaged with the task of estimating consequences, without making value judgments

- Equity concerns: tasked with creating the appropriate value function describing our preference for different outcomes

However, there are numerous points of intersection and analytical issues seem tractable. An important challenge we will face is evidence. What are the implications of TB policy change, broadly, for the equity outcomes we are discussing? How can we establish this empirical evidence base, so that the models can readily follow? In addition, different metrics have different informational requirements:

- Marginal distribution of health outcome
- Joint distribution of health and named characteristic
- Individual-level changes in health outcome
- Health experience summed over lifetime

The choice of metric will have very different implications for modelling framework and data needs.

The discussion so far assumes a paradigm where we are interested in additional outcomes, i.e. this is about making the result set richer. But he perceives this as an opportunity. Many 'equity' outcomes are correlated with individual or group-level features describing disease burden, health behaviors, and health system access. Given this, the task of redesigning models to reflect equity considerations may also indirectly improve the model for estimating traditional outcomes.

Yet, with greater complexity we risk losing transparency, and the intuition that a model can help build. In Nick's view the interesting question is not whether, but how to refactor models to take on these equity considerations.

Day 1 ended with a sub-group discussion on challenges and opportunities when including equity considerations in modelling frames with regards to structure and data needs, as well as recommendations for the scope of possible outputs from the workshop. This discussion continued during Day 2 and is summarised at the end of the document.

## Session 3: Further developments in equity methods and policy perspectives

Day 2 started with a brief feedback from the groups discussions (Gabriela Gomez, LSHTM). But the focus of this morning was a reflection on further work as part of the development of the reference materials and input from funders and technical assistance organisations on global and national perspectives for equity in global and country level decisions.

### Handbook of Equity-Informative Health Economic Evaluation

The Oxford University Press Handbook of Equity-Informative Health Economic Evaluation is planned for publication in autumn 2019. Editors include Richard Cookson (University of York), Susan Griffin (University of York), Ole Norheim (University of Bergen and Harvard TH Chan School of Public Health), and Anthony Culyer (University of York and University of Toronto). The structure of the handbook aims to cover conceptual issues of health equity as well as equity-informative economic evaluation with detailed case studies. However, Richard noted that applications to disease transmission models are not specifically addressed, as the methods are general.

### Policy applications - global perspective

Shufang Zhang (GFATM) welcomed the workshop initiative. She outlined the GFATM's strategic resource allocation process and the steps informed by modelling analysis (i.e. between disease allocations, between and with-in country allocations). Between disease and between country allocations are supported during the replenishment phase of the GFATM funding cycle. Portfolio-level modelling informs the investment case development. Within country allocations are supported through the development of National Strategic Plans. Country-level modelling informs the development of funding requests. Equity considerations are central to the GFATM's allocation process – at portfolio-level, there is an alignment need between investment efficiency and need (with service provision to key populations); at country-level, a strategic goal is to promote and protect human rights and gender equality. She described two country case studies funded by the GFATM where MCDA has been applied to inform resource allocation processes and improve outcomes (e.g. Sudan and Bangladesh).

Finally, she reflected on areas of the resource allocation cycle that could be addressed to promote equity and where analysts could have an impact (Figure C). Questions relevant to the GFATM include those related to:

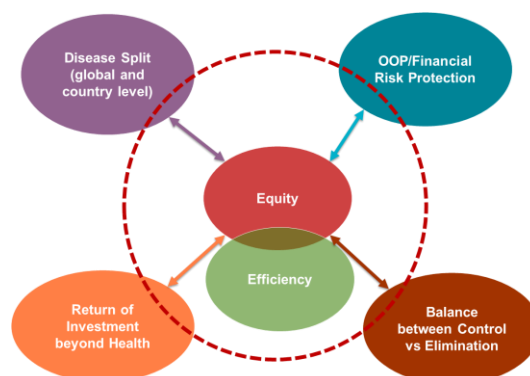
- equity-efficiency trade-off (what is likely to be the combined effect of resource allocation supported by modelling and advice and effort to address gender equality and human rights barriers on equity?);
- equity impact (if pro-equity “new” interventions are considered, what would be their modelled impact?);
- outcomes and data needs (should resource allocation be redefined with new outcomes of models (for example, equity-adjusted impacts)? what data is needed to



support equity-adjusted resource allocation decisions? cost data, estimation of budget constraints?); and

- process (what is the proper process to support such policy deliberation? How to guide/inform the policy makers choice in equity framework?).

Figure C. Areas of resource allocation to be better addressed to promote equity



### Policy applications - country perspective

Lori Bollinger (Avenir Health) presented on current equity work led by Avenir Health using the Spectrum (20) and OneHealth (21) tools. Impact models hosted in Spectrum can calculate and display health impacts disaggregated into the following equity dimensions:

- Age/sex: results of intervention scenarios can be disaggregated by age/sex in general across models.
- Geography: specific packages such as LiST (Lives Saved Tool – maternal and child health(22, 23)) or Malaria modules explicitly model regional or subnational projections (with either default or user-defined data). Geographic equity (regional, urban/rural) can be modelled using separate projections with unified results shown in most packages.
- SES: “Equity” tool uses household survey data disaggregated by wealth quintile and setting the wealthiest quintile coverage as target coverage for all quintiles to calculate impact.
- Vulnerable populations: Goals (HIV) allows differential coverage of vulnerable populations.

OneHealth tool includes a stratification tool, so that resources for any intervention can be stratified (e.g., quintile, geographic). It is user-defined (type of stratification, % of population in each stratum) and affects costs/financing needs, not impact estimations.

She described examples of how countries considered equity when applying models. In the West Africa region, the main application has been using the stratification tool of OneHealth to inform EQUIST analyses(24, 25). In Ethiopia, the government’s objective was to push services out to lower levels of delivery channels in order to reach rural areas and used the modelling and costing tools to examine cost per delivery channel at lower levels.

Key points on communication with policy makers:

- Any approach needs to be methodologically sound and yet transparent and understandable
- Resulting recommendations need to be locally relevant, contain concrete action steps

## Discussion

Following the presentations, the meeting attendees discussed the possible scope of a statement on specifications to inform principles 7 and 11 of Reference Case as a document to promote transparency in how analysts address methodological considerations when they want to answer an equity question in the context of priority setting, rather than providing guidance on what exactly to do. This document could drive demand/need for further research in this area. Suggested areas for further research are also reported.

### Specifications to inform principles 7 and 11 of Reference Case

The starting point of such specifications should address their scope with a clear delimitation of what is and what is not included. A case study would help in the applications. There was a discussion about whether the scope of this work should be broader than transmission models. The application of equity to transmission models alone may be considered niche and much of the methodology is general to non-dynamic models. However, there was an acknowledgement that a focus on specific issues related to application of general methods to transmission models could help us avoid a dilution of the message/readership.

Transparency should be the guiding principle in this complex field. Specifications for principles 7 and 11 of the Reference Case could be used to promote transparency in the reporting of:

- the process to identify and engage appropriate decision makers (who, what type of decision, what stage of decision process?). There should be an emphasis on making results useful to policy makers. This includes engagement and use of their definitions, and framework choices incorporating political constraints where we can.
- the definition of the research question (ex post or ex ante evaluation) and choice of equity frame
- methods (data use, type and model structure)
- assumptions which are implicit in results
- outcomes (equity of what? Investment, access, outcomes?)
- uncertainty in results and inputs

### Further research areas

#### *Frame and scope*

Further research is needed on the impact of equity framing in the methods and results, i.e. how different concepts of equity are represented in models, including whether equity will be implemented in models as a constraint or as a policy objective. How can the relevant concept of equity be elicited from decision makers? Are they interested in equity as a constraint on the analysis and/or the interface between constraints and equity (for example, health system constraints have an impact on the equity effect of interventions e.g. child meningitis cards for referral in Malawi not being used by poorest families for lack of means even though intervention overall feasible and effective)? There needs to be further guidance on when equity can be implemented within models, or simply estimated using model outputs.

Is HTA the appropriate frame for equity concerns, exploring trade-offs and determining when equity matters? Is equity a concern that can be dealt with on a per-intervention basis or is equity relevant only when looking at the entire package, e.g. in large healthcare reforms? If so, how do we do that? Finally, greater consideration of melding multiple perspectives on equity will be needed in a global health landscape with multiple payers. Approaches for engagement and fair processes will be key when defining analytical perspectives, and guidance should address both.

### *Data*

Data gaps could be conceptualised in two dimensions: 1) whether the data are relevant and important for the decision at hand (relevance), and 2) whether data are missing (availability). With regards to relevance, modelling can inform the identification of key gaps in data that drive results to policymakers' queries. It could be used to encourage data collection/collation and disaggregated reporting. Significant data availability gaps correspond to several aspects of the data:

- baseline population distributions of access, health, or financial outcomes across equity dimensions and over time (for example, access to services or burden by SES data, esp. in rural areas, access to clinics can be a good surrogate for SES; SES changes over time; household income and costs);
- population distributions of impact (identifying who benefits from an intervention: missed (sub)populations are often important targets for demand stimulation campaigns or further interventions; data from reached population may be used to extrapolate to missed parts of the population);
- correlation between equity and risk dimensions (for example, links between SES and mortality links are not always understood);
- social mixing (referring to the distribution of contacts between subgroups).
- interventions descriptions and cost of reaching different population groups
- population/ recipient values and perceptions of distributions of health outcomes
- income and other household economic data by sub-group

### *Model complexity*

There is an important balance between model complexity and model parsimony. In this light, it will be essential to characterize and restrict heterogeneity in the model to only dimensions affecting the results or those relevant for the decision at hand. The guidance can outline an approach to making design choices, but further research will also help quantify these trade-offs.

### *Next steps*

There was agreement between the attendees that this initiative is timely and highly relevant to current developments in priority setting in global health. Increased collaboration between modellers and economists to advance the methods aiming to include equity considerations in priority setting processes should be fostered. The strengthening of methods will benefit the progress towards the sustainable development goals and universal health coverage targets. In the meantime, as a next step, participants agreed to work towards a joint statement to inform data and methods specifications related to the Reference Case for Economic Evaluation by the end of 2018.

## References

1. Wilkinson T, Sculpher MJ, Claxton K, Revill P, Briggs A, Cairns JA, et al. The International Decision Support Initiative Reference Case for Economic Evaluation: An Aid to Thought. *Value Health*. 2016;19(8):921-8.
2. Cibulskis R. MPAC meeting: Financing Malaria Control – allocating limited resources. March 2013.
3. Persad G. Justice and Public Health [working title]. In: Kahn J, Kass N, Mastroianni A, editors. *The Oxford Handbook of Public Health Ethics*. New York: Oxford University Press; 2018 (forthcoming).
4. Faden R, Shebaya S. Public Health Ethics. In: Zalta E, editor. *The Stanford Encyclopedia of Philosophy*, Winter 2016 Edition. available from: <https://plato.stanford.edu/archives/win2016/entries/publichealth-ethics/> [accessed 8 June 2018]2016.
5. Bailey TC, Merritt MW, Tediosi F. Investing in justice: ethics, evidence, and the eradication investment cases for lymphatic filariasis and onchocerciasis. *Am J Public Health*. 2015;105(4):629-36.
6. Dukhanin V, Searle A, Zwerling A, Dowdy DW, Taylor HA, Merritt MW. Integrating social justice concerns into economic evaluation for healthcare and public health: A systematic review. *Soc Sci Med*. 2018;198:27-35.
7. Zwerling A, Dowdy D, von Delft A, Taylor H, Merritt MW. Incorporating social justice and stigma in cost-effectiveness analysis: drug-resistant tuberculosis treatment. *Int J Tuberc Lung Dis*. 2017;21(11):69-74.
8. Nussbaum M. *Creating Capabilities: the Human Development Approach*. Cambridge, Mass.: The Belknap Press of Harvard University Press; 2011.
9. Wolff J, de-Shalit A. *Disadvantage*. New York: Oxford University Press; 2007.
10. Powers M, Faden R. *Social Justice: the Moral Foundations of Public Health and Health Policy*. New York: Oxford University Press; 2006.
11. Merritt M, Sutherland C, Tediosi F. Ethical considerations for global health decision making: Justice-enhanced cost-effectiveness analysis of new technologies for *Trypanosoma brucei gambiense*. *Public Health Ethics*. (in press).
12. Asaria M, Griffin S, Cookson R, Whyte S, Tappenden P. Distributional cost-effectiveness analysis of health care programmes—a methodological case study of the UK Bowel Cancer Screening Programme. *Health Econ*. 2015;24(6):742-54.
13. Verguet S, Laxminarayan R, Jamison DT. Universal public finance of tuberculosis treatment in India: an extended cost-effectiveness analysis. *Health Econ*. 2015;24(3):318-32.
14. Thokala P, Devlin N, Marsh K, Baltussen R, Boysen M, Kalo Z, et al. Multiple Criteria Decision Analysis for Health Care Decision Making—An Introduction: Report 1 of the ISPOR MCDA Emerging Good Practices Task Force. *Value Health*. 2016;19(1):1-13.

15. Dawkins BR, Mirelman AJ, Asaria M, Johansson KA, Cookson RA. Distributional cost-effectiveness analysis in low- and middle-income countries: illustrative example of rotavirus vaccination in Ethiopia. *Health Policy Plan.* 2018;33(3):456-63.
16. Verguet S, Kim JJ, Jamison DT. Extended Cost-Effectiveness Analysis for Health Policy Assessment: A Tutorial. *Pharmacoeconomics.* 2016;34(9):913-23.
17. Chang AY, Riumallo-Herl C, Perales NA, Clark S, Clark A, Constenla D, et al. The Equity Impact Vaccines May Have On Averting Deaths And Medical Impoverishment In Developing Countries. *Health Aff (Millwood).* 2018;37(2):316-24.
18. Verguet S, Riumallo-Herl C, Gomez GB, Menzies NA, Houben R, Sumner T, et al. Catastrophic costs potentially averted by tuberculosis control in India and South Africa: a modelling study. *Lancet Glob Health.* 2017;5(11):e1123-e32.
19. Winskill P, Walker PG, Griffin JT, Ghani AC. OPTIMIZING THE GLOBAL ALLOCATION OF MALARIA FUNDS. *AMER SOC TROP MED & HYGIENE;* 2017. p. 117-.
20. Stover J, McKinnon R, Winfrey B. Spectrum: a model platform for linking maternal and child survival interventions with AIDS, family planning and demographic projections. *Int J Epidemiol.* 2010;39 Suppl 1:i7-10.
21. Wong JQ, Haw NJ, Uy J, Bayani DB. Reflections on the use of the World Health Organization's (WHO) OneHealth Tool: Implications for health planning in low and middle income countries (LMICs). *F1000Res.* 2018;7:157.
22. Bollinger LA, Sanders R, Winfrey W, Adesina A. Lives Saved Tool (LiST) costing: a module to examine costs and prioritize interventions. *BMC Public Health.* 2017;17(Suppl 4):782.
23. Winfrey W, McKinnon R, Stover J. Methods used in the Lives Saved Tool (LiST). *BMC Public Health.* 2011;11 Suppl 3:S32.
24. Uneke CJ, Sombie I, Uro-Chukwu HC, Johnson E, Okonofua F. Using equitable impact sensitive tool (EQUIST) and knowledge translation to promote evidence to policy link in maternal and child health: report of first EQUIST training workshop in Nigeria. *Pan Afr Med J.* 2017;28:37.
25. Waters D, Theodoratou E, Campbell H, Rudan I, Chopra M. Optimizing community case management strategies to achieve equitable reduction of childhood pneumonia mortality: An application of Equitable Impact Sensitive Tool (EQUIST) in five low- and middle-income countries. *J Glob Health.* 2012;2(2):020402.

## Appendices

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## Meeting Agenda

### EXAMINING THE EQUITY OF GLOBAL HEALTH INTERVENTIONS USING INFECTIOUS DISEASE TRANSMISSION MODELS: Informing the Reference Case for Economic Evaluation in Global Health

DAY 1: Monday 26<sup>th</sup> March 2018

Venue: Prince's room, BMA House (British Medical Association), Tavistock Square, London, WC1H 9JP

Time	Session	Content	Presenter
<b>8:45-9:15</b>	Arrival		
	<b>Chair: Anna Vassall (session 1)</b>		
<b>9.15-9.30</b>	Welcome	Welcome and introductions	Francis J Ruiz Richard White
<b>9.30-10.00</b>	Introduction to workshop	Background and objectives	Gabriela Gomez
<b>10.00-10.30</b>	Equity in economic evaluation	Economic perspective on equity	Kara Hanson
		Discussant: ethical framework	Maria Merritt
<b>10.30-11.00</b>	Break		
<b>11.00-12.30</b>	Approaches to equity in priority setting	Distributional cost-effectiveness analysis (DCEA)	Susan Griffin
		Extended cost-effectiveness analysis (ECEA)	Stephane Verguet
		Multi criteria decision analysis (MCDA)	Rob Baltussen
	Guided discussion		Anna Vassall
<b>13.00-13.45</b>	Lunch		
	<b>Chair: Richard White (session 2)</b>		
<b>13.45-15.00</b>	Modelling heterogeneity	Review of heterogeneity in modelling	Graham Medley
		Quantifying heterogeneity in impact: elimination	Déirdre Hollingsworth
		Quantifying heterogeneity in impact: geography	Pete Winskill
		Discussant: reflections from economic perspective	Nick Menzies
	Guided discussion		Richard White
<b>15.00-15.30</b>	Break		
<b>15.30-16.45</b>	Group work - recommendations	Heterogeneity and data requirements	Tom Drake
<b>16.45-17.00</b>	Wrap up of the day		Gabriela Gomez
<b>1800 -</b>	Dinner	Caravan, King's Cross, 1 Granary Square, N1C 4AA	



## EXAMINING THE EQUITY OF GLOBAL HEALTH INTERVENTIONS USING INFECTIOUS DISEASE TRANSMISSION MODELS: Informing the Reference Case for Economic Evaluation in Global Health

DAY 2: Tuesday 27<sup>th</sup> March 2018

Venue: Prince's room. BMA House (British Medical Association), Tavistock Square, London, WC1H 9JP

Time	Session	Content	Presenter
<b>8:45-9:15</b>	Arrival and coffee		
<b>9.15-9.30</b>	Introduction to the day and summary of previous day discussions		Gabriela Gomez
<b>9.30-10.00</b>	Equity Handbook	Overview of the work	Richard Cookson
<b>10.00-10.45</b>	Policy applications	Policy applications - global perspective	Shufang Zhang
		Policy applications - country perspective	Lori Bollinger
<b>10.45-11.45</b>	Panel discussion	Future directions	Deirdre Hollingsworth
			Richard White
			Jolene Skordis-Worrall
			Anna Vassall
			Fabrizio Tediosi
<b>11.45-12.00</b>	Next steps	Meeting report, collaborative publication	Gabriela Gomez
<b>12.00-13.00</b>	Lunch		