Develop, disseminate and apply transdisciplinary, human-centered systems thinking to health system design and modeling in a North-South collaboration in the Access-To-Medicines field.
Health System (Re-)Design: Human-Centered Systems Thinking & Design Thinking

Access-To-Medicines’ Health System Re-Design Projects

Childhood Immunization Supply Systems Access
- EU, Rwanda, Kenya, Uganda, Madagascar
- Catherine, Kim, Stany, Carla, Leen, David

Multi-protection Yellow Fever/Rabies Climate, Zoonoses
- Kenya
- Catherine, Kim, Stany, Carla, Leen, David

HIV Long Acting Injectable, Vaccine, Resistance
- Kenya, South-Africa, Tanzania, Botswana
- Marika, Catherine, Laurent

Pathogen ‘X’ Lassa, Nipah, MERS, RVF, CHIKV
- W-Africa, SE-Asia, M-East
- Carla, Kim, Marika, Catherine

Covid-19 Antivirals, Vaccine, Allocation, Hesitancy
- Global, EU, Norway, Germany, Belgium
- Carla, Kim, Marika, Robin, Catherine, Lise, Grace, Tarun

Pandemic Preparedness
- Global, EU, Sub Saharan Africa
- Catherine, Charlot, Donovan

Living Models & Tools Dynamics in Context, Data, Agents
- Carla, Kim, Marika, Robin, Catherine, Lise, Grace, Tarun
- Dobran, Catherine

Overarching
- Carla, Kim, Marika, Robin, Catherine, Lise, Grace, Tarun

Access - To Medicines’ Health System Re-Design Projects
- Health System Design Projects

David Kim Laurent Marika Carla Tarun Charlot Robin

Nico
# Access-To-Medicines’ Projects Partners

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<th>Project</th>
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<td>Childhood Immunization</td>
<td>GSK, Bill &amp; Melinda Gates Foundation, HA, KU Leuven</td>
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<td>Yellow Fever/Rabies</td>
<td>rega, KU Leuven</td>
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<td>HIV</td>
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<td>Emerging Infectious Diseases</td>
<td>CEPI</td>
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<td>Covid-19</td>
<td>CEPI, IMI, EFPIA, The Research Council of Norway</td>
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<td>Pandemic Preparedness</td>
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<td>Living Models</td>
<td>Associatie KU Leuven</td>
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and many others …
**Goal:** Increase access to health for families that live > 5 km from the health center by analyzing the needs of the different stakeholders involved in outreach services and the sustainability and resilience requirements of the close-to-community health system.

**Problem**

Outreach services in Uganda are in high need but under pressure for sustainability. Moreover, as they are largely organized based on ‘vertical’ (one disease) services, there is potential for integrated services.

**Method**

- Stakeholder analysis
- Outreach system map
- Key performance indicators
- Case study of business model that focuses on community fees, motorcycles micro-financing and integrated services

**Insights**

- Local mobilization within the community is a crucial last link in outreach effectiveness
- Lack of correct medicine availability and related governance problems reduce trust
- Implementing user-fees asks for large buy-in of local government AND community
**Goal:** Increase and maintain immunization coverage in a health center’s catchment area by supporting community health workers to anticipate caregivers’ specific needs and by collecting and coordinating those needs across the catchment area.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Method</th>
<th>Solution</th>
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<tbody>
<tr>
<td>Community health workers are a crucial link between the community and health system but are overworked and often lack supportive supervision. This limits their abilities to engage with households.</td>
<td>User-centered design</td>
<td><strong>PERSO-CARD</strong> to support community health workers in conversation with the households aiming at solving caregiver-specific needs in accessing health center</td>
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<td>Field research to capture needs of caregivers &amp; community health workers</td>
<td><strong>PERSO-MAP</strong> tool to coordinate and prioritize needs and foster group learning</td>
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Figure 1. Training of community health workers in Tanzania
**Goal:** To use vaccine supply chain models to get better insights on the throughput of vaccines and enable identification of the manufacturing and network related decisions that affect the volume and timing of the throughput.

**Problem**

Even basic manufacturing steps necessary to produce vaccines are complex and experience process variability. This makes it difficult to predict the timing and volume of vaccine throughput in global supply chain networks.

**Method**

- Discrete-event simulation model
- Scenario simulation
- Industry expert co-creation

**Application**

- **COVID-19 vaccine COVAX** manufacturing network: based on key suppliers network: can the commitments be reached? *(Working paper)*
- **Global stockpiling model** for high priority WHO pathogens (e.g., LASSA, MERS) *(Working paper)*
Goal: Proactively address COVID-19 related vaccine hesitancy in Flanders by bridging the gap between public concerns and public health stakeholders through online and offline social listening.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Method</th>
<th>Results</th>
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<tr>
<td>Vaccine hesitancy is not limited to anti-vaccination sentiments but extends to a broad range of personal, socio-economic, political and cultural concerns.</td>
<td>Hybrid social listening</td>
<td>The root causes for vaccine hesitancy in Flanders include but are not restricted to: (i) lack of social belonging; (ii) impact of pandemic-related disruptions on personal/community life; (iii) misalignment between personal values and the vaccine; (iv) access barriers; (v) concerns regarding vaccine safety and efficacy; (vi) influence of social circle.</td>
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<tr>
<td>Lack of understanding of the root causes of vaccine hesitancy inhibits adapted interventions and building long-term trust with the public.</td>
<td>Group discussion on specific sub-themes</td>
<td>Need for building long-term trust in vaccines through lasting local relationships between the public and intermediary stakeholders.</td>
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<tr>
<td></td>
<td>Stakeholder analysis</td>
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HIV long-acting injectable

**Goal:** To use a model of the health care system to support strategic decision making related to the set up of the supply chain for a new HIV treatment. The new treatment is a long-acting injectable that requires cold chain, making it a challenge to set up a supply chain in high-risk settings.

**Problem:**
There are many decisions to be made related to the set up of the supply chain as well as environmental conditions to account for. It is necessary to understand the implication of decisions and external events on the supply chain’s ability to deliver.

**Method:**
- Discrete-event simulation
- Scenario simulation
- Stakeholder discussions

**Application:**
Support strategic decision making related to the set up of a resilient distribution network at launch by simulating relevant scenarios and discussing the results.
Goal: Improve and support vaccine development by connecting the "last-mile" to early vaccine R&D decisions. Evaluate the potential health impact of a more accessible combination vaccine for LMICs as an alternative to the current yellow fever and rabies vaccines.

Problem

Yellow fever and neglected tropical diseases (NTDs), such as rabies, are not sufficiently and equitably prevented with vaccines or other disease-control strategies. Factors that impede the effectiveness of the current strategies are:

- Limited vaccine supply capability for yellow fever vaccines
- The lack of a human preventive vaccine for rabies

Method

User-centered design
- Field research
- Stakeholder interviews
- KPI identification

System Dynamics (SD)
- Conceptual systems map
- Group model building workshops
- SD modeling
- Scenario simulation

Aims

An integrated immunization system analysis of the target population health impact.

Scientific decision framework for the development of vaccines against NTDs from an implementation research perspective.

Impact of innovative vaccines guided by simulation models.

Figure 1. The immunization system, its subsystems, and the impact of R&D decisions.
**Goal**: Show and explain added value of integrated and differentiated models of HIV and TB care introduced by MSF in Eshowe (KwaZulu-Natal, South Africa)

**Problem**

- People living with HIV and TB
  - More likely to become sick with TB
  - Complicated treatment (drug interaction)

**Similarities TB and HIV**

- Stigma
- Need for discretion
- Daily medication
- Chronic disease

**Need for integrated HIV and TB care**

**Need for personalized care** based on age, gender, context

**Method**

- Conceptual model
- System map
- Based on MSF programs in Eshowe
- Field visits
- Stakeholder analysis

**Application**

- Showing value of integrated and personalized care
- Sustainability of programs: support anchoring in national programs

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**Figure 1.** Estimated HIV prevalence in new and relapse TB cases, 2019 (Global Tuberculosis report 2020)

**Figure 2.** Simplified representation of system map
CARE
Corona Accelerated Research & Development in Europe

**Goal:** To capture the impact of the antiviral drugs developed by the CARE consortium on patient health. To gain insights from the development process to improve drug development in future consortiums.

**Problem**

No small molecule antiviral drug is currently fully approved for the treatment of the novel coronavirus. The CARE consortium is developing antiviral drugs for the treatment of covid-19. Our research aims to help the drug developers in CARE to understand the impact of their R&D decisions.

**Method**

- **Stakeholder Analysis:** Interviews, Group model building workshops and model validation workshops.
- **Systems Dynamics:** Conceptual system maps, scenario simulation and system dynamics modelling.

**Application/Insights**

Some insights our research focuses on are:
- The impact of the size of the consortium
- How decisions are made in the consortium
- Impact of funding on R&D decisions
- Impact of drugs developed on health outcomes
CONTRA

Goal: Contribute to the effectiveness, efficiency, equity, and sustainability of the COVID-19 response. Developing a decision support system (DSS) for pandemic responders.

Problem

- Hard to make effective, efficient, sustainable, and fair decisions with regards to vaccine allocation under pandemic pressure
- Lots of uncertainties (deliveries, new safety data..)

Method

- System map
- Actors map
- User-centered design
- Stakeholder analysis

Application/Insights

- Decision support system for central vaccine allocation problem
- Constraints shifted from lack in supply to vaccine hesitancy
- Learnings from Norway can be useful for LMIC (emergency response, hard-to-reach areas, widespread settlements)

Norway

Norwegian Research Council
**Immunization systems diagram:**

6 loops, 3 flows, 2 paradigms

**Goal:** Improve systems view of all stakeholders involved in immunization programs (planned and emergency) to increase immunization performance, resilience, and sustainability in LMICs.

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**Problem**

Vaccine supply alone is not sufficient to guarantee **vaccine uptake** and disease prevention.

The **complexity** of the immunization system is not fully known to stakeholders to address mechanisms behind (sub)national **under-immunization**.

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**Method**

Stakeholders’ mental model elicitation from interviews and **group model building** workshops.

Construction of systems diagram using **Systems Thinking**

Validation based on data from local settings.

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**Application/Insights**

**Understand** complexity of national-level health system and human behavior in vaccine delivery and uptake.

**Assessment** of local immunization system performance and sustainability.

Intervention and system **design** for improved health outcomes.
Assessing Vaccines Supply Chain System design in the EAC Region. Challenges and Opportunities. Case Study: Kenya and Rwanda.

**Goal:** Assess the current iSC System design, link it with vaccination coverage and health outcomes for Kenya and Rwanda and propose suitable models to increase access and effective use of vaccines.

**Problem**

- Data visibility (coverage and wastage rates, dropout rates, etc).
- Policy and Strategies (Sustainability beyond GAVI Graduation),
- Infrastructure related issues (CCEs Status and Maintenance, etc) and,
- HR and capacity of people managing vaccines at the last mile settings

**Method**

* Field visits to the last-mile facilities to learn/observe practical challenges and opportunities
  - Local Stakeholder engagement
  - Interviews with vaccinators, mothers and iSC Managers.

**Aims**

- Assess the effectiveness of the iSC systems and its impact on Programme’s performance
- Identify key areas of strength and weaknesses in the last mile SC,
- Build future scenarios for effective vaccines SC management in Kenya and Rwanda (Country Profile and Redesign distribution models,)

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**Last Mile Vaccines SC Challenges for Kenya & Rwanda**

**Trends in Vaccination Coverage per residence**

- **Urban, Coverage rate (DHS 2014), 83.51%**
- **Rural, Coverage rate (DHS 2008/2009), 76.35%**

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**Kenya, Rwanda**

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**gsk**
Vaccine supply chains in resource-limited settings: the impact of rainy season disruptions

Goal: Assess and mitigate the role of rainy season induced supply chain disruptions on vaccination coverage and inequalities.

Problem

During the rainy season, several facilities are cut off from the road network and therefore not supplied with vaccines.

What is the role of rainy season induced supply chain disruptions on vaccination coverage and inequality to vaccine access?

Method

Discrete-event simulation
Spatial modeling
Case study: Madagascar

Insights

Two intertwined drivers of low vaccination coverage and inequality within the Malagasy vaccine supply chain exist:

- Rainy season disruptions
- Operational inefficiencies: storage and transportation capacity

Jointly increasing the replenishment frequency and implementing a rainy season inventory buffer (using currently available resources) can improve vaccination coverage and equality in vaccine access.

The impact of climate change through increased flooding is substantial.
Goal: Offer model-based support to local and subnational stakeholders for tailored immunization strategies and service delivery solutions

Problem
Subnational under-immunization of measles triggering local outbreaks.

Vaccination strategies to improve local service delivery are difficult to design based on data only.

Method
Bottom-up primary data collection and systems modeling.

Revealing causes of historic local under-immunization and outbreaks based on field research and system dynamics simulation modeling.

Application/Insights
Sustainable and effective interventions for timely immunization depend on local service delivery (supply-side) and local vaccine hesitancy (demand-side).

Community health workers’ capacity, focused campaigns based on coverage data, and accessibility to vaccination services are key.

Figure 1. System dynamics simulation model dashboard showing vaccine stock levels at the health center, vaccine hesitancy levels for different measles vaccine doses, susceptible children and vaccine coverage levels

Figure 2. National measles–rubella campaign during mother and child health week (photo: www.afro.who.int)
Vacs-to-the-Future: Manufacturing in Africa

**Goal:** Develop conceptual, analytical and decision-support tools to support the design and operationalization of local vaccine manufacturing networks in Africa, both for routine immunization and pandemic use.

**Problem**
Historically, Africa has been highly dependent on vaccine imports: producing ~1% of its doses despite consuming ~25% of the global supply (GAVI, 2021).

During COVID-19, mechanisms aimed at promoting fair and equitable distribution of vaccines have **partially failed**.

Sustaining local, large-scale vaccine production & supply is a complex endeavour.

**Method**
Stakeholder analysis, interviews, field work

Compare manufacturing platforms and innovations in the supply chain

**Aims**
Understand market dynamics and vaccine needs to meet public health priorities

Identify bottlenecks and levers across regional immunization systems

Inform investments in different manufacturing technologies and design of vaccine networks
Anticipate, prevent, prepare and respond to future pandemics

**Goal:** Design integrated decision-support tools across systems (e.g., operations, financing, governance, R&D, public engagement, immunization) to more equitably and effectively anticipate, prevent, prepare for, and respond to future pandemics.

**Problem**

The COVID-19 pandemic shows that

1. losses are catastrophic *(GDP drop in 2020, Fig. 1)*

2. preparedness efforts are inadequate *(Fig. 2)*

Moreover, the frequency and severity of zoonotic spillover events is increasing, especially in regions with the lowest capacity to address infectious outbreaks *(Fig 3.).*

**Method**

**Engage** stakeholders
- Stakeholder mapping
- Key informant interviews

**Analyze** complex systems
- Conceptual framework
- Systems modeling
- Scenario planning
- Simulations

**Design** decision-support tools
- User-centered design

**Aims**

**Identify** socio-political and biologic risks

**Examine** the subsystems of pandemic preparedness e.g. surveillance, production, ...

**Understand** the complex dynamics of pandemic preparedness, using lessons from COVID-19

**Develop** tools for global cooperation and coordination
A Living Supply System Design

Goal: Developing a web-based decision support tool for the modeling of a vaccine supply system.

Problem
The global vaccine supply chain is a complex system. Trying to understand it is key to make better decisions about it.

One example is the COVAX program, where not one, but multiple supply systems have to be modelled with a changing set of actors.

Method

Engage stakeholders
- Stakeholder mapping
- Interviews

Analyze complex systems
- Systems models
- Scenario planning
- Simulations

Aims

Develop a ‘living system’, that updates with new information and insights about the system.

Support decision makers to understand the complexity of the system and which characteristics could have a major impact on the supply chain of vaccines.

Develop a tool that makes the complexity of the system manageable.
Access-To-Medicines Research Center

Develop, disseminate and apply transdisciplinary, human-centered systems thinking to health system design and modeling in a North-South collaboration in the Access-To-Medicines field.

LOGISTICS CLUSTER GLOBAL MEETING
October 2021

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