Decision Support for Evidence-Based Integration of Disease Control

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Background and Objectives

Managing infectious disease requires rapid and effective response to support decision makers. The decisions required are complex and require an understanding of the diseases, intervention and control measures, and relevant contextual characteristics. While data from clinical and modeling studies have demonstrated the potential benefit of integrating vertical disease programs, few evidence-based tools exist to assist decision makers in evaluating and comparing approaches, to determine the most impactful and cost-effective approaches for their setting. We created an application available on the web, with a simple user interface, to support on-the-ground decision-making for integrating disease control programs or their components given local conditions and practical constraints. The model provides predictive analysis for the effectiveness of integration of schistosomiasis and malaria control, two common parasitic diseases with extensive geographical and epidemiological overlap, to evaluate the effectiveness of integration and provide a proof-of principle for using this type of web-based dashboard to inform modeling-based decision support. **The objectives of the project were to:**

- Develop a web-based modeling application to support public health decision making
- Demonstrate how the use of this tool can provide guidance on how to optimize the integration of vertical disease control programs

Methodology

1) Model Development: Parameters and algorithm are based on a previously-published model[1] describing the epidemiological dynamics of malaria and schistosomiasis infection and effectiveness of common interventions. Parameters, including proportion receiving treatment, cure rates, and impact of interventions, are defined from the literature or by the user[1-4]. The model quantifies malaria prevalence, including the observation that infection with schistosomiasis increases malaria infection risk[1,2] and the relative impacts of indoor residual spraying (IRS), bednet distribution (ITN), treatment, and MDA for schistosomiasis[4]. Malaria control Interventions are optimized by timing to precede peak transmission season. Two simulations are compared to evaluate relative effectiveness of non-integrated control and optimally-timed integrated control.

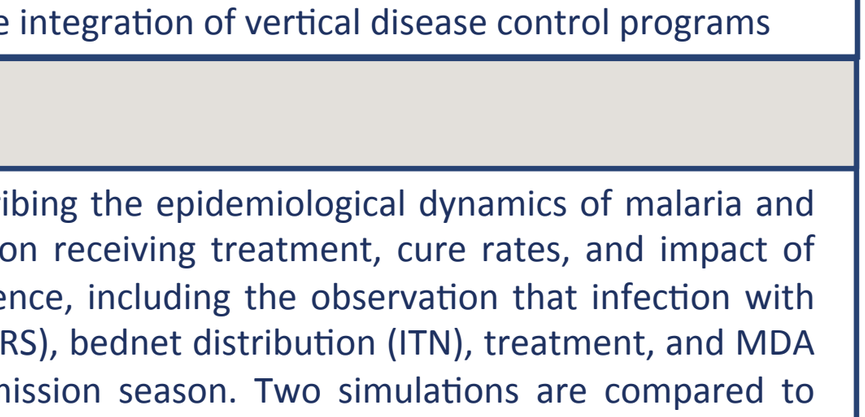
2) Development of prototype web-based decision tool as a user interface: To facilitate decision-making, we developed a user-friendly interface for the model, allowing disease control officers and/or policy makers to customize parameters such as demographic data, initial prevalence values, and timing/ type of existing non-integrated disease control interventions. The interface provides the final model outcome, in a simple graphical format.

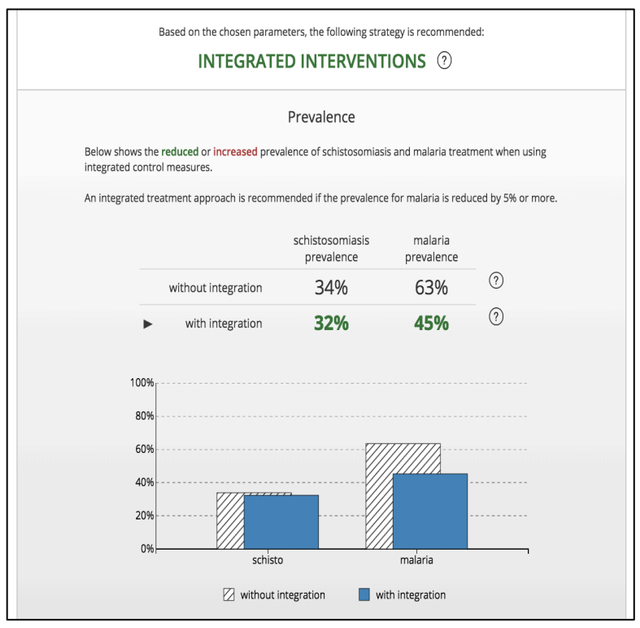
3) Feedback and input from partners in co-endemic countries: Throughout the project, we corresponded with partners in Mali, Uganda, and Yemen to collect data on initial model parameters, and ensure the model and decision-tool addressed on-the-ground needs.

Results | http://integratedntd.talusanalytics.com/

Decision Support Web Interface

The user interface provides access to and mediates interaction of users with the model, to enable users to easily and quickly customize key parameters. To estimate the potential benefits of schistosomiasis mass drug administration (MDA), users supply demographic information (see screenshot to the right) and outline their current schistosomiasis prevalence and MDA strategy. Schistosomiasis interventions are often targeted selectively to school-aged children so demographic information is required in order to align MDA simulation in the back-end model with the approach in use on the ground. Similarly, malaria seasonality, and transmission rate are user-defined input parameters in the tool.





Modeling Results for Decision Makers

The graphic of the model output to the left highlights the challenge of successfully communicating the results of a complex academic model for easy use on the ground by decision-makers. Our user interface translates these modeling outputs into a straight-forward comparison of benefit that facilitates decision-making. Ultimately, the most critical finding of the current model is whether the conditions support a recommendation for integration of schistosomiasis and malaria control efforts. This recommendation is based on whether an integrated program "moves the needle" on disease prevalence compared to existing non-integrated approaches. The graphical output summarizes this comparison; integration is shown as "recommended" if prevalence of either disease is reduced by greater than 5%, relative to the current program (assumed to be non-integrated). An additional graphic on the user interface provides an overview of recommended implementation strategies for the timing of interventions, providing immediately practical information for users. By breaking complex model outputs down into straight-forward comparisons of benefit, in language and terminology familiar to disease control officers, our prototype tool provides a critical and novel layer of support to evidence-based decision making, which could be applied at national, regional, or even local levels.

Conclusions and Policy Recommendations

This tool represents a significant step forward in effectively translating the best available scientific models to support practical decision making on the ground with the potential to significantly increase the efficacy and cost-effectiveness of disease control, enhancing both health and resilience. Next steps for the current model include expanding the model to incorporate schistosomiasis re-infection and additional intrahost epidemiological dynamics, assessing resource allocation for integrated versus non-integrated control, and field-testing the model and tool to determine utility and efficacy. Perhaps most importantly, this work provides sufficient proof of concept to allow for these methods to be applied towards other integration efforts – such as those involving other infectious diseases or One Health efforts – which hold the potential to greatly improve the health of vulnerable populations globally.

Other Information

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