HARVARD T.H. CHAN SCHOOL OF PUBLIC HEALTH

Infectious disease mathematical modeling: an Africa-based training to support evidence-based policies

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CENTER *for* COMMUNICABLE DISEASE DYNAMICS

Outline

- Overview of training
- Applications
- Who are the trainees?
- Highlights of the first session
- Training evaluations
- Next steps
- Bonding moments

Training partnership

- **Core training team:** Caroline Buckee, Emmanuelle Dankwa, Bethany Hedt-Gauthier, Sylvia Ofori
- **UGHE advising team:** Alemayehu Amberbir, Abebe Bekele, Emmanuel Ngwakongnwi
- **Harvard advising team:** Mary Bushman, Flavia Camponovo, Megan Murray, Yonatan Grad
- **Training advisor committee:**
  - Vincent Cubaka, Partners In Health/Rwanda
  - Baylie Damtie, Kepler University/Rwanda
  - Thumbi Mwangi, Center for Epidemiological Modelling and Analysis (Kenya)
  - Edison Rwagasore, Rwanda Biomedical Center
  - Sheetal Silal, Modelling and Simulation Hub, Africa (South Africa)

Training goals

- **Overall goal**
  - Build capacity among Africa-based health officials and researchers to use mathematical models to support infectious disease program response.

- **Specific course objectives**
  - Understand the fundamental concepts of infectious disease transmission and dynamics.
  - Understand the types of models and their use in public health for different infectious diseases.
  - Identify research questions suitable for mathematical modeling.
  - Critically appraise, and review modeling studies; interpret and use findings to support decision making.
  - Build models to assess the effectiveness of interventions.
  - Use routine data to support parameter decisions.

Course structure

The training structure is adapted from previously successfully implemented Intermediate Operational Training Courses.

- 8-12 months alternating between in-person and practicum sessions.
  - 4 weeks of in-person sessions occurring approximately 3 months apart.

- **In-person sessions:**
  - Lectures, group and panel discussions, journal clubs, group presentations, and in-depth practical sessions with Berkeley Madonna.

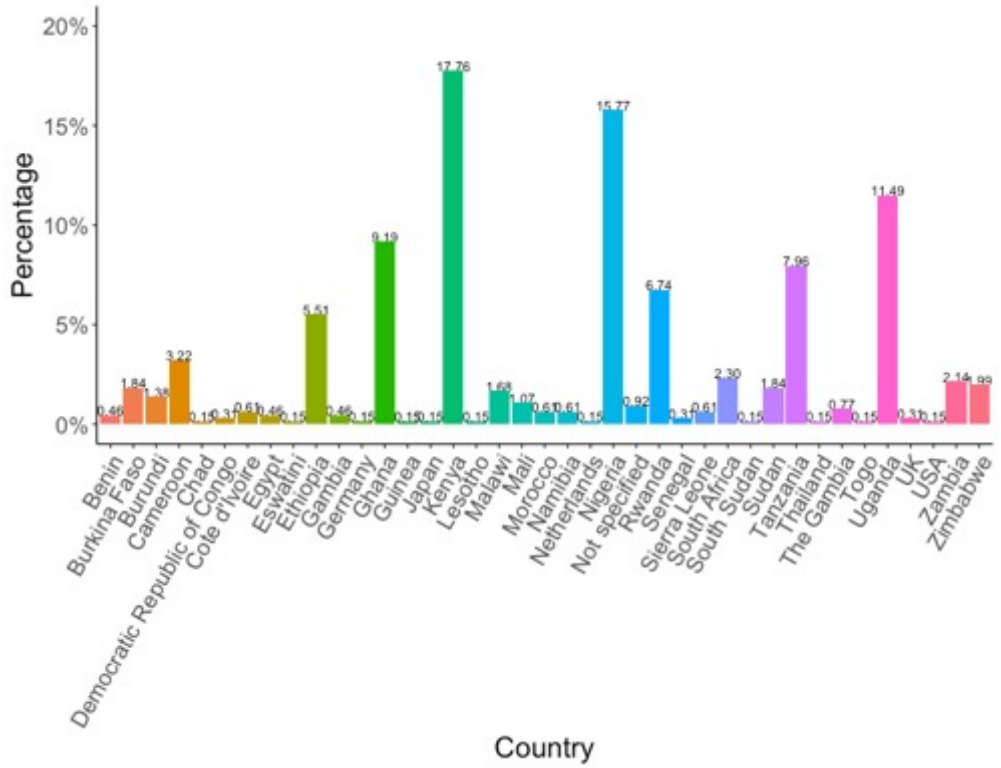
- **Practicum sessions:**
  - Completed at trainee's home site.
  - Intensive mentorship will be offered in person and/or long distance.

Curriculum Overview

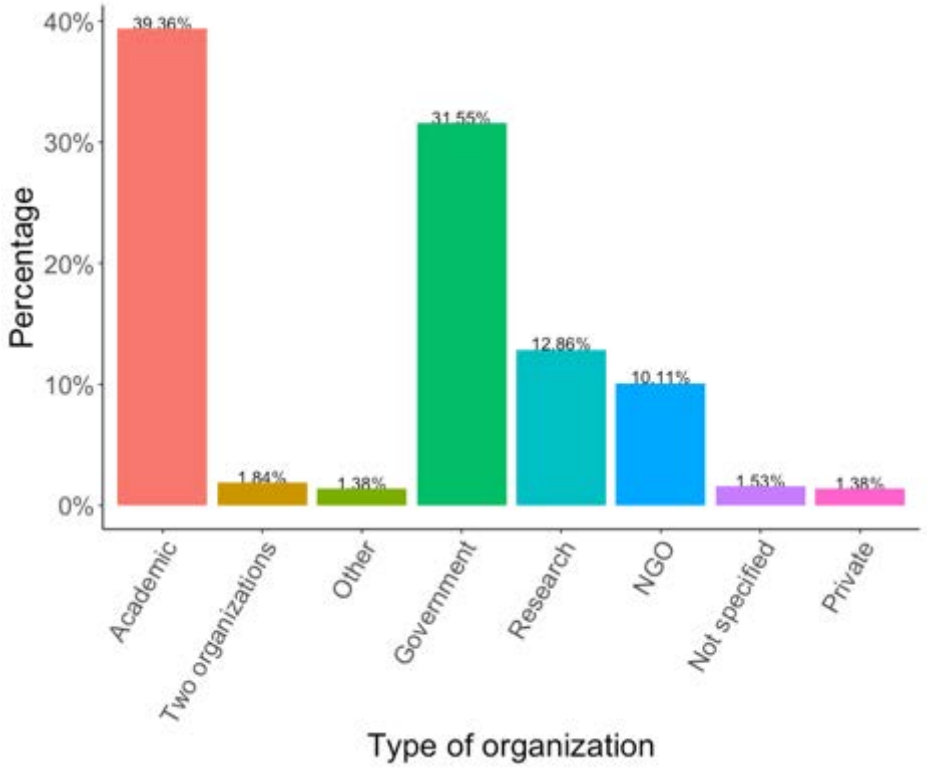
Week	Session title	Learning outcomes
1	Introduction to infectious disease modeling	• Know basic definitions. • Identify types of models and approaches. • Simulate the SIR model and extend it to answer basic questions and assess interventions. • Understand modeling assumptions and limitations.
2 & 3	Building mathematical models to answer research questions	• Develop models for research questions with equations. • Identify parameter values for models. • Incorporate scenarios and/or interventions into models. • Present preliminary results for projects. • Know other disease-specific compartmental models (TB, HIV, and malaria).
4	Communicating and disseminating model findings	• Effectively communicate model results to different audiences. • Explain the differences between policy briefs and research articles. • Able to draft policy briefs. • Ability to find relevant conferences and develop abstracts.

875 applications in <2 weeks!!

Countries



Background



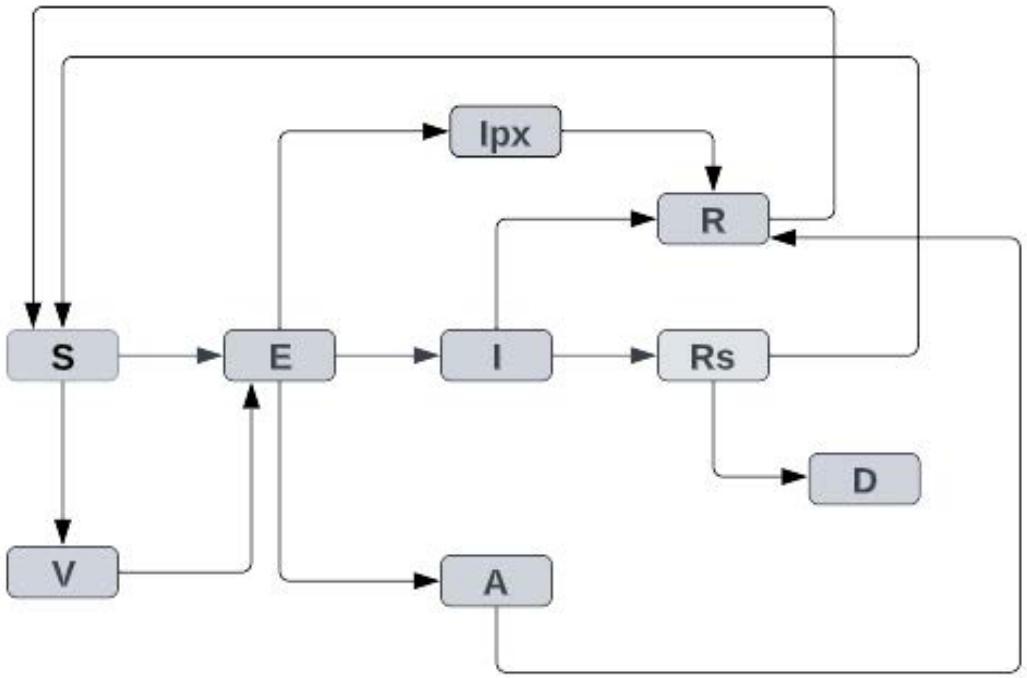
Who are the trainees?

- 10 trainees (5 teams) were selected:
  - 6 from Rwanda, 2 from Kenya, and 2 from Uganda
  - 4 females

- Each team has one person with a policy/program background and another with a research background
  - 7 trainees work with government institutions, 1 from an academic organization, and 2 from NGO

Team COVID-19: Rwanda

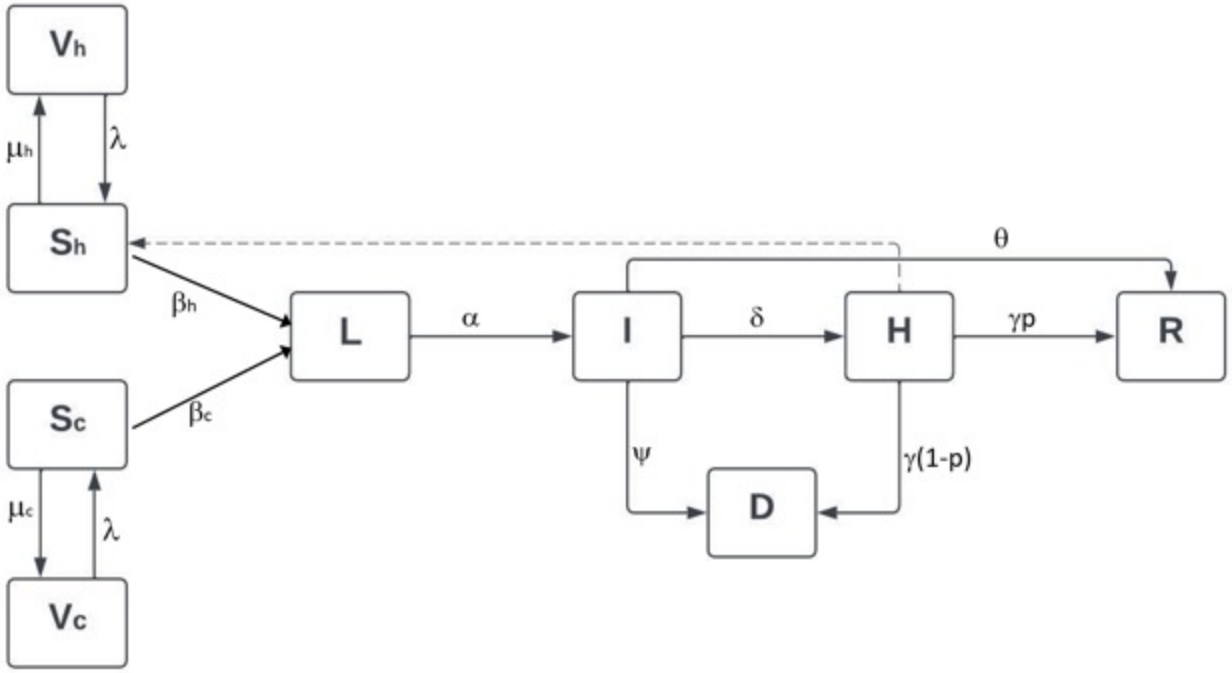
Mathematical modeling of vaccination and the test-all-and-treat strategy on COVID-19 outcomes in Rwanda



- **Outcomes**
  - Cumulative cases averted with the test-and-treat approach (Paxlovid) with different vaccination scenarios.
  - % change in hospitalizations under the intervention scenarios

Team Ebola: Rwanda

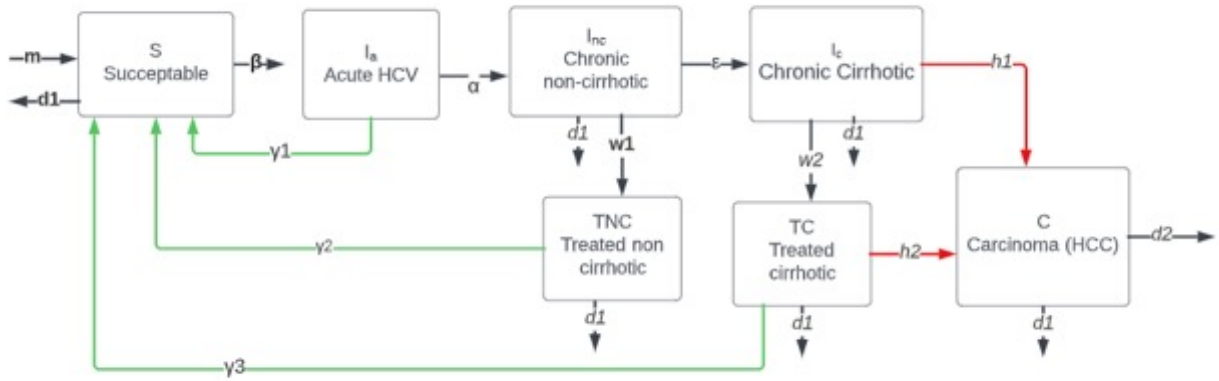
Modeling vaccination strategies and surveillance on Ebola outcomes in Rwanda



- **Outcomes**
  - Varying rates of vaccination coverage in both "frontliners" and general population.
  - Varying rates at which new cases are detected and isolated.
  - Outcomes are hospitalization, deaths, and recovery

Team Hepatitis C: Rwanda

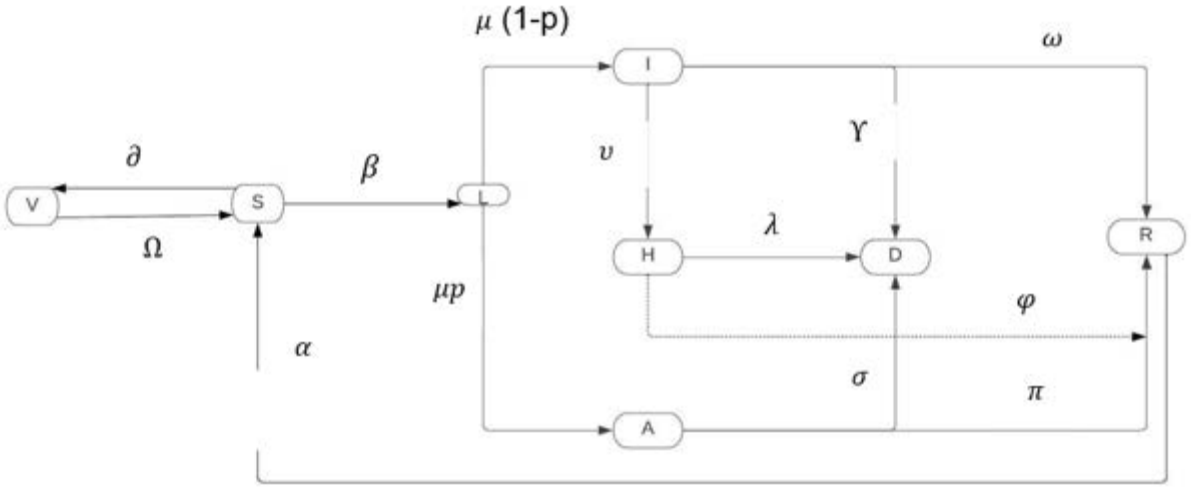
Assessing impact of screening and treatment of Hepatitis C on hepatocellular carcinoma (HCC) outcomes



- **Outcome**
  - Vary rates of treatment of HCV-infected individuals on the incidence of HCC.
  - Vary rates of HCC screening among patients cured of HCV.

Team Ebola: Uganda

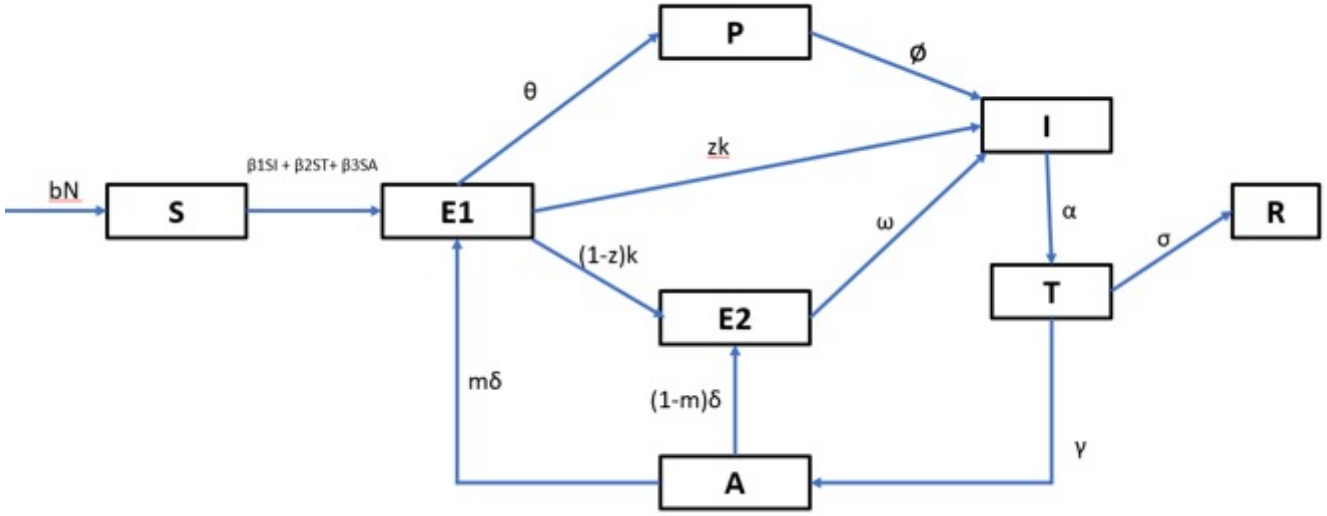
Assessing Sudan Ebola virus vaccination and quarantine in Mubende district, Uganda



- **Outcome**
  - Compare health outcomes for vaccination only, quarantine only, and both vaccination and quarantine

Team TB: Kenya

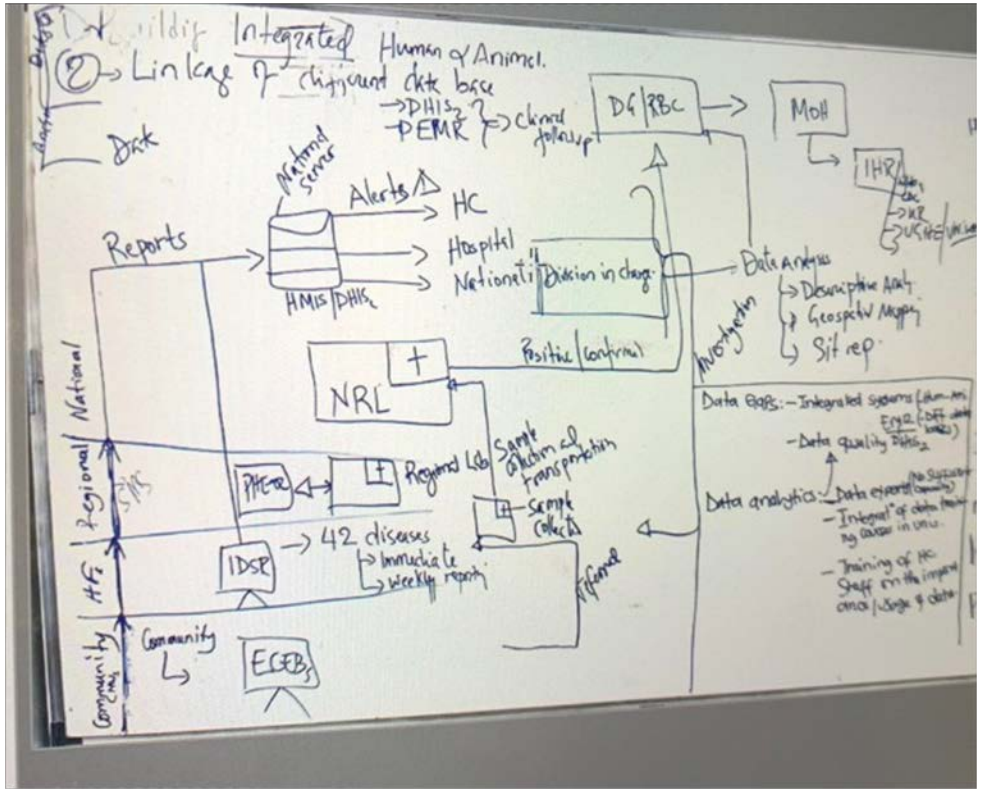
Mathematical modeling of TB preventive therapy on incidence and relapse of TB infections in Nakuru County, Kenya



- **Outcome**
  - TB incidences for Nakuru County with different scenarios of TPT interventions

Highlights: March 13-24, 2023

- **Tabletop activity**
  - The flow of data to decision-making with the key actors involved in outbreak scenarios by country



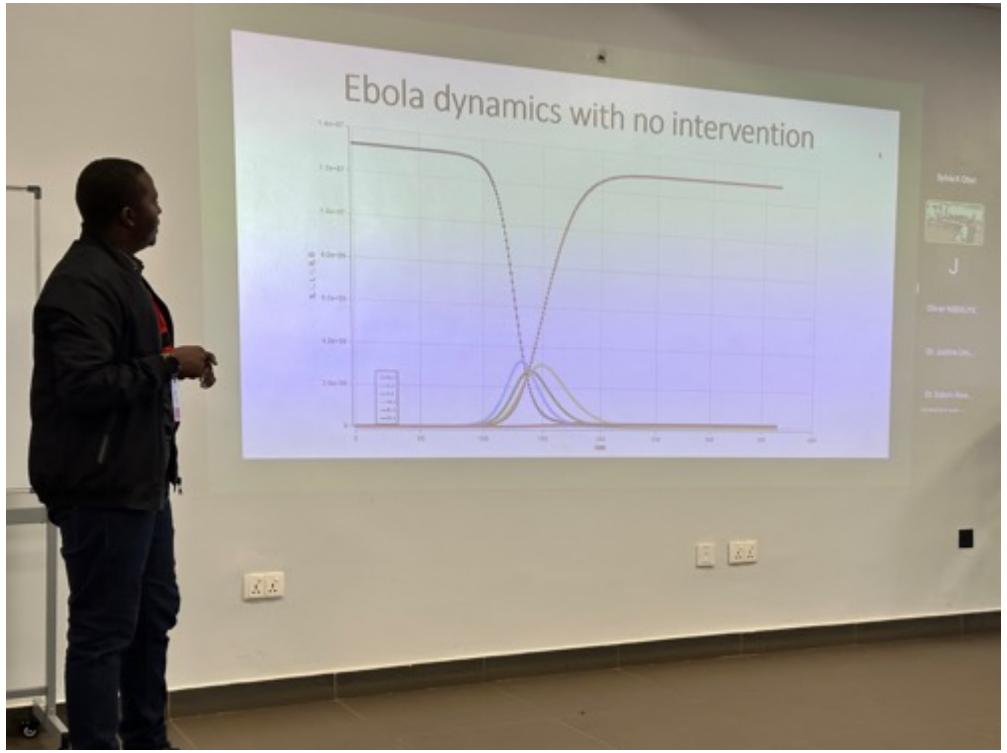
- If you were to invest $50 million in your country's ability to respond to outbreaks, where would you invest along the pathway?
  - Decentralize analytical training
  - Sensitization of decision-makers- RBC visit example.
  - Licensed analytical software
  - Strengthening academic and government collaborative networks
  - Retention of analytic capacity

Highlights: March 13-24, 2023

- **Critique activity**
  - Review a paper on incorporating equity in infectious disease modeling
  - Pilot tested an infectious disease modeling quality assessment form for our scoping review paper
- **Panel**
  - The current trends in the mathematical modeling of infectious diseases in Africa.
  - Four infectious disease modelers in Kenya, Ghana, Nigeria, and the US (CDC).
  - Advice for someone learning about mathematical modeling for the first time
- **Guest lectures**
  - Mathematical modeling capacity in Africa- a case study of a systematic review
  - Addressing heterogeneity and equity in infectious disease modeling

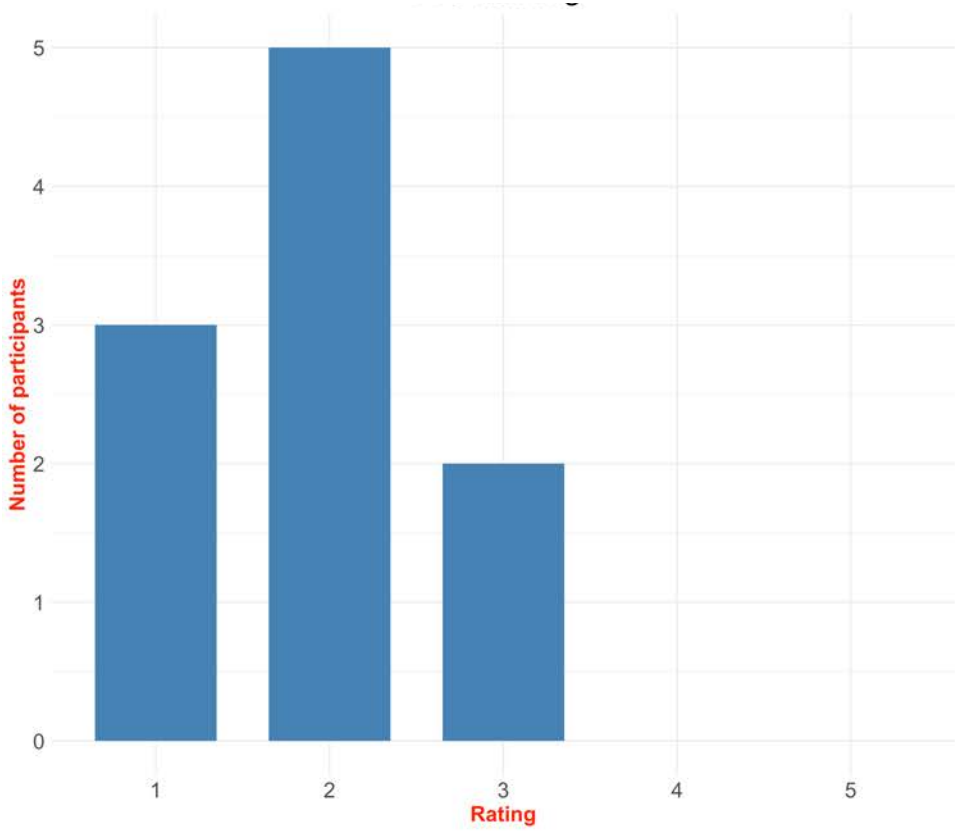
Highlights: March 13-24, 2023

- Berkeley Madona outputs
- Speed presentations
- Zotero citation management tool

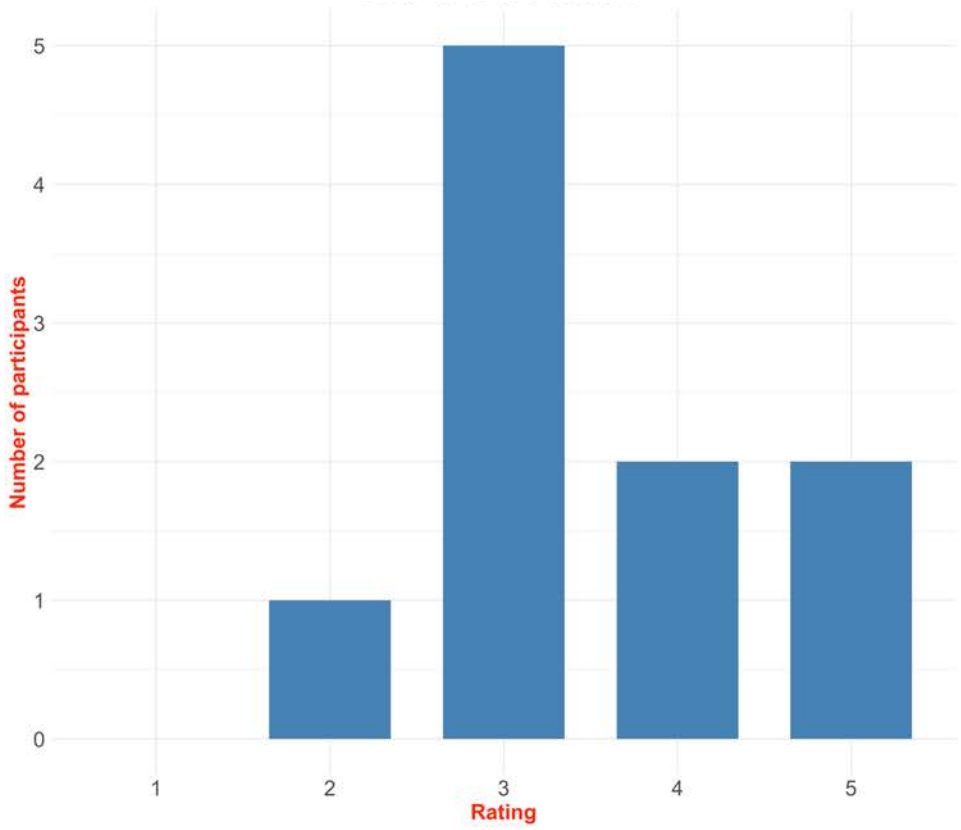


Training evaluations

How would you rate your current understanding of infectious disease modeling?



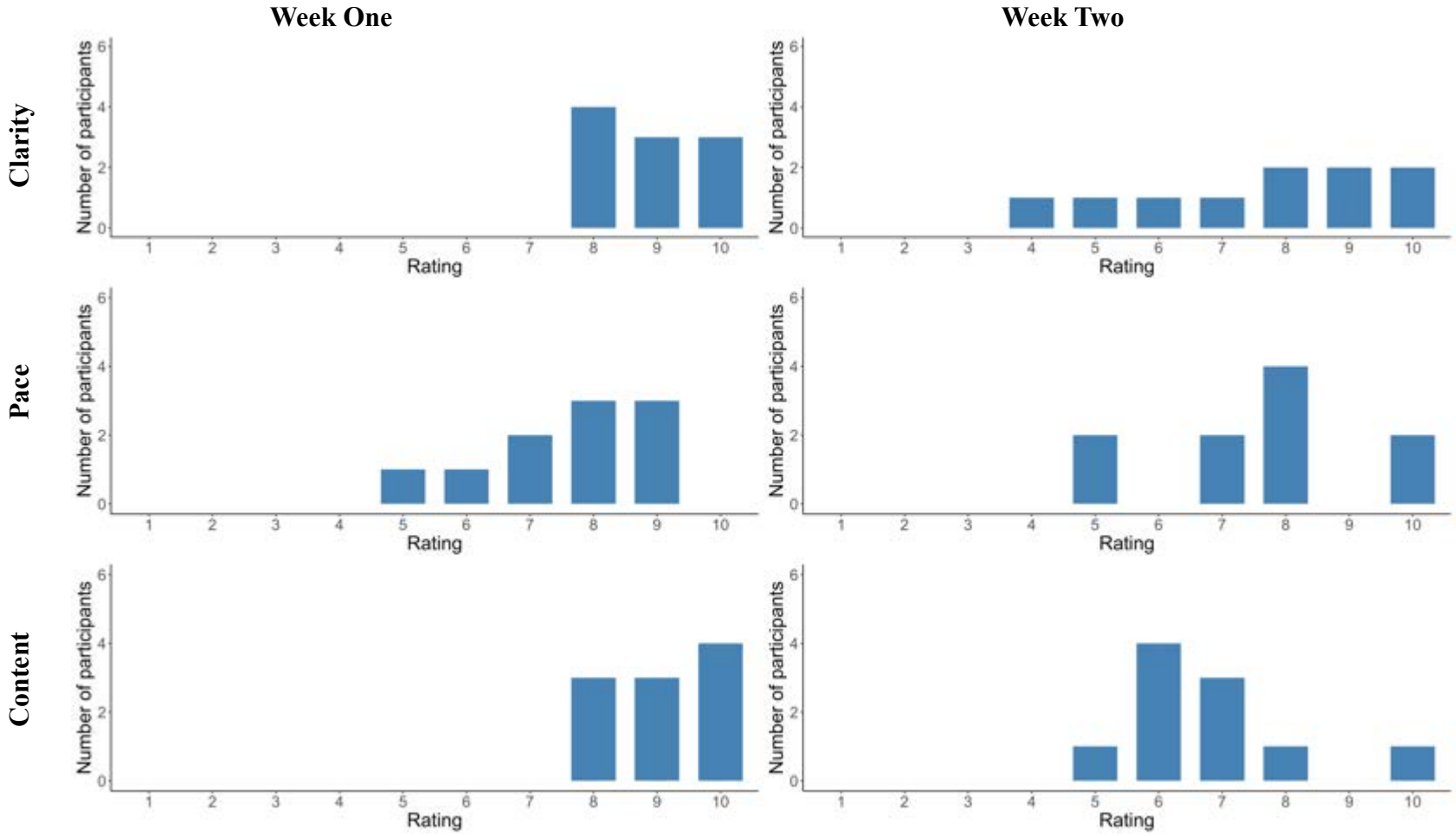
Before the training



At the end of the first session

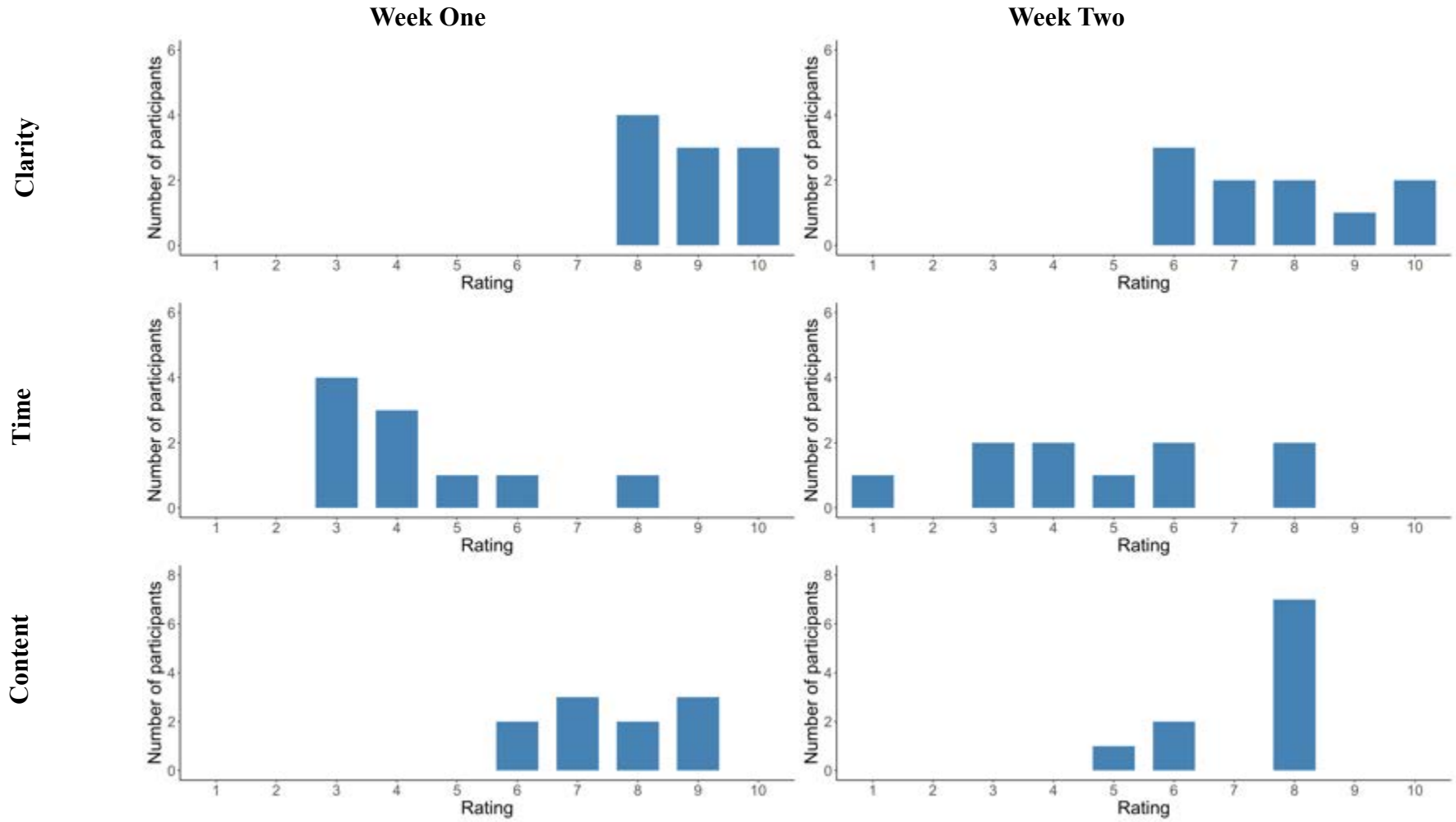
1 = None, 5= Very proficient

Training evaluations- lectures



Clarity: 1= very unclear, 10: very clear; **Pace**: 1= too slow, 10= too fast; **Content**: 1= too basic, 10= very complex

Training evaluations- activities



Clarity: 1= very unclear, 10: very clear; **Time**: 1= too short, 10= too long; **Content**: 1= too basic, 10= very complex

What recommendations do you have to improve the course content and/or structure?

- Allocate more time to class activities and student projects
- Lower the pace at which new concepts are introduced
- Leniency in time management
- Balance the days of doing activities and leave out time slots for self-revision: *those who understand can support others who don't*
- Increase the number of hands-on activities
- More practice in developing model structures using diseases with different natural histories
- Recap concepts from previous days

Next steps

- Second session: July 24- August 4, 2023
- Practicum session
  - Refine and formalize research questions
  - Update the compartmental model with equations and flow diagrams
  - Identify outcomes of interest to be assessed by your model
  - Identify the parameters relevant to your interventions and to be varied in the sensitivity analysis
  - Complete table of parameters including the biological meanings and sources

Our training and logistics team.

Aiban Rono and Joyce Kiarie (Kenya) sketching their compartmental model.

Edson Rwagasore (Rwanda, trainee and advisory committee member) explaining the pressing need for an Ebola model to evaluate containment strategies.

Olivier Nsekuye (Rwanda) presenting his model.

Nadia Hitimana (Rwanda) giving feedback to Moses Kizito (Uganda).

Celebrating Caroline's birthday.

The fun moments

Zumba sessions

Scavenger hunt

The body spellers game

Tea breaks

Quiz

Caroline's birthday

Thank you

- **Training team**
  - Caroline Buckee
  - Emmanuelle Dankwa
  - Bethany Hedt-Gauthier
  - Sylvia Ofori
  - Emmanuel Ngwakongnwi
- **Advising team**
  - Alemayehu Amberbir
  - Abebe Bekele
  - Mary Bushman
  - Flavia Camponovo
  - Yonatan Grad
  - Megan Murray
- **Harvard Logistics team**
  - Laurie Coe
  - Zach Schwartz
  - Abby Campbell Wong
  - Jesse Rezende
- **UGHE hospitality, procurement, and transport teams**
  - Vivian Keza
- **The training advisory committee**