Allocative Efficiency Tools & Methods to Support Country HIV Programme Budget Allocation

Pinnacle Vancouver Harbourfront Hotel

18 July 2015

Methods Meeting Summary Report

Objectives of The HIV Modelling Consortium

The HIV Modelling Consortium aims to improve scientific support for decision making through the co-ordination of a wide-range of research activities in mathematical modelling of the HIV epidemic. This project is currently funded by the Bill & Melinda Gates Foundation through a grant to Imperial College London.

The Consortium's key objectives are to:

1. Identify questions that demand mathematical modelling input and identifying new modelling results that may require further validation.
2. Facilitate sharing of information, modelling techniques, data and expertise between research groups.
3. Provide a forum for rigorous review of new mathematical modelling research and tools.
4. Provide funding through sub-contracts to commission research to address those needs.

A Steering Committee of leaders in HIV programme and policy directs the focus of the work of the consortium. Further information on the HIV Modelling Consortium is available in a standard briefing document and information about other work packages undertaken by the HIV Modelling Consortium is available at the website www.hivmodelling.org.

Executive Summary

Background

Allocative efficiency (AE) – as part of a health financing focus on allocative, technical and productive efficiency and effectiveness – is a cornerstone to maximizing health outcomes derived from health care investments. The HIV Allocative Efficiency and Programme Effectiveness Working Group (AEPE ERG TWG), a technical working group of the global HIV Economics Reference Group (ERG) that is co-convened by the World Bank and UNAIDS, has been tasked with providing guidance on different mathematical approaches to allocative efficiency. Within this context, one of the main aims of the group has been to review and assess the existing modeling tools related to the efficiency, effectiveness and sustainability of HIV responses, to develop an inventory of these tools, and to provide guidance on the way in which the tools work, so as to support Governments in deciding which tool might be used for different policy environments.

The AEPE ERG TWG identified three widely-used modelling tools each with their own epidemiological model to model disease progression and that integrate both program impact and cost data to inform decision-making based on allocative efficiency considerations within HIV programmes: Goals, AIDS Epidemic Model (AEM), and Optima. In this context, the AEPE ERG TWG requested the help of the HIV Modelling Consortium to facilitate an opportunity for the modellers who created these different modelling tools to participate in an assessment and collaborative discussion about how the different modelling tools work. Accordingly, a workshop was organized on July 18, 2015 in Vancouver, Canada, to serve as an opportunity to understand and discuss the different approaches used by these AE modelling tools.

Objectives

(**a**) Create an opportunity for the HIV modelling community to better understand the technical characteristics of the different models used to inform country programs;

(**b**) To generate discussion of how the models address the specific HIV policy questions for

which these models might be used;

(**c**) To create a suitable space for the modellers to interact, comment on and learn from each other's approaches.

Meeting Summary

The workshop provided an opportunity for the model developers to present in detail the technical aspects of each tool as well as to create a collaborative discussion regarding issues of implementation of each of these AE tools. The workshop was divided into the following session topics:

Session 1: Introduction

- Theme: Key economic principles and problems in estimating optimal allocation
- Meeting introduction, and discussion about the essential components of an AE analysis

Session 2: Models overview

- Theme: Technical description of the AE tools Goals, AEM, and Optima
- Detailed description of the three modelling tools conducted by the model developers of each tool

Session 3: Putting the pieces together

- Theme: General discussion and comments regarding issues of usage of these modelling tools
- Discussion regarding technical aspects of the modelling tools, issues of interpretation and usage

Meeting Conclusions

Arising from discussions had at the workshop are the following outcomes:

- In an environment where the rate of increase of external financial support for the HIV epidemic in recent years is less than in the past period and the financial requirements for programs are increasing (rising ART eligibility thresholds alongside the need to maintain people on ART and intensifying non-ART based HIV prevention services), approaches to improve the allocative efficiency of HIV resources are critically important as part of broader efforts to maximise the use of every AIDS dollar; as such, efforts to review and refine current approaches will continue to be highly valued.
- The three tools discussed (AEM, Goals, Optima) each offer governments an approach through which to consider how to best project, estimate or optimise HIV resource allocations. The tool that would be most suitable to a country will depend on the policy and programming questions they are faced with, the purpose of the exercise (e.g. for resource allocation or resource mobilisation efforts), their time and data availability and the level of support required. The process through which model estimates are produced and resultant policy decisions are made is of utmost importance and should be supported by provision of guidance for this process.
- There is a need to better understand the cost of intervention implementation at different stages of program scale up, for different volumes, in different implementation arrangements, for different epidemic contexts. This includes considerations concerning costs of implementing interventions jointly or in combination. Accurate cost data and cost functions (that recognises potential non-linearity of marginal and total cost within different program stages, volumes, and contexts) do not exist in many settings; however, efforts to collate such cost data and develop cost functions from it for different epidemic scenarios and for different stages of maturity of programmes are underway by a newly established HIV Costing Consortium.
- Being explicit about the assumptions on program effectiveness is essential. Such assumptions should routinely be updated as new information and data become

available, and should distinguish between individual-level efficacy and population-level effectiveness. However, inevitably, important assumptions will have to be made and these should be transparently described in all models, documentation, and results.

Future Directions for the HIV Modelling Consortium

Further research is needed on cost-functions that could be used to help inform these models. Consequently, the HIV Modelling Consortium will look to work closely with the new HIV Costing Consortium.

The HIV MC is encouraged to consider a longer-term role as a convener of detailed discussions relating to these models in order to continue support for their development, working closely with the AEPE TWG. For further information on this work, please contact the HIV Modelling Consortium Project Manager Ellen McRobie e.mcrobie@imperial.ac.uk

For more information about the work of the AEPE ERGTWG and the AE inventory, please visit www.hiv-erg.org or contact Marelize Görgens at mgorgens@worldbank.org

Contents

Introduction

Background:

The HIV epidemic remains one of the global health challenges of the 21st century; it is a leading cause of disease burden in several parts of the world, despite recent successes. As HIV programs look to maximize efficiency and effectiveness to achieve the end of AIDS by 2030, improving allocative efficiency has become critical.

In this context, due to their ability to link program coverage to program impact and to epidemic projections (and changes therein because of changes in coverage or effectiveness), mathematical models are a powerful tool to support allocative efficiency improvements. Given the power of these tools and the increased use of such model outputs to prioritize HIV resources, assess HIV program impacts, and undertake economic analyses, several modelling tools have been developed and are currently being used. Among them, the main tools being applied at country level are Goals, the AIDS Epidemic Model (AEM), and Optima.

As part of the efforts of the UNAIDS/World Bank HIV Economics Reference Group (ERG) to establish normative guidance in the sphere of HIV economics (including efficiency and effectiveness), guidance on allocative efficiency tools is being developed. The HIV Modelling Consortium received support from their Steering Committee to conduct – on behalf of the ERG's technical working group focusing on allocative efficiency and program effectiveness – an assessment that would hopefully support governments in choosing the more appropriate modelling tool to use when making HIV allocative efficiency decisions.

This meeting report summarises the presentations and discussions from the meeting that took place on Saturday 18 July 2015 in Vancouver, Canada. The structure of the report is as follows:

- Workshop Summary
    - Session 1: Introduction, including discussion about the key economic principles and problems in estimating optimal allocation
    - Session 2: Each of the AE tools (Goals, AEM, and Optima) provide a technical description of their model and present on some policy questions
    - Session 3: Comments and recommendations in relation to the fit-for-purpose assessment including issues of interpretation and usage
- Recommendations Arising
- Future Directions

Allocative Efficiency Tools Assessment: Workshop Summary

The HIV Modelling Consortium Secretariat convened a one-day workshop in Vancouver on Saturday 18 July 2015 which brought together the modelling teams for the three AE tools identified by the ERG: AEM, Goals, and Optima. In addition researchers from a number of different disciplines relevant to aspects of allocative efficiency analysis were in attendance (mathematical modellers, health economists, researchers in behavioural science) as were representatives from the World Bank and UNAIDS.

In advance of the meeting, the HIV Modelling Consortium had liaised with each of the modelling groups and proposed a set of policy questions for each group to respond to in their presentation in order to form the basis of a valued discussion. Further, through collaboration with a consultant at the World Bank, a review was conducted of results from the models in countries in which all three AE tools had been used in order to allow for a comparison. These models were

selected through a scoping analysis that found that these three models were widely used in countries.

Meeting aims:

The aim of the assessment was to:

(**a**) Create an opportunity for the HIV modelling community to better understand the technical characteristics of the different models
(**b**) To generate discussion and an assessment of how the models address specific HIV policy questions for which these models might be used
(**c**) To create a suitable space for the modellers to interact, comment on and learn from each other's approaches.

Session 1: Principles in estimating optimal allocation

Paul Revill and Mead Over opened the workshop by providing a summary of the key economic principles and problems in estimating optimal allocation. Several essential steps to conduct an analysis on resource allocation were outlined:

- Identify the most relevant programme interventions and population groups as well as the relevant evidence of the cost and health benefit
- Specify a function that links benefits and cost, which is relevant to the entire population
- Specify the constraints that could limit the realization of the objectives
- Characterize and explore the implications of uncertainty

- Mathematical modelling has become a useful tool to inform efficient resource allocation. It needs a clear specification of the objective function as well as its constraints. Likewise, when constraints are relaxed, shadow prices associated with these constraints emerge. Thus, in addition to determining HIV budget allocation across different programme interventions, mathematical modelling could also contribute to properly estimate shadow prices i.e. the cost of constraints.
- When optimizing resource allocation it is essential to ensure that the global optimum has been identified.
- It would become essential to explore the impact of integration of HIV services delivery cost into the broader health system.
- Exploring and quantifying the implications of uncertainty should be an essential step when conducting analysis on resource allocation. Uncertainty might provide positive guidance if the uncertainty of decision and cost is low.

Session 2: Presentations from modelling groups

Each modelling group began by summarising the technical details of their model, including the epidemiological module (e.g. natural history assumptions, population groups and mixing, data calibration), intervention module (e.g. which are included and what are the baseline interventions), costing module (e.g. the cost function used for funding and spending) and the optimisation algorithm (i.e. the methods and constraints). The data requirements and limitations of each tool were also discussed.

Following this, two policy questions were addressed by the model developers of each modelling tool. The first question related to the best use of resources, and the second queried the funding necessary for achieving specific objectives proposed in the National Strategic Plan (NSP) for a given country. A summary of each presentation is detailed in turn for each model.

In this report we will summarise the salient points of the technical description, but more detailed information can be located in **Appendix I**. **Appendix II** includes some country examples of the implementation of these modelling tools.

2.1 Goals

Summary technical description:

- The GOALS tool is a model in the *Spectrum* suite of policy tools. GOALS has been designed to compare different projection scenarios to assess the impact of diverse HIV intervention programmes. It is designed to examine the cost and impact of sets of scenarios of intervention scale-up.
- Goals includes standard population groups and programme interventions with pre-populated default values for intervention effectiveness and a structure of HIV transmission that is simple but considered suitable for most applications.
- GOALS can be used to explore and compare several scenarios with different programme interventions to provide guidance to policymakers to implement resource allocation. It can support national and international planning for HIV prevention programmes by projecting the expected impact and cost of combinations of prevention and treatment programmes.
- GOALS includes an impact matrix for the behaviour interventions that has been populated with coefficients calculated from data in published literature on behaviour change following HIV-related prevention interventions introduced in low and middle income countries. The coefficients contained in the impact matrix imply a linear relationship between population coverage and proportional reduction in risky behaviors.
- GOALS can be integrated with the Resource Needs Model (RNM) and with the OneHealth planning tools from the *Spectrum* suite of policy tools, for performing HIV costing estimations.
- GOALS is a well-established HIV planning tool. The characteristics and projections arising from this model have been compared to many other models in the previously published literature (Eaton *et al.* 2015, Eaton *et al.* 2012)
- GOALS can be downloaded online and can be used by country teams alone or with support of Avenir Health. GOALS is usually applied during workshops where the model is calibrated and scenarios relevant to the country are developed and analyzed. These usually last between 3-5 days with ongoing support as countries refine their analyses and scenarios in post workshop consultations.

Response to Policy Questions

- The model has been applied extensively in both donor-dependent and self-financing countries. The former typically confront resource allocation questions relating to the cost and impact of achieving full coverage of interventions and whether the National Strategic Plan (NSP) is cost-effective. The latter, however, have used GOALS to address slightly different questions, such as what can be done with the available resources and assessing future treatment costs for people already living with HIV.
- Policy questions are usually addressed in Goals using standard procedures:
    - Define the impact and cost of the different programme interventions.
    - Define the funding levels from programme elements that have no direct impact (development synergies etc. and other constrains in general).

- Using the above, alternative scenarios are constructed and evaluated, and finally scenarios with the desired outcome are selected and discussed.

1) *What is a suitable (or maximum) target for reductions in HIV incidence and AIDS-related deaths for a country, given a specified amount of resources (current budget, 20% more; 50% less) and what interventions would be used?*

   The following steps are taken to respond to this question using GOALS:

   - Analyse impact and cost-effectiveness by intervention to prioritize interventions
   - Agree on funding levels for programme elements without direct impact
   - Construct alternate scenarios within the resource envelope
   - Select desirable scenarios

   In summary, a scenario approach would be used to evaluate the different combinations of funding level for each programme and their corresponding impact to identify the most suitable combination.

2) *How much money would be needed to achieve National HIV Strategic Plan (NSP) objectives of halving new HIV infections and reducing new AIDS-related deaths by 90% (or other target)?*

   Similar to the approach for Q1, scenario comparisons would be conducted. The two main steps would be implemented:

   - If the NSP objectives are specified as coverage objectives, the model should be run to estimate the resources needed
   - To achieve NSP goals (outcomes) follow the scenario approach

2.2 AEM

Summary technical description

- AEM has been designed to reflect the primary groups and transmission modes driving HIV transmission in concentrated epidemics. It focuses on the major transmission routes of the virus among adults: heterosexual contact (sex work, casual sex, marital sex), injecting drug use through needle sharing, and homosexual male to male contact through anal sex.
- AEM allows flexibility in the definition of population groups and programme interventions to be used in the model, with countries defining the local definitions of up to two sex worker and MSM groups and the content of their "best practice" prevention packages for each key population.
- AEM can be used to assess and compare the impacts of different programme interventions on the epidemics based on expected levels of behaviour change in each major key population as a function of coverage achieved. In AEM, the association between the fraction of the population covered by the programme and the behavioural outcomes of the intervention can be represented in three different forms (linear, exponential and quadratic).
- Programme interventions evaluated using scenario comparisons are usually focused in the key population groups that are driving the epidemic and on varying future levels of ART coverage, by group if desired. AEM allows the user to propose appropriate local programme interventions and specify the corresponding behavioral impact based on observed behavioural changes from programs in-country
- AEM costing is done on an intervention specific basis with annual unit costs provided for each of the key population programs to be supported and for ART treatment. These costs have been derived from bottom-up approaches and higher-level decomposition of NASA expenditures. These are summed as a function of coverage and group size to estimate the

costs of these intervention. The unit costs can be varied over time in an Excel spreadsheet which can allow for incorporation of more sophisticated cost functions if they are available.

- AEM is a well-established tool having been used extensively in concentrated epidemics.
- Conducting analysis with AEM involves an interactive process between model developers and in-country partners. The process is normally conducted in at least three in-country workshops, typically of one-week duration, which can be extended depending on the country's needs. The country itself owns the final model product. But the analysis process requires substantial amount of time and logistics arrangements, as it encourages close examination by country counterparts of the data inputs and outputs of the model and the resulting analyses.

Policy Questions

- The model has been extensively used by Asian countries to support national modelling, concept notes and funding applications for international donors, and inputs to NSP processes. The model also enables scenarios to be generated that advocate for expanded national resource mobilizations and greater investment on HIV programmes.
- AEM uses scenario comparisons to evaluate the impact of programme interventions in the course of the epidemic. With AEM the impact of programmes targeting key population groups is assessed, and the combination of programme interventions that are most cost-effective can be identified. Key policy indicators can be derived from scenario comparison analyses such as resource needs for prevention and treatment, cumulative epidemiological impacts (e.g. infections averted, lives saved and DALYs saved), marginal costs of prevention and treatment, and cost-effectiveness measures including cost per infection averted, cost per DALY saved, and treatment cost savings.

1) *What is a suitable (or maximum) target for reductions in HIV incidence and AIDS-related deaths for a country, given a specified amount of resources (current budget, 20% more; 50% less) and what interventions would be used?*

   AEM would approach this question, like GOALS, by scenario comparisons. Once scenarios are designed and the impact of these scenarios is evaluated in a specific health outcome, then it becomes possible to estimate the resources needed for the implementation of each scenario. There is an optimisation module although this has not been widely used to date and is under-development.

2) *How much money would be needed to achieve National HIV Strategic Plan (NSP) objectives of halving new HIV infections and reducing new AIDS-related deaths by 90% (or other target)?*

   Countries have routinely used AEM to find the amount of funding, coverage and behaviour change needed to achieve NSP targets. Similar to the previous policy question, the approach used in this case would be scenario analysis. The scenario comparisons will illustrate the impact of the NSP on a specific health outcome, and it would be possible to estimate the resources needed for the NSP.

2.3 Optima

Summary technical description

- Optima is designed to assist national decision-makers, programme managers, and funding partners to achieve maximum impact with the funding available for the country's HIV response. It can inform prioritization of HIV investment by attempting to estimate the optimal

allocation of resources across programmes for specific HIV epidemic settings to achieve the maximum health or economic impact.

- Optima does not have a fixed structure and the user can specify a structure of population groups and interventions that is considered suitable for the epidemic in question and data available; the population structure of AEM or Goals could easily be used or another structure of relevance to the country application.
- Optima is used for optimization analyses aimed to identify the most suitable resource allocation to achieve specific objectives (e.g. minimizing HIV/AIDS indicators or minimizing money spent with maximal impact). Optima can also be used to perform scenario analysis and projections of financial commitments.
- Optima uses cost functions, which associates program expenditure with coverage levels. By default, Optima uses a logistic/sigmoid function (i.e. costly per additional unit in the at low volumes, then cheaper near the inflection point, then costly again at the highest volumes) to estimate the cost-coverage curves used to describe the relationships between the spending on a programme and its coverage level using any data that are available from the country. Routinely, these curves are fit to macro spending data (such as from NASA reports). To conduct such country analysis with Optima, it is desirable to convene country workshops to discuss appropriate population groups and programmes for inclusion, key policy questions, and gather data. Like Goals, these workshops usually last between 3-5 days with ongoing support as countries refine their analyses in post workshop consultations. Further workshops are often conducted for consolidating data and analyses and then for disseminating findings.
- Optima analyses are usually conducted jointly between national monitoring and evaluation experts with trained country consultants and Optima experts from the World Bank/University of New South Wales support team. The tool is accessed by a graphic user interface, and the model and data are hosted in remote servers.

Policy questions

- Optima, as a relatively new tool, has been used less extensively than AEM or GOALS to date.
- Optimization analysis is conducted to identify the most cost-effective mix of intervention programmes to achieve specific objectives such as minimizing HIV incidence, AIDS-related deaths, or both, and identifying programmes that need to be prioritized. Financial commitment analyses could be conducted using Optima to assess the cost of the interventions in the future.

1) *What is a suitable (or maximum) target for reductions in HIV incidence and AIDS-related deaths for a country, given a specified amount of resources (current budget, 20% more; 50% less) and what interventions would be used?*

   Optima would have a different approach from the one used by Goals and AEM. Using Optima, the main analysis would focus on identification of the optimal funding allocation across the different programme interventions available, to achieve the maximum impact on a specific health objective. In general this approach would try to address two main questions

   - If less money is available, what is considered essential to protect?
   - If more money is available, what is the next most cost-efficient programme that should be scaled-up?

The tool would identify the optimal allocation for the funding depending on the amount of resources available and potentially subject to additional constraints (such as the need to continue certain programs that have already been established etc.).

2) *How much money would be needed to achieve National HIV Strategic Plan (NSP) objectives of halving new HIV infections and reducing new AIDS-related deaths by 90% (or other target)?*

Optima would focus on identification of the minimum resource requirements to achieve the NSP and long-term programme commitments, determination of the gap in funding required to achieve the NSP targets, and identification of the optimal resource allocation across the different programme interventions. The model results would illustrate the minimum spending to achieve the NSP targets and the optimal resource allocation across the specific programme interventions.

Table 1: Main intended uses of the models

All models		
• Estimating the amount of funding, coverage and behaviour changes needed to achieve national strategic plan objectives (short term, 5 years) • Development of the Investment Case scenarios (longer term, 15+ years) • All can be used for return on investment • Assessing the effects of combinations of intervention programmes in different populations. • Assessing the impact of scaling up prevention and treatment programmes • Conducting global analysis to support target settings and resource mobilization (UNAIDS) and guidelines development (WHO) • Informing donor strategic planning (PEPFAR, Global Fund) • Assessing the projected future trajectory of the country's HIV epidemic with and without investment in specific programmes, or with/without attaining programme-specific targets • Financial commitment analysis to assess the spending commitment towards people living with HIV, the long term projections of the annual unit cost for people in various health states, and the public debt implication for the Government.		
Goals	AEM	Optima
• Assessing the effect of alternate allocation patterns • Estimating the impact of available funding on the HIV epidemic	• Assessing the effects of scaling up programs with different effectiveness and cost in concentrated epidemics • Assessing the effect of alternate allocation patterns	• Estimating how much funding should be optimally allocated to which HIV service delivery model across the mix of HIV programmes targeting different population groups and geographies to best meet objectives

Session 3. Comments arising from presentations from model developers of allocative efficiency tools

Following each of the presentations from the model developers the meeting attendees discussed the commonalities and differences of the models. Below the major areas of discussion from the group are detailed:

There are many commonalities across models. The process through which decisions are made is of great importance and should support country deliberation.

- All three modelling tools have broadly similar technical characteristics for the representation of HIV transmission, disease progression and the scale-up of interventions (Table 1).
- In all cases, the models should be used to facilitate the discussion about program design, trade-offs and targets, rather than obfuscate it, and all models could be successfully used in this way.
- All three modelling tools are constrained by limited data availability, most notably in regard to costs and epidemic drivers. There is a clear need to improve availability of such data, but as there remains value in the application of these models, the conclusions derived must be considered carefully in light of these restrictions.
- *The models are best used in different ways and suited for different purposes.*
- The analysis process for each model has differences and the suitability of a model depends on the policy and programming questions they are faced with, the purpose of the exercise (e.g. for resource allocation or resource mobilisation efforts), their time and data availability, country engagement, training, and other resources available. In order to aid understanding in this report, some of the main features for each of the allocative efficiency tools have been summarized and detailed in Table 2, and also listed below:
    - **Goals** is a parsimonious tool with pre-populated values and simple and generic assumptions that can be used for concentrated or generalised epidemics, and which can be edited quickly and easily by country teams if need. The main output of scenarios comparisons can be performed relatively quickly by the user and does not necessitate a country workshop to populate the model. The results have been subject to much peer review allowing understanding of potential biases, which can assist the user in interpretation. It may not be straight-forward to fully represent special population sub-groups that are not included in the model by default although various 'work-arounds' can be proposed for doing this.
    - **AEM** is suited for concentrated epidemics. It allows some flexibility in populations and interventions, but does include some default parameters. Country workshops are convened in which country specific interventions and impact can be discussed and incorporated (following data gathering), which could be important as the local effectiveness of the programmes and the current levels of key risk behaviours are likely to vary between countries. AEM includes non-linear costing functions to assess the association between cost and coverage. AEM is intended to be applied to concentrated epidemics only.
    - **Optima** allows inclusion of any population or intervention appropriate to the local context following data gathering. This makes it necessary to specify the structure of the model and this potentially gives greater acuity in the representation of the transmission in the epidemic. Optima attempts to estimate the relationship between cost and coverage empirically using data if it is available. Country workshops are not required but desired for discussion and data gathering, following which the model is implemented by Optima-trained country teams, consultants or developers at UNSW-WB. As Optima is a relatively new tool, the modelling community should ensure the evaluation of this tool and its application as it is more routinely used by countries, as previously for AEM and Goals.

Table 2: Summary of the main features of each model

	Goals	AEM	Optima
1. What is the main objective of the analysis?	• Application for International or local funding • Scenario comparisons	• Application for International or local funding • Scenario comparisons	• Application for International or local funding • Scenario comparisons • Optimal allocation of the current available resources
2. How much information on the epidemic and intervention effectiveness is available?	• Little input necessary as default assumptions provided in many cases, although more input improves projections.	• Local data collation is necessary	• Local data collation is necessary
3. Is the epidemic concentrated or generalized?	• Applied on concentrated or generalized epidemics	• Applied only on concentrated epidemics	• Applied on concentrated or generalized epidemics
4. How many components of the ART scale-up programme assessment to consider?	• Few components of the ART programme can be assessed	• Few components of the ART programme can be assessed	• Several components of the ART cascade can be assessed e.g. interventions to improve linkage, retention, and adherence on ART
5. Need to assess novel programme interventions?	• Conventional programme interventions are assessed	• Novel programme interventions can be assessed	• Novel programme interventions can be assessed

Across all models there are some issues of interpretation

These are noted below:

Representation of programme interventions

- Across all models, there remains a contentious issue about the effectiveness of interventions, and how this is best represented – in terms of individual-level efficacy and population-level effectiveness. A key issue is in regard to the limitations in behavioural data and effectiveness of programme interventions targeting behaviour where most of the foregoing evaluations have focussed on self-reported behaviours. Effect sizes at scale are unknown; Goals and AEM attempt to take a systematic approach to this but this can be overridden by a user; the approach of Optima is to solicit the assumption from the user but work is in progress to also develop defaults for Optima., including defaults used by Goals and AEM, where applicable.
- The specification of interventions for country-level analyses is weak in all models but improved for city- or district-level analyses. All models offer to generate sub-national estimates, but this requires further assumptions about epidemic and cost data, for which guidance is quite weak.

- All three modelling tools assume that interventions act independently, and synergies among interventions (as well as between HIV interventions and broader primary health care interventions), both epidemiological and at implementation level, are not well addressed. This mutual exclusion among interventions means that interaction between programmes or technical and production efficiencies (particularly as programs are integrated within primary care and the public sector health system in a country) cannot be adequately explored at present.

Representation of ART

- Goals and AEM include ART as a single programme intervention. ART is provided to eligible individuals according to selected criteria such as CD4 cell count or population group. But components of the treatment cascade such as diagnosis, treatment failure, second line of treatment and viral suppression are not explicitly included in the models. This prevents the evaluation of other interventions targeting specific components of the treatment cascade.
- The ART module in Optima includes several components of the treatment cascade. Diagnosis is explicitly modelled, and infected individuals are categorised as unaware and diagnosed. Likewise, first and second lines of treatment as well as viral suppression are also included. ART adherence is also modelled separately.

Epidemic projections and model fitting

- Each of the models have fitting procedures and approaches for collecting sets of parameters that give a reasonable fit to the epidemic data. All models have the facility to reproduce analyses on each of these fits in order to understand the uncertainty that arises in model results from uncertainties in the underlying epidemic data. There are minor differences in the approaches taken by each. The meeting attendees commented on the importance of this as it provides an opportunity to discuss data requirement and deficiencies. It was noted that results used in final outputs by the modelling groups rarely communicate these uncertainties explicitly and more could be done.

Costs

- Structurally, Goals included a linear relationship between coverage and cost whereas AEM and Optima provide facility for incorporating other non-linear patterns. Optima attempts to make inference on the relationship between cost and coverage by fitting a function to available data points from within a country. Whilst an innovative approach, the data available will often be sparse, of unsure compatibility and the model will still usually require a heavy reliance on extrapolation beyond the data points. It is believed that functions that convey a non-linear relationship between cost and coverage should be preferred *a priori*, but the group advises users of the Optima model to inspect curves used in the model. For all models, assumptions of the stability of unit costs are contentious, and due to the nature of projecting the future and, in many cases, massive scale-up of interventions - with concomitant scope and scale efficiencies as programs are integrated into broader health systems and step changes as new and better technologies are made available - it is impossible to have a great deal of confidence in historical cost data as a basis for future costs, or of future projections of any kind.

Recommendations Arising

During the discussion session, attendees noted some items for the model developers to consider reviewing for inclusion in their models. We have collated these here for reference for the model

developers, however, please note that many of these comments are already well known or understood limitations of the models used.

Goals

- Consider allowing the model to represent age structure to allow for age-targeting interventions.
- Consider allowing for the inclusion of non-linearity in the cost-coverage relationship if data are available.
- Consider inclusion of interventions for the treatment cascade
- Consider fitting to sex worker prevalence data as well as other prevalence data if available.
- Consider update of behavioural interventions including studies using biological markers to validate self-reported data
- Consider use of algorithms that could automatically find a mix of intervention coverage that would achieve some target.
- Consider removing the HTS from the impact matrix as it still suggests that an HIV test done equates to infections averted.

AEM

- Consider inclusion of age-structure in the demographic model so that this would enable age-targeting interventions.
- Consider expanding the infected population and CD4 cell model to include interventions targeting elements on the treatment cascade.
- Consider including automatic fitting and goodness of fit analysis
- Improve uncertainty analysis for both epidemiological and programmatic data
- Assess the impact of the exponential curves on the main outcomes.
- Consider including some default data for key parameters that could help to conduct the analysis in countries with scarce data.

Optima

- Consider the imposition of contraints and checks on certain parameter values to ensure internal consistency.
- Illustrate the impact of the different saturation cost functions on the resource allocation outcomes with sensitivity analyses. Look for opportunities to independently verify estimates of cost and coverage relationship
- Consider including some default data of key parameters that could help to conduct the analysis in countries with scarce data.
- Consider benchmarking and triangulating epidemiological projections against other models.

All Models

- When presenting results, discuss the uncertainties in the underlying data more explicitly
- Models need to be expanded to include analyses for geographic prioritization and for different service delivery modalities.
- Consider adding more granularity in the ART model to include disengagement in care, adherence, and treatment failure.
- Consider allowing user to specify a lower level of ART efficacy to allow for adherence failures, and allow this to potentally change as the program develops (recognising that this may affect the calibration of the model to epidemic data).
- Consider including of synergies and joint costs for interventions and scale-dependent effects – pending availability of such data to inform analysis.

Future Directions

The group largely agreed on two important avenues for further work as an outcome of this workshop:

Encourage continued research and evaluation of allocative efficiency tools and their application

- Continued evaluation of these models is necessary. One such approach could be by comparing their past predictions with subsequent observation. Identify settings where data are available to explore in retrospect the accuracy of the predictions made by the modelling tools, and assess whether they had the expected health impact. Understanding how these models are used or not used and learning from this brings science and policy closer together.
- As different models are now 'on the market,' countries might have results from more than one more. In these cases, country teams would be strongly encouraged to use results from these multiple model to come to overall conclusions.
- Continue to develop ways in which these models could incorporate and leverage the programme data that are increasingly becoming available.
- Also, the HIV Modelling Consortium was asked to consider a longer-term role as a convener of detailed discussions relating to these models in order to continue support for their development.

Advocate for access to accurate cost data and improved representation of costs in models

- There is a need to better understand the cost of intervention implementation at different stages of program scale up, for different volumes, in different implementation arrangements, for different epidemic contexts. This includes considerations concerning costs of implementing interventions jointly or in combination. The new HIV Modelling Consortium work package will address this point and results will be presented back to this research group.
- There is a need to gain more accurate cost data and cost functions (that recognises the non-linearity of marginal and total cost within different program stages, volumes, and contexts) as currently such data do not exist for many settings. Efforts to collate such cost data are being supported as a newly established Cost Consortium funded by the Bill and Melinda Gates Foundation is mandated to this task. Research can be conducted in collaboration with this Consortium to understand the non-linearity of cost-functions in order to better inform these models, acknowledge the non-linearity of these costs, and reduce the current level of uncertainty and simplicity with linear assumptions and point estimates of the relations between unit costs and coverage attained.
- Following the above work, it would be important to assess the impact of these cost functions on the allocation outcome.

Closing remarks

There was agreement by attendees that each of the three tools discussed (AEM, Goals, Optima) hold value in offering governments an approach through which to consider complex decisions on how to best project, estimate or optimise HIV resource allocations. There should be support for their use and evaluation, through sharing experience and techniques. It is hoped that such an approach will strengthen the tools to further benefit the future HIV/AIDS response.

HIV Modelling Consortium

Fit-for-Purpose Assessment on Allocative Efficiency Tools & Methods to Support Country HIV Programme Planning and Budget Allocation

Pinnacle Vancouver Harbourfront Hotel
Vancouver, Canada
18 July 2015

Organised by: HIV Modelling Consortium

Workshop Objectives

(**a**) Create an opportunity for the HIV modelling community to better understand the technical characteristics of the different models used to inform country programs;

(**b**) To generate discussion of how the models address the specific HIV policy questions for which these models might be used;

(**c**) To create a suitable space for the modellers to interact, comment on and learn from each other's approaches

Saturday, 18 July 2015		
Timing	*Agenda item*	*Facilitator/Speaker*
	Introduction	
08:45 - 09.00	Meeting Introduction: • Workshop aims and objectives	Tim Hallett
09.00 – 09:45	Key Economic Principles and Problems In Estimating Optimal Allocation	Mead Over Paul Revill
	Models Overview	
09:45 - 11.15	Allocative efficiency analysis using GOALS • Purpose and approach of the model • Technical description of the model • Country analysis examples • Discussion (30 min Q&A)	John Stover
11.15 – 11.30	Coffee break	
11.30 – 13.00	Allocative efficiency analysis using the AIDS Epidemic Model (AEM) • Purpose and approach of the	Tim Brown

	model • Technical description of the model • Country analysis examples • Discussion (30 min Q&A)	
13.00 – 14.00	Lunch break	
14.00 – 15.30	Allocative efficiency analysis using OPTIMA • Purpose and approach of the model • Technical description of the model • Country analysis examples • Discussion (30 min Q&A)	David Wilson
15.30 – 15:45	Coffee break	
	Putting the pieces together	
15:45 – 16:15	A comparative analysis of model case-studies • Indonesia • Thailand • Zambia	Diego Cuadros
16.15 – 17.30	General discussion model developers	All *(Discussion chaired by Tim Hallett)*
17.30 – 17.45	Final remarks and further steps	Tim Hallett

List of participants

Pinnacle Vancouver Harbourfront Hotel
Vancouver, Canada
18 July 2015

Organised by: HIV Modelling Consortium

	Name	*Institution*
1	Sarah-Jane Anderson	Imperial College London / HIV Modelling Consortium
2	Ruanne Barnabas	University of Washington
3	Anna Bershteyn	Institute for Disease Modelling
4	Scott Braithwaite	New York University
5	Margaret Brandeau	Stanford University
6	Tim Brown	East West Center
7	Calvin Chiu	University of the Witwatersrand
8	Diego Cuadros	Weill Cornell Medical College in Qatar
9	Jeff Eaton	Imperial College London / HIV Modelling Consortium
10	Ginny Fonner	Medical University of South Carolina
11	Noah Haber	Harvard T.H. Chan School of Public Health
12	Tim Hallett	Imperial College London / HIV Modelling Consortium
13	José-Antonio Izazola	UNAIDS
14	Leigh Johnson	University of Cape Town
15	Sherrie Kelly	Kirby Institute
16	Mead Over	Centre for Global Development
17	Wiwat Peerapatanapokin	Policy Research and Development Institute Foundation
18	Andrew Phillips	University College London
19	Michelle Remme	London School of Hygiene and Tropical Medicine
20	Paul Revill	University of York
21	Nalinee Sangrujee	Centers for Disease Control and Prevention
22	Iris Semini	UNAIDS
23	John Stover	Avenir Health
24	Anna Vassall	London School of Hygiene and Tropical Medicine
25	Brian Williams	Wits Reproductive Health and HIV Institute & SACEMA
26	David Wilson	Kirby Institute