

**Innovative, Integrated and Standardized Approaches in Mapping IDM Diseases**

<b>Session Date &amp; Time:</b>	Tuesday, November 19; 9:00 AM to 12:00 PM
<b>Session Location:</b>	Beau Rivage
<b>Session Description:</b>	Several innovative and intensified disease management neglected tropical diseases (IDM-NTDs) are targeted for “elimination” but control programs lack data on their distribution and burden, which is essential for targeting resources and interventions. Challenges include lack of agreement on mapping strategy and lack of point-of-care diagnostics.
<b>Session Chairs:</b>	Kebede Deribe and Jorge Cano-Ortega
<b>Session Rapporteur:</b>	Katherine Sanchez, FHI 360

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**KEY DISCUSSION POINTS****Integrated Mapping of Yaws and Podoconiosis in Cameroon** (Prof. Samuel Wanji)

Cameroon does not have a national podoconiosis control program despite high disease burden, in part due to lack of information about its geographical distribution. Disease mapping is the first control intervention step. Mapping identifies priority areas for intervention and quantifies disease endemicity and the population at risk.

Cameroon is endemic for yaws but little is known about its geographical distribution; pre-intervention mapping is needed to identify endemic districts which can be targeted for mass drug administration with azithromycin.

The joint podoconiosis/yaws mapping exercise surveyed 69 communities in 38 districts; clinical signs of yaws were found in 36 children (0.93% of those surveyed) with 3 serologically confirmed cases. Eighteen (18) districts were found endemic for yaws and 11 were possibly endemic. For podoconiosis, over 10,000 individuals were screened and 52 podoconiosis cases were identified. The northwest region of Cameroon showed the highest disease endemicity.

Because the two diseases were co-endemic in many districts, integrated interventions may be feasible.

Advantages of the joint mapping exercise included common logistics use, lower cost, time-savings, and identification of two skin diseases. Challenges were that different age groups were targeted, management of two databases, extra time required in each community.

**Integrated Intensified Case Management of NTD Surveys in West Africa** (Dr. Rie Roselyne Yotsu and Dr. Rachel Pullan)

Used a two-phase approach involving w nurses/community health workers (CHW) and dermatologists to assess the feasibility of skin surveys for early detection of skin NTDs including buruli ulcer (BU), leprosy, yaws, and LF in rural Cote d'Ivoire and determine disease prevalence.

Over 25% of the almost 23,000 children screened in Adzope and Gagnoa districts had a skin disease, mostly fungal infections; 1 and 8 children in Adzope and Gagnoa districts, respectively, had a skin NTD confirmed via a rapid diagnostic test (RDT) or polymerase chain reaction (PCR) – 5 BU, 2 leprosy, 2 yaws; 37 and 76 cases respective cases of scabies were identified. In Zouan Hounien, 13 cases of leprosy, 10 yaws, 218 scabies, and 511 other non-NTD skin diseases were found in 24,000 people screened in 5 villages. The latter survey took one week and cost 10,000 Euros.

A second survey in Liberia aiming to assess prevalence of BU, leprosy, yaws and LF in Maryland Country screened 57,000 people in 94 communities via door-to-door CHW visits. The survey found a high burden of skin NTDs in Maryland County: 41.3 per 10,000 (287 confirmed cases, including 169 LF morbidity, 39 leprosy, 24 yaws and 55 BU). Disease distribution was focal, spatially heterogeneous with large differences between neighboring health centers; different patterns for different diseases; and notable differences with routine case data, uncovering a previously unknown large disease burden, including confirmed yaws cases.

Lessons learned: survey approach worked; electronic data capture and tailored training materials helped; community health workers (CHW) were better at screening than verification; and large burden of scabies and non-NTD skin diseases was uncovered. However, the approach was expensive and time-and resource-intensive.

**Precision Mapping: Towards the Global Atlas of Podoconiosis: Experiences from Ethiopia and Rwanda (Dr. Kedebe Deribe)**

Endemic countries and global burden and distribution of podoconiosis (podo) are not known; therefore, there are no global or national control/elimination strategies currently. Mapping is needed to identify endemic countries and districts, quantify at-risk populations, prioritize areas for intervention, and gather baseline data. Eighteen African countries have some evidence of podo and 6 (Cameroon, Ethiopia, Kenya, Rwanda, Uganda and Tanzania) have strong evidence. The approach taken combined prevalence data with environmental covariates to predict risk, estimate at-risk population and identify districts requiring mapping, and estimate the podo disease burden and disability-adjusted life years (DALYs).

Three different approaches were used in the countries to collect empirical data (purposive sampling, random sampling and house to house case search) and modeling were used to identify environmentally suitable areas and estimate disease burden and population at risk.

Findings informed program implementation in Ethiopia, which now targets podo elimination for 2030. In Cameroon, they used the model developed in Ethiopia to predict podo risk and found that the predictors are similar across countries. The model was later used to determine the numbers of people living in areas suitable for podo (only) and both podo and LF. It was also used to identify the numbers of environmentally suitable districts and districts requiring mapping.

Lessons—surveyors should consider target group characteristics and overlap—both podo and LF have target ages of 15 years and older. Phased approach surveys can save money and make better use of trained technicians. Ground truth-field testing is key to refine models. Planning should be done to estimate proper sample size.

Conclusions—spatial modeling can identify risk areas, guide mapping, help estimate at-risk population and disease burden.

**Challenges for the Low-Scale Mapping and Spatial Modeling of IDM NTDs (Hope Simpson)**

Mapping BU is necessary because while some countries (Cameroon) have strong reported evidence of disease in existing data (WHO Global Observatory, GIDEON, national program data, literature review), other countries (Senegal) with weak health systems lack access to diagnostics/treatment yet have weak evidence for disease absence (4 similar presenting diseases and low health expenditure).

The study aimed to use environmental characteristics from areas with strong evidence of BU to identify “pseudoabsences” in areas with low disease evidence scores. However, note that distance is a confounding factor due to environmental differences; the model addressed this by generating pseudoabsence points at a higher density in areas of weaker evidence within the environmental domain of presence points. It also generated background points to represent geographical bias.

To identify environmental predictors of BU, a database was assembled with 51 potential covariates and covariates reflecting a range of risk factors—temperature, precipitation and wetness, vegetation, topsoil silt, distance to rivers, and mean predicted suitability for waterbugs (a potential BU vector)—were selected and arranged into 7 model algorithms, with high-performing algorithms run in an ensemble to determine predicted suitability for BU and *M. ulcerans*. As predicted, the model found overlap between suitability for *M. ulcerans* and BU.

Evidence consensus mapping allows for integration of data on IDM NTDs from various sources and levels. Species distribution modeling techniques can account for clustered occurrence data and sparse absence of data. Further, these two approaches are complementary and spatial modeling can identify areas at most risk, which can then be targeted for case finding and control activities.

### **The Burden of Lymphatic Filariasis in Africa: 2000, 2020 and 2025** (Dr. Natalie Vinkeles Melchers)

The research objectives were to estimate the burden of LF with morbidity in Africa in 2000, 2020, and 2025, based on the number of cases of lymphedema/elephantiasis and hydrocele and DALYs. The methodology sought to standardize microfilarial (mf) prevalence using 4 different diagnostic tests (using thick blood smear as the historical standard), quantify the pre-control association between disease morbidity and mf prevalence, estimate pre-control disease prevalence using existing maps of mf prevalence and associations, and project disease prevalence trends since the start of MDA.

The total population at risk in Africa is expected to approximately double between 2000 and 2025 (from 303M to 602M), with the following respective numbers of cases of associated morbidity in 2000, 2020, and 2025: 4,499K (1.5%), 6,283K (1.2%), 5,879K (1.0%) lymphedema cases and 12,207 (4.0%), 17,268 (3.3%), 16,337K (2.7%) hydrocele cases. Nigeria (~29% of total), DRC (~9% of total), Tanzania (~7% of total), Madagascar, Cote d'Ivoire, Mozambique, South Sudan, Burkina Faso, Mali and Cameroon were the 10 countries predicted to lose the most

DALYs in 2025, with Nigeria far in the lead with well over 600,000 DALYs, followed by DRC, with about 200,000 DALYs.

Overall, more than 22M cases of clinical LF-related morbidity are expected in Africa by 2025, with hydrocele representing 74% and lymphedema/elephantiasis accounting for 26%. This translates into 2.2 DALYs lost by 2025.

**Cameroon: How Large-Scale Modeling of IDM Diseases Can Support and Guide Micro-Scale Integrated Mapping** (Dr. Jorge Cano)

The aim is to provide practical applications of the models presented in the session for field staff to help programs use the models to improve micro-mapping and manage cases of morbidity, keeping in mind that most of the data comes from health systems (passive and active detections) as well as random cross-sectional disease burden data, with diagnostic, geographical, and (with passive detection) informational biases and may involve high costs.

A robust modelling framework should combine data compilation (systematic searches) of disease prevalence evidence and potential risk factors; evidence consensus modeling using point data and aerial data (adjusted for under- and mis-diagnoses) to generate scores for presence/absence evidence; ecological niche modeling (ensemble modeling) to derive the disease prevalence probability; and disease burden modeling using population-based surveys and taking into account all of the preceding models and compilations, to estimate disease burden.

These estimates could be used to: identify suitable areas for disease mapping/active searches, support a morbidity management tool, assign weights to communities selected for randomized cross-sectional surveys based on environmental suitability, and estimate populations at risk and disease burden.

Ecological niche models have already been successfully used to identify previously unknown suitable areas for BU in Equatorial Guinea, for example. Geostatistical modeling can estimate disease burden per area unit when used with population-based survey data. The models provide data relating to potential disease risk factors and a framework for constructing better models. They can guide field work interventions such as micro-mapping and even health care delivery.

**Poll Exercise***Relevant data for skin-NTD mapping*

Field staff favor the use of randomized surveys and active case searches, which they scored as most relevant, relevant or moderately relevant; routine data are viewed as having little to moderate relevance.

Overall, disease modelers score routine data as most relevant; randomized surveys are seen as relevant; and active case searches are considered moderately relevant.

*Meaning of Skin-NTD Mapping*

Field staff think skin-NTD mapping means estimating the number of cases and burden of skin-NTDs (8 votes) and only 1 person each think it means predicting the presence/absence of skin-NTDs or finding unknown cases requiring intervention.

Disease modelers think skin-NTD mapping means predicting the presence/absence of disease or estimating the skin-NTD burden/number of cases (6 votes each). Only 1 person thinks it means finding unknown cases.

*Priority Reasons for Skin-NTD Mapping*

Field staff believe mapping is most important for improving understanding of skin-NTD epidemiology and co-endemicity and informing implementer planning and resource mobilization (5 votes each), estimating the true skin-NTD burden (3 votes), and advocacy (1 vote).

Disease modelers also believe mapping is most useful for informing implementer planning and resource mobilization (6 votes), followed by improving understanding of skin-NTD epidemiology and co-endemicity and estimating the true skin-NTD burden (4 votes each), and advocacy (3 votes).

Neither group see value in mapping to develop improved methods for predicting skin-NTDs.

## Group Discussions

The overall aim of the session was to develop an outline of refined guidelines on integrated mapping of IDM diseases.

The goals of the group discussions were to: 1) establish consensus on the definition of skin-NTDs mapping; 2) identify opportunities to improve communication and collaboration between modelers and field staff; and 3) encourage discussion about what each group (field staff and modelers) can provide to the other to help achieve their priorities. To achieve these aims, group facilitators led discussions according to the following parameters:

**Group 1:** The role of modelling in developing country, continental and global risk maps, and tools for local programing and decision making.

- What are the practical applications of such approaches?
  - Are program staff/decision makers already implementing these or is uptake lacking?
- What are the limitations of such approaches?
  - How can input from modelers and field workers help address these?
- What are the main evidence gaps to be addressed in the use of model outputs for decision making?
  - Potential operational research questions (+ hypotheses)?

**Group 2:** Burden estimates at subnational level using modeling and case searching.

- Which of these approaches can best address program needs?
  - Can they be integrated?
  - What would this require from modelers and fieldworkers?
- What are the main evidence gaps to be addressed in terms of comparisons between model-based estimates and case searching?
  - Potential operational research questions (+ hypotheses)?

**Group 3:** Sampling approach for IDM diseases: randomized vs house to house case search.

- Which of these approaches can best address program needs?
- Are they complementary? Why/how
- What is the relationship between survey cost and data quality?
  - Can we use modelling outputs to maximize data quality?
- Potential operational research questions (hypothesis)?

**Group 4:** Best practices and tools for data collection of integrated mapping IDM diseases.

- What tools are available for the integrated mapping of IDM-NTDs? (Survey

- tools, diagnostic tools etc.)
- How could modelling approaches improve existing tools or develop new ones for more effective integrated mapping of IDM-NTDs?
  - Potential operational research questions (hypothesis)?

### **Main Points Discussed by the Groups**

Group 1: The role of modelling in identifying risk areas and develop country, continental and global risk maps tool for local programing and decision making:

- Disease modelers should focus on what to address, priorities, data quality, inputs going into model.
- Identify different uses/objectives of models depending on what information is known about how different diseases are transmitted and whether the goal is control or elimination.

Group 2: Burden estimates at subnational level using modeling and case searching to quantify morbidity burden:

There needs to be some level of precision around a burden estimate, not just thresholds.

The priority should be to validate predictive maps, especially in areas where we don't know what to do programmatically, to help determine whether there should be an intervention and if so, what intervention is appropriate.

Ethics should be considered—is it ok to map but not treat? Consider integrating mapping with treatment, when feasible.

Applications:

- Utility to explore likely transmission in areas with no data
- Cost-effective alternative to prioritize locations with high uncertainty and/or high probability of disease
- Identify fine-scale data needed for interventions
- Describe disease burdens at different spatial scales or levels
- Resource mobilization
- Scenario exploration

Group 3: Sampling approach for IDM diseases randomized versus house to house case search:

- Diagnostics and using visual diagnoses alone is not sufficient or appropriate for identifying skin NTDs.



- We also need to look at barriers to health-seeking behaviors.
- Cases need to be validated.

Group 4: Best practices and tools for data collection of integrated mapping IDM diseases:

- There are already good tools available specific to diseases (difficult to say which tools are the best); how to leverage each tool and integrate will be the key.
  - Integration by distribution
  - Integration by symptoms, e.g., fever for malaria and typhoid
  - Other ways?
- Care is needed on the origin of data / how the data was collected, e.g., house-to-house survey, PHCs, etc.

### **KNOWLEDGE GAPS IDENTIFIED**

Group 1:

- We need better understanding about where models have been applied effectively and how to improve integration between models and data collection on ground.

Group 2:

- Quality of data and predictions
- Challenges of communicating academic-oriented results to programs and engaging programs in process of model development
- Unrealistic expectations of what models can provide
- Need for further ground validation data to improve models and understand limitations

Group 3:

What are the barriers/facilitators to health-seeking behavior?

Are diagnostic tools and visual inspections only sufficient?

Group 4:

There is a need to come up with a framework to operationalize integration.

### **RECOMMENDED NEXT STEPS**

Group 1:

- Models should be used to direct data collection and data should be used to improve model prediction.
- Models should not be used on their own in the absence of data.

## Group 2:

- Develop feedback and communication between field activities and models to ensure models are data-driven and field activities use model data appropriately
- Improved evaluation of the predictive power of models
- Identification of new sources of data to fit and validate models iteratively
- Identification of the uses and objectives of models at different phases of understanding transmission and steps between control and elimination
- Further research on where and how models have been applied most effectively
- Research on integration and applications across diseases
- Need to develop capacity locally to support model development as well as interpretation of results

## Group 3:

- Validate models
- Integration of the health system at the community level

## Group 4:

## Potential operational research questions:

- Validation of the mapping vs. actual survey results and what are the ways to do so?
- Overlay the healthcare capacity (access to care, healthcare worker per population, training, community education, etc.) vs. the disease and understand how/how much the healthcare capacity has impact on prevalence of disease(s).
- What are the ways to understand the infection dynamics?
- What are the ways to understand the burden estimate?