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SWISS SCHOOL OF PUBLIC HEALTH

THIS IS PUBLIC HEALTH

Swiss TPH
Swiss Tropical and Public Health Institute
Schweizerisches Tropen- und Public Health-Institut
Institut Tropical et de Santé Publique Suisse
Associated Institute of the University of Basel

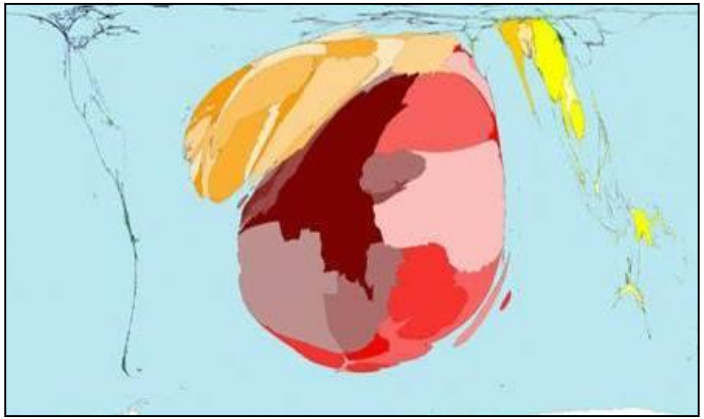
ETH zürich

Applying public health science in the quest for malaria elimination

Manuel Hetzel & Christian Lengeler
Swiss Tropical and Public Health Institute

www.worldmapper.org

Malaria cases



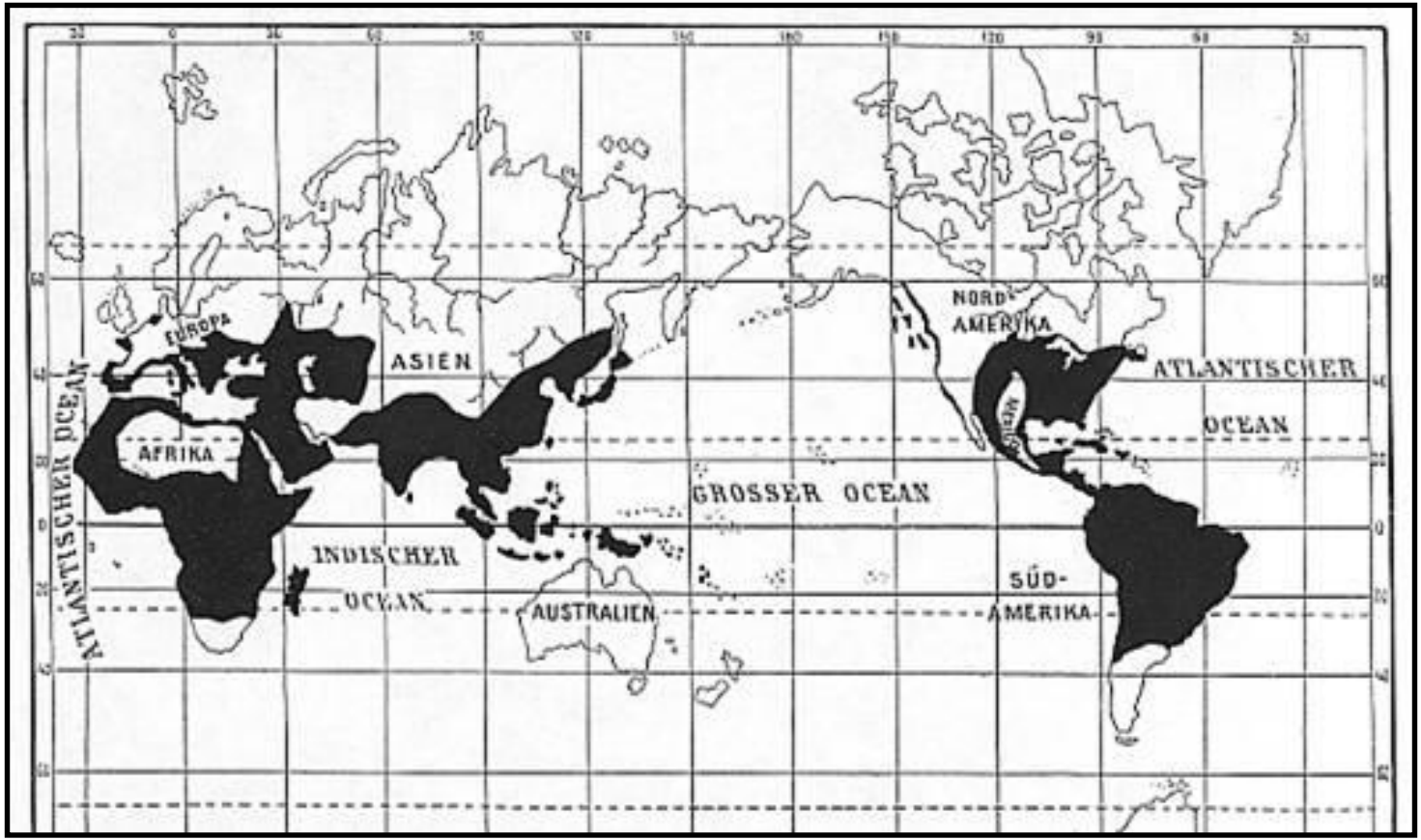
Malaria deaths

In 2019

- ✓ **229 million cases per year (vs ca 500 million in 2000)**
- ✓ **409,000 deaths, mainly African children (vs >1 million in 2000)**
- ✓ **1 Billion individuals living in areas at risk of malaria**

WHO - World Malaria Report 2020

Malaria in the World around 1900 (Celli 1913)



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Malaria was transmitted in Switzerland before 1896

Seeland ca.
1880 und 2021

Grenzacher
Fluh / Basel ca.
1750 und 2021

Swiss TPH

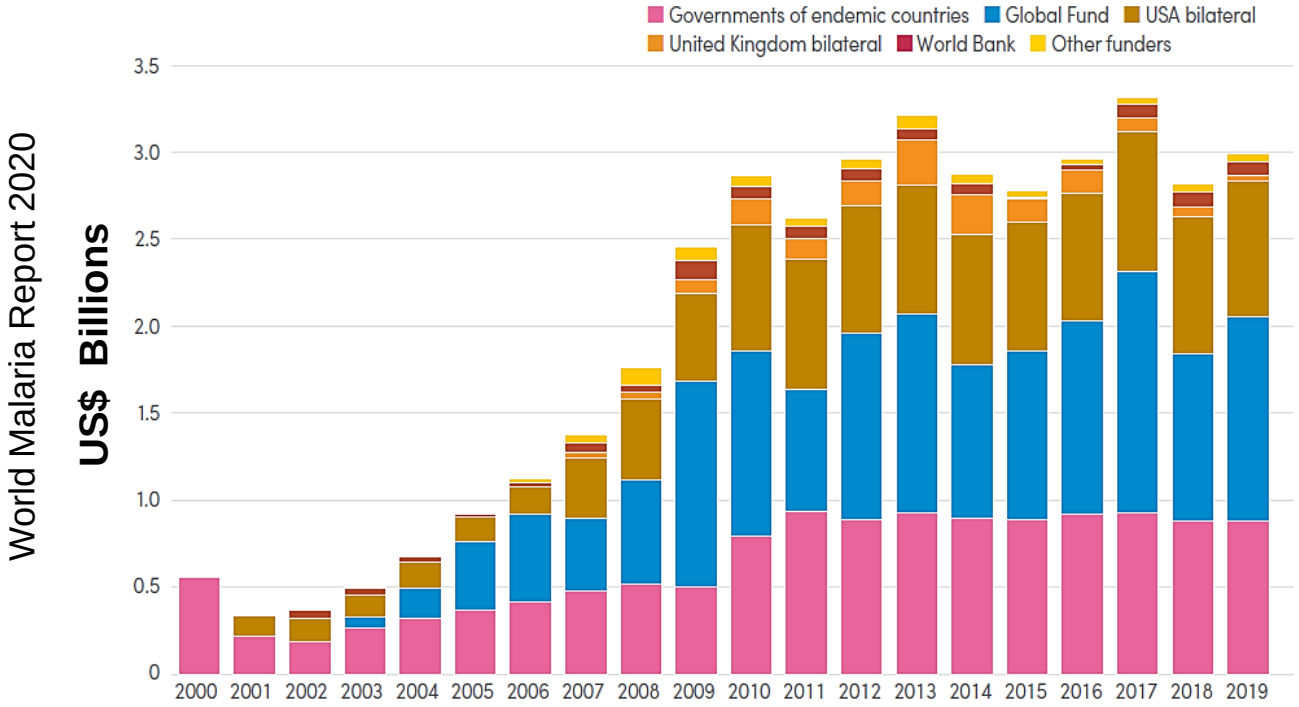
Malaria, as many other similar diseases, ist not a "Tropical Disease".

It is a disease of **poverty**, which nowadays has a strong concentration in tropical areas.

Other examples are:

- Comon worms (*Ascaris sp., Hookworms, Schistosoma sp.,* etc.)
- Cholera
- Tuberculosis
- Typhus
- Amoebas
- Etc.

Funding for malaria control 2000 – 2019: 6x increase



Global Fund: Global Fund to Fight AIDS, Tuberculosis and Malaria; NMP: national malaria programme; OECD: Organisation for Economic Co-operation and Development; United Kingdom: United Kingdom of Great Britain and Northern Ireland; USA: United States of America; WHO: World Health Organization.

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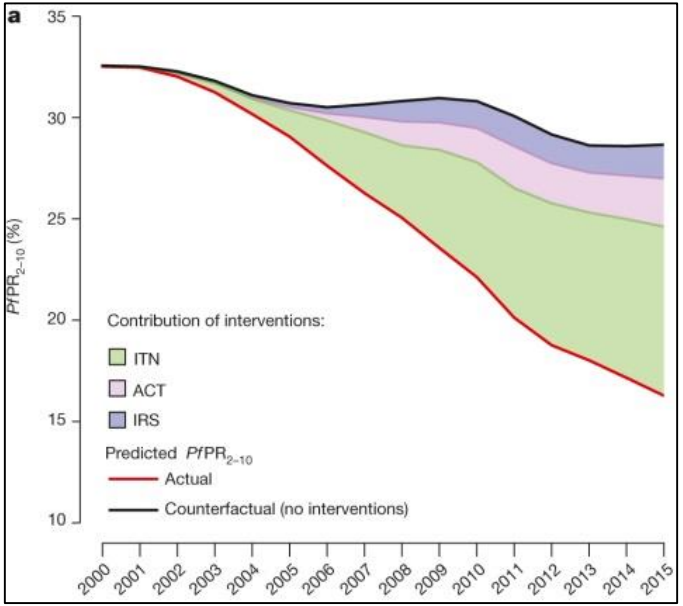
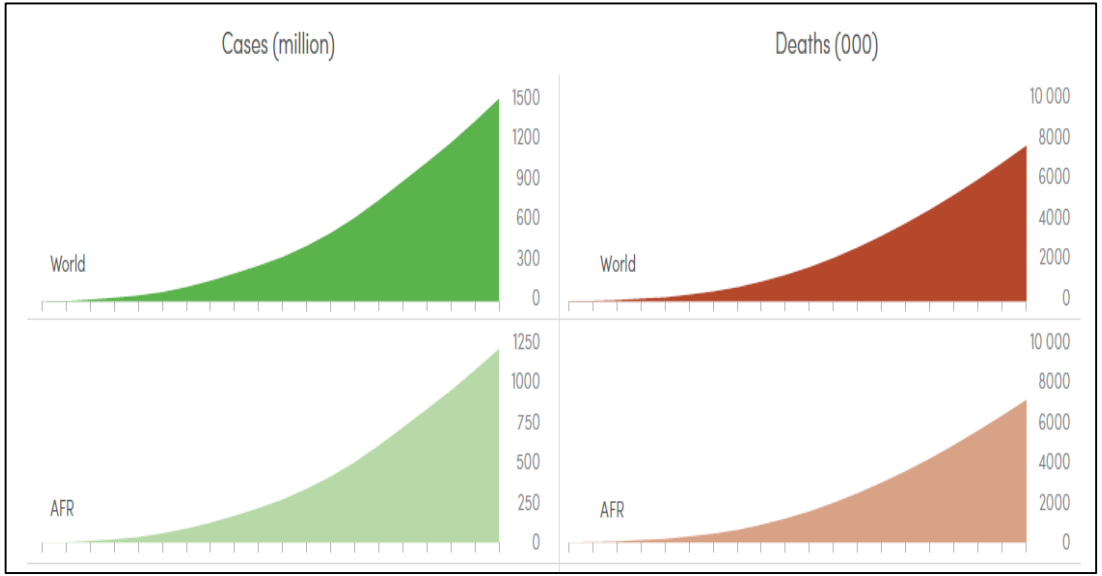
Trends in infections and deaths 2000 – to-date



Average infection rates in children 2-10 years

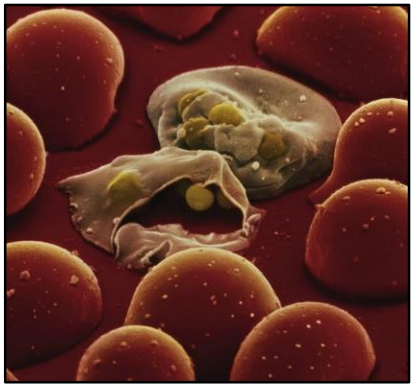
Bhatt *et al.* 2015 Nature



Cumulative number of cases and deaths averted globally, 2000-2019

WHO: World Malaria Report 2020

The malaria life cycle



Parasite

Plasmodium falciparum,
P. vivax, P. ovale,
P. malariae, P. knowlesi

Mosquito (vector)

Night-biting
Anopheles spp.

Human (host)

Photo credit: National Geographic

The malaria life cycle

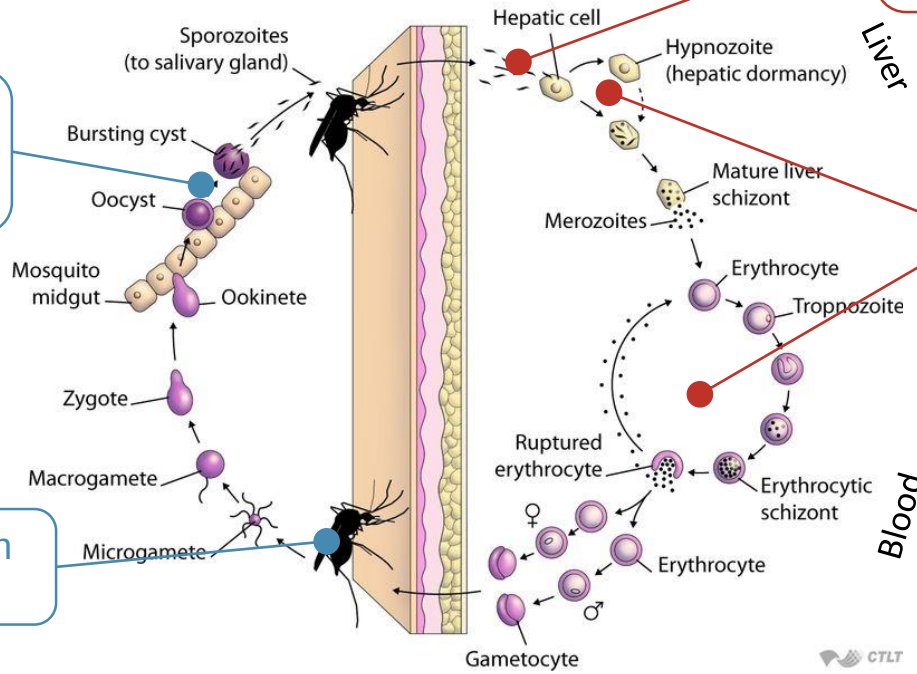
Cycle in mosquito

Cycle in human

3. Human infected during bite of infectious *Anopheles* moqsquito

2. *Plasmodium* parasites multiply in mosquito

4. *Plasmodium* parasites multiply first in liver, then in red blood cells



1. Mosquito infected with *Plasmodium* parasite

Malaria control: prevention & treatment
(Simplified)

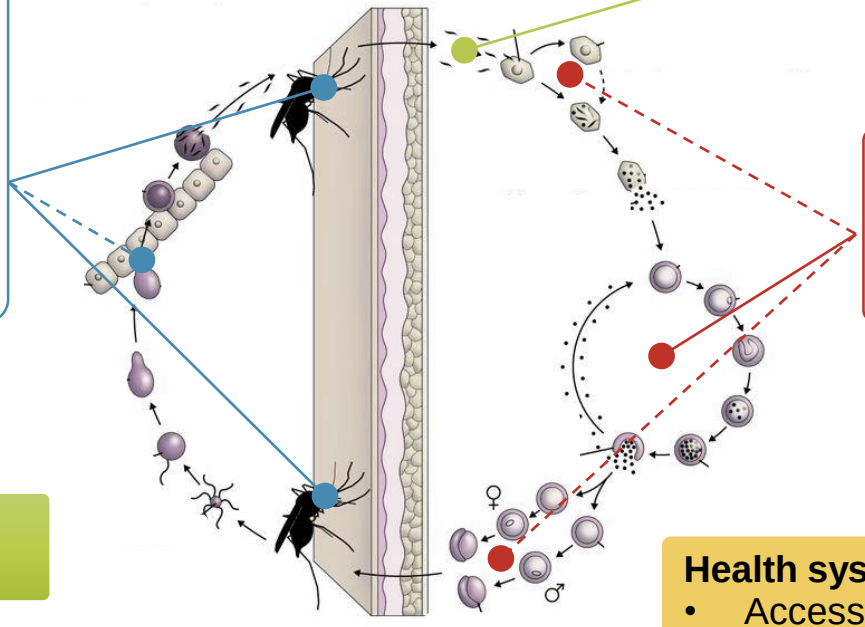
Human genetic resistance

Cycle in mosquito

Cycle in human

Vaccine (RTS,S)

Vector control
- Mosquito nets
- Insecticide spraying
- Repellents
- Environmental management
- Genetically modified mosquitoes



Drugs in humans
- Treatment of infection
- Chemoprophylaxis
- Chemoprevention

- Education
- Behaviour change

Health systems
- Access to diagnosis & treatment
- Surveillance-response

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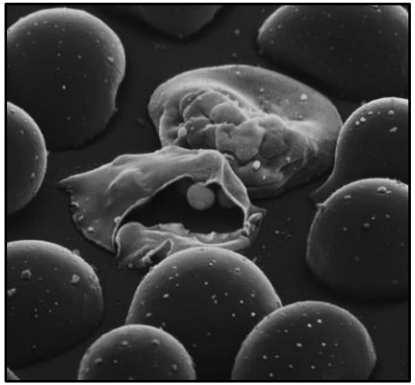
Challenges to malaria control & elimination



- Drug resistance
- *P. vivax* hypnozoites
- Diagnostic sensitivity

- Insecticide resistance
- Biting behaviour (plasticity)

- Human behaviour
- Diagnostic sensitivity
- Socio-economic situation

- Health system & policies
- Infrastructure & access
- Quality of care
- Health data

Photo credit: National Geographic

From research to implementation: vector control in Tanzania

KINET project 1996-2000

15 Publications
5 PhDs

ARTICLES

Effect of large-scale social marketing of insecticide-treated nets on child survival in rural Tanzania

Joanna R M Armstrong Schellenberg, Salim Abdulla, Rose Nathan, Oscar Mukasa, Tanya J Marchant, Nassor Kikumbih, Adiel K Mushi, Haji Mponda, Happiness Minja, Hassan Mshinda, Marcel Tanner, Christian Lengeler

Summary

Background Insecticide-treated nets have proven efficacy as a malaria-control tool in Africa. However, the transition from

Introduction

Malaria remains the greatest threat to survival for young African children, causing at least 750 000 deaths each year.[1] In endemic areas, people of all ages have regular

Tropical Medicine and International Health

VOLUME 7 NO 2 PP 149–158 FEBRUARY 2002

© International Epidemiological Association 2002 Printed in Great Britain *International Journal of Epidemiology* 2002;**31**:175–180

Usefulness of a dispensary-based case-control study for assessing morbidity impact of a treated net programme

S Abdulla,[a] JRM Armstrong Schellenberg,[a,b] O Mukasa[a] and C Lengeler[b]

Tropical Medicine and International Health

VOLUME 6 NO 8 PP 614–623 AUGUST 2001

Introducing insecticide-treated nets in the Kilombero Valley, Tanzania: the relevance of local knowledge and practice for an Information, Education and Communication (IEC) campaign

Happiness Minja[1], Joanna A. Schellenberg[1,2], Oscar Mukasa[1], Rose Nathan[1], Salim Abdulla[1], Hadji Mponda[1], Marcel Tanner[2], Christian Lengeler[2] and Brigit Obrist[2,3]

1 *Ifakara Health Research and Development Centre, Ifakara, Tanzania*
2 *Swiss Tropical Institute, Basel, Switzerland*
3 *Institute of Anthropology, University of Basel, Basel, Switzerland*

On the KINET evidence base, a *National Strategic Plan* was produced in August 2000 and discussed among all stakeholders. This plan was approved by the MoH as the national policy in December 2000, creating the national ITN initiative (NATNETS).

NATNETS consist(ed)s of four main components:

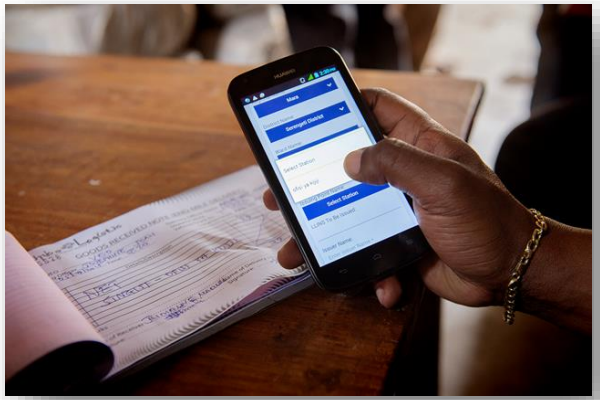
1. An ITN coordination cell within the NMCP - Supported by the Swiss Agency for Development and Cooperation & Swiss TPH — **2002-present**

2. A strategic social marketing programme to support the commercial ITN sector - SMARTNET (DfID/RNE, implemented by Population Services International) — **2002 - 2007**

3. A subsidy scheme targeting pregnant women and infants with vouchers (price reduction around $ 4.50) — **2004-2014**

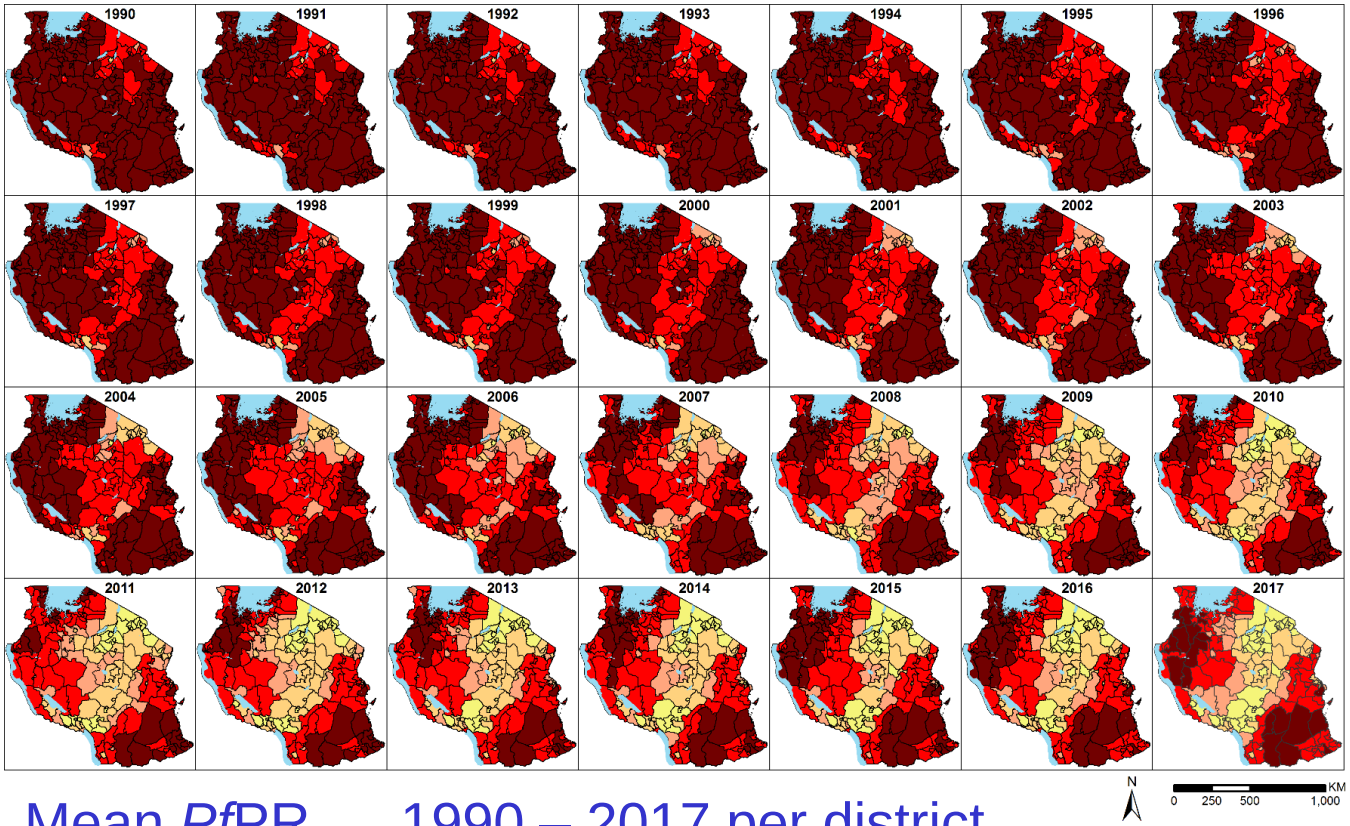
4. Mass distribution of free nets to all U5 and to the rest of the population — **2009 -2011**
2015-2016
2020-2021

To-date, nearly 100 million treated nets have been distributed in Tanzania (2.5 billion globally)



Health impact...

NMCP TZ/KEMRI



Mean *Pf*PR$_{2-10}$ 1990 – 2017 per district

Mean *Pf*PR$_{2-10}$

- <1%
- 1 - 4%
- 5 - 9%
- 10 - 29%
- >=30%

Improvement of 43% (from 100 to 57 per 1000) in U5 mortality; 70,000 less deaths per year

From research to implementation: case management

Drug resistance

- Parasites have become resistant to many “traditional” antimalarial drugs (e.g. chrolorquine, sulfadoxine-pyrimethamine)
- Artemisinin-based combination therapies are currently the most efficacious treatment (e.g. artemether-lumefantrine)

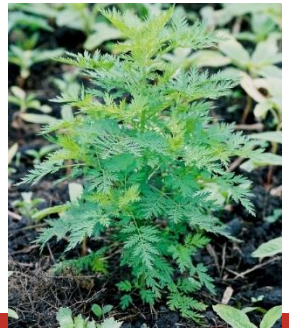
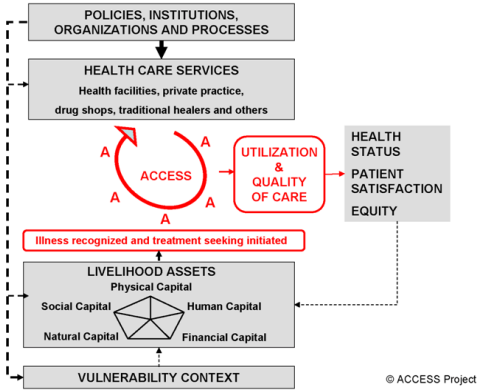


Photo: Scamperdale on Flickr

Access



- Availability
- Accessibility
- Acceptability
- Affordability
- Adequacy

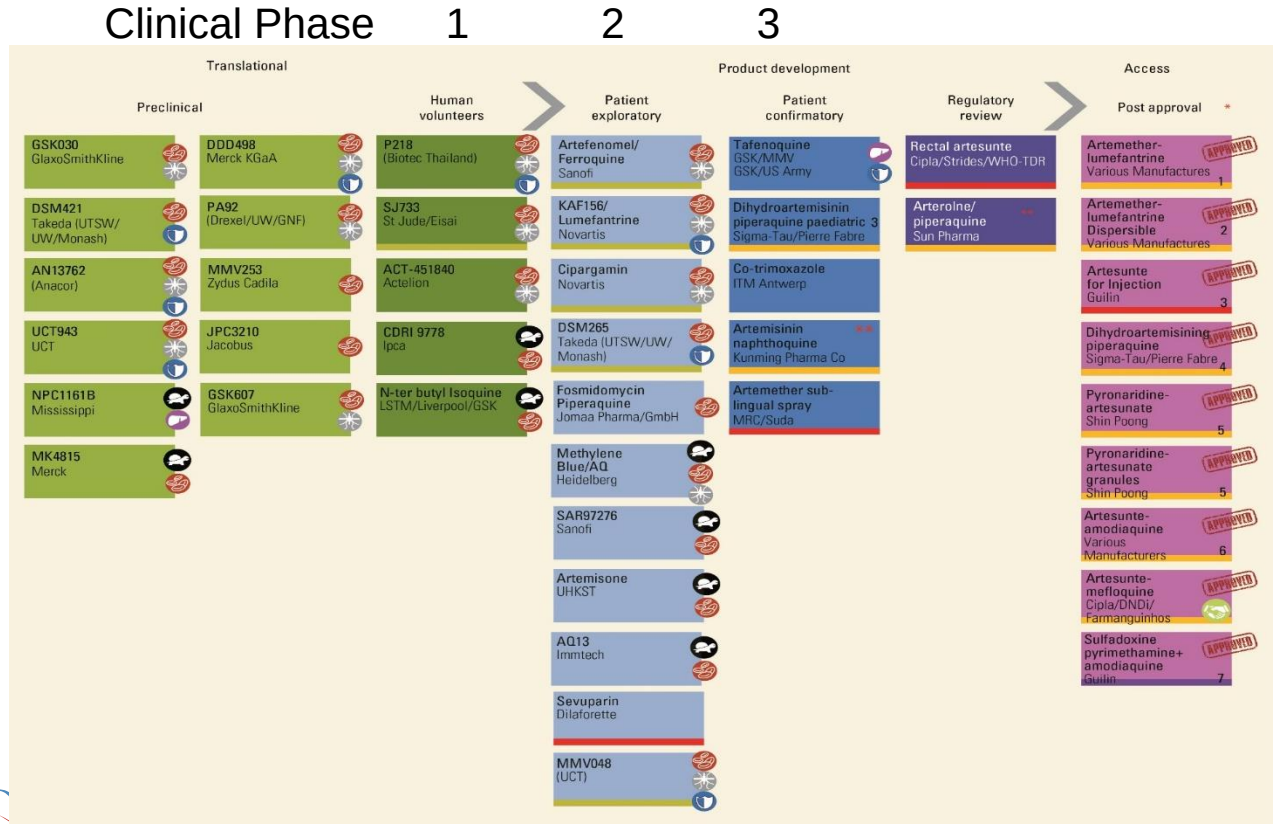
Obrist *et al.* PLoS Medicine 2007

Fake drugs

- 1 in 10 medicines administered in low- and middle-income countries are thought to be substandard or falsified.

https://fightthefakes.org/

Resolving the lack of incentives for investing in new antimalarials: Product Development Partnerships (PDPs)



MMV Medicines for Malaria Venture

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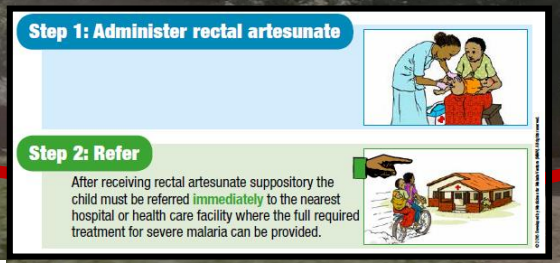
Remote rural environment, high malaria transmission

Children < 5 years with severe fever

Community health worker

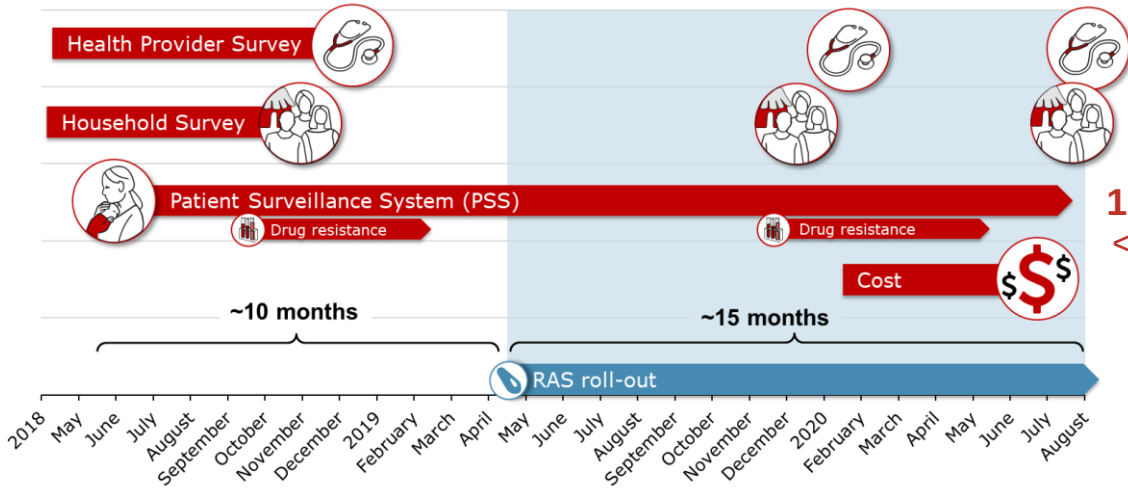


Pre-referral rectal artesunate and referral

Referral health facility, treatment of severe malaria

From research to implementation: case management

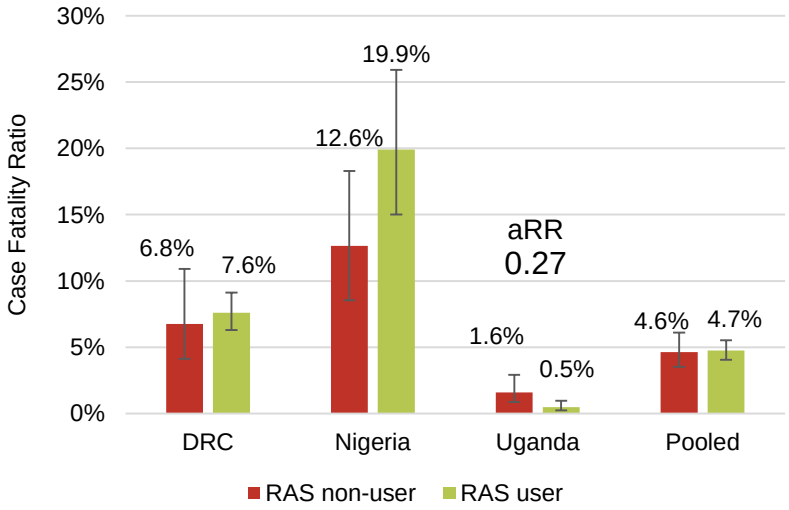
Observational research to measure effectiveness of rectal artesunate
in DR Congo, Nigeria, Uganda (CARAMAL Project)



12,000 children
<5 years of age

From research to implementation: case management

Can rectal artesunate reduce case fatality “in the real world”?



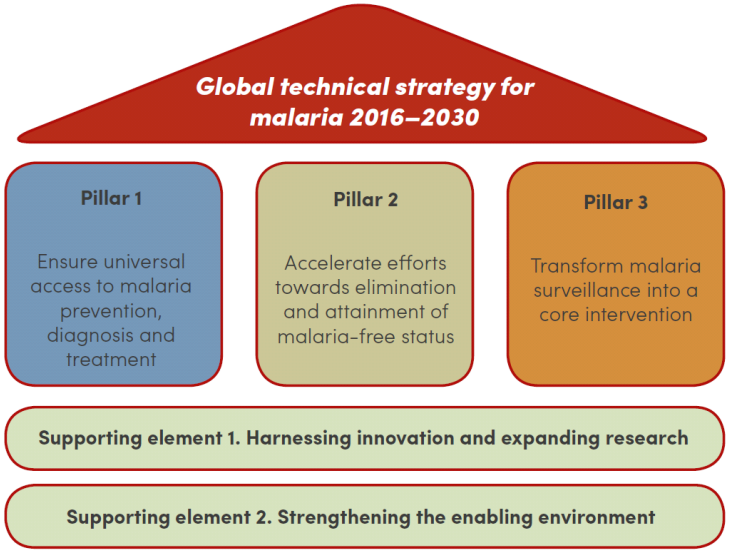
CARAMAL Scientific Report, April 2021

Rectal artesunate is just one ‘piece in the puzzle’:

- Children >3 years often received only 1 instead of 2 rectal capsules
- Children treated with rectal artesunate are less likely to go to a hospital
- Children referred to a hospital are usually treated with injectable artesunate but often do not receive a full course of oral artemisinin combination therapy
- 13% of children were sick 28 days after initial treatment
- RAS had no effect in Nigeria, where case fatality was highest

From research to implementation: surveillance-response

Malaria control & elimination activities must be based on data



"…transformation of malaria surveillance into a core intervention in all malaria-endemic countries and in those countries that have eliminated malaria but remain susceptible to re-establishment of transmission."

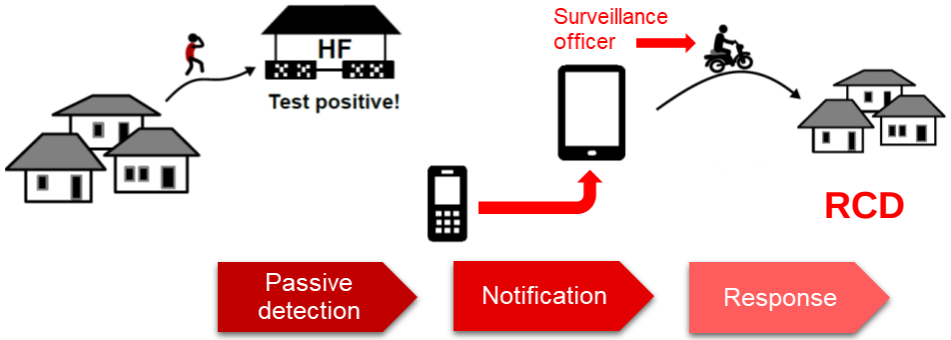
- **Passive case detection**
- Active case detection
- **Reactive case detection**

WHO 2018

From research to implementation: surveillance-response

Re-active case detection (RCD) of malaria in Zanzibar (Tanzania)

Find and eliminate undetected infections in the community

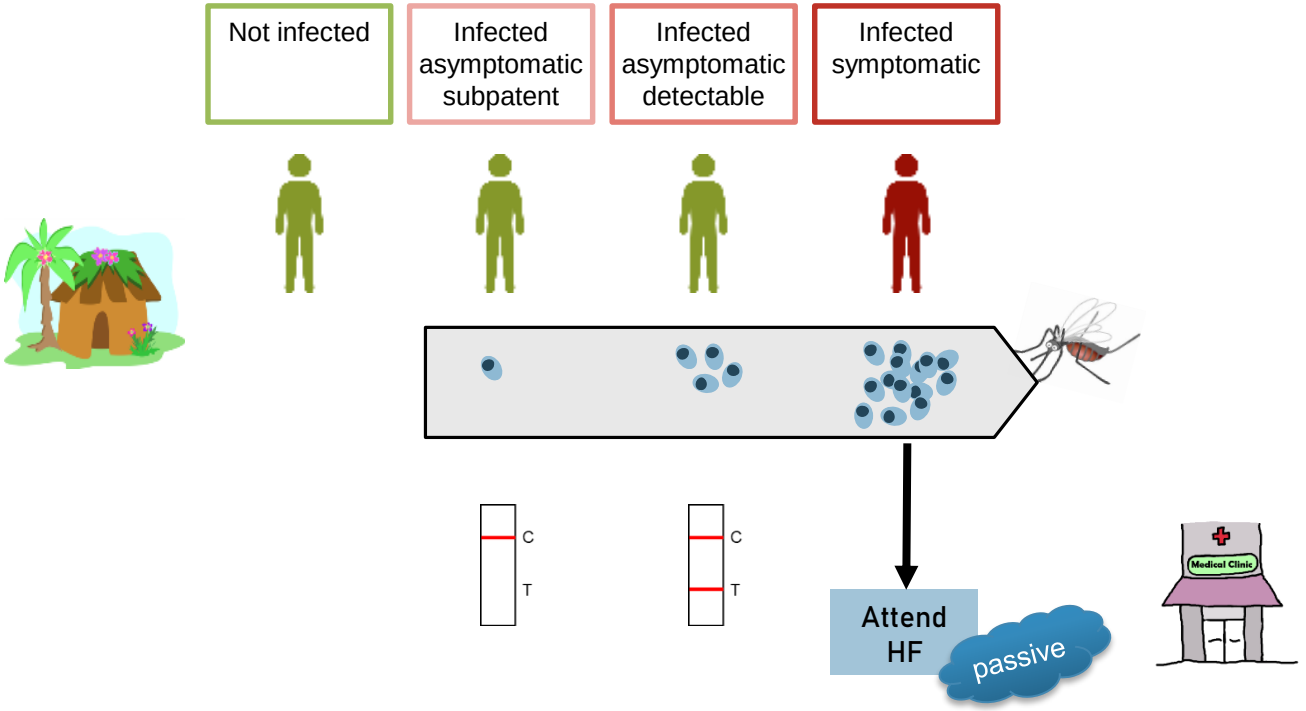


System effectiveness of RCD depends on:

- Treatment seeking
- Notification
- Follow-up
- Diagnostic sensitivity
- Treatment adherence
- Drug efficacy

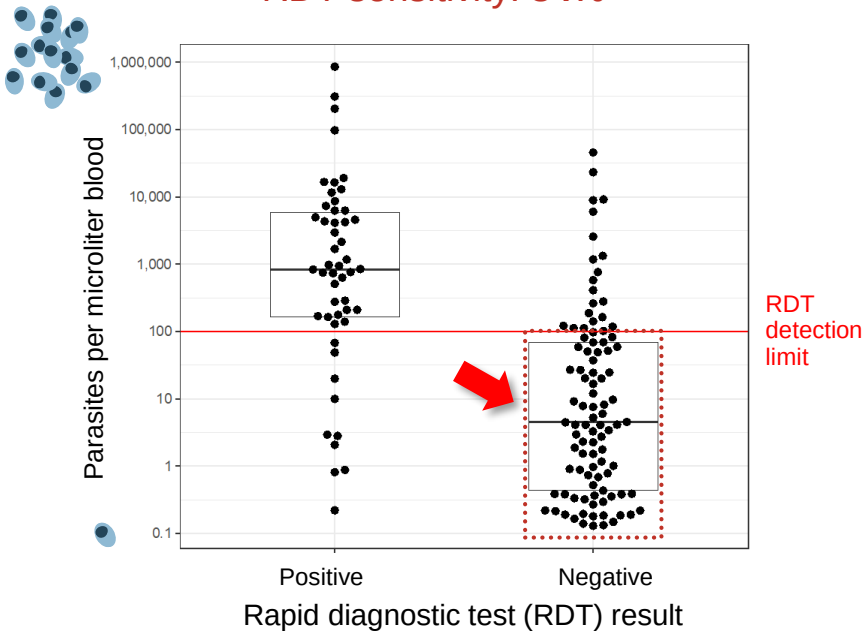
van der Horst *et al.* Am J Trop Med Hyg 2019

From research to implementation: surveillance-response



From research to implementation: surveillance-response

RDT sensitivity: **34%**



Grossenbacher *et al.* Malar J 2020; 19:50. Stuck et al. IJID 2020; 97: 337–346.

Current System Effectiveness: 3.2%
(qPCR detected infections cleared
by the current reactive case detection system)

Scenario	S with h=0	S with h=20
RCD with RDT	3.2 (2.1-4.5)	8.1 (5.9-10.5)
rfMDA	10.8 (8.1-13.8)	34.4 (30.3-38.4)

RCD = Reactive Case Detection; rfMDA = reactive focal Mass Drug Administration; RDT = rapid diagnostic test

Logan Stuck, PhD Thesis, Tulane University, 2019
Manuscript in preparation

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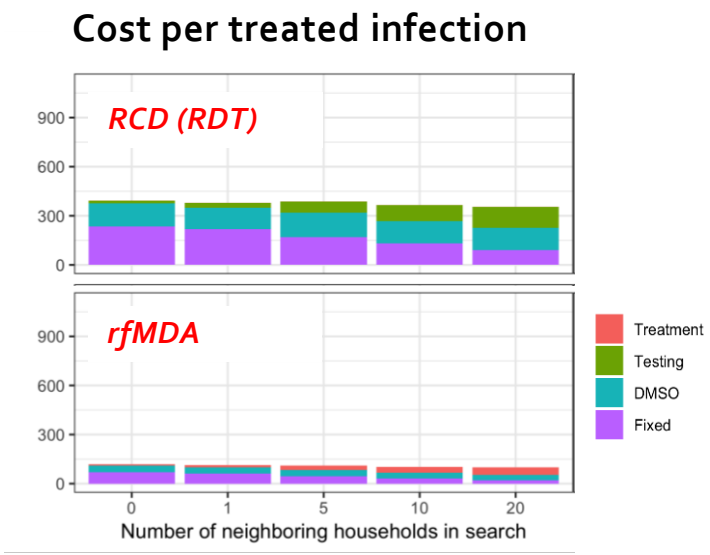
From research to implementation: surveillance-response



Cost-effectiveness calculation

- Total costs of reactive case and **reactive focal Mass Drug Administration** (rfMDA) are comparable
- A much larger number of infections can be treated at a similar total cost by switching from reactive case detection (RCD) to rfMDA

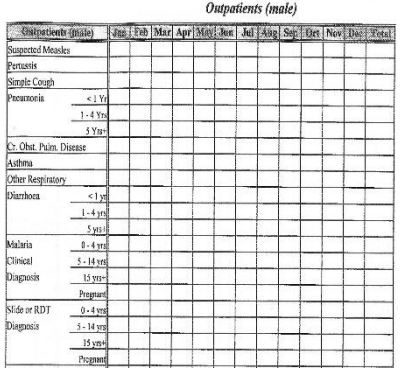
➔ Pilot implementation of rfMDA by the Zanzibar Malaria Elimination Programme

Stuck, Fakih, Yukich, Hetzel et al. manuscript in preparation

From research to implementation: surveillance-response

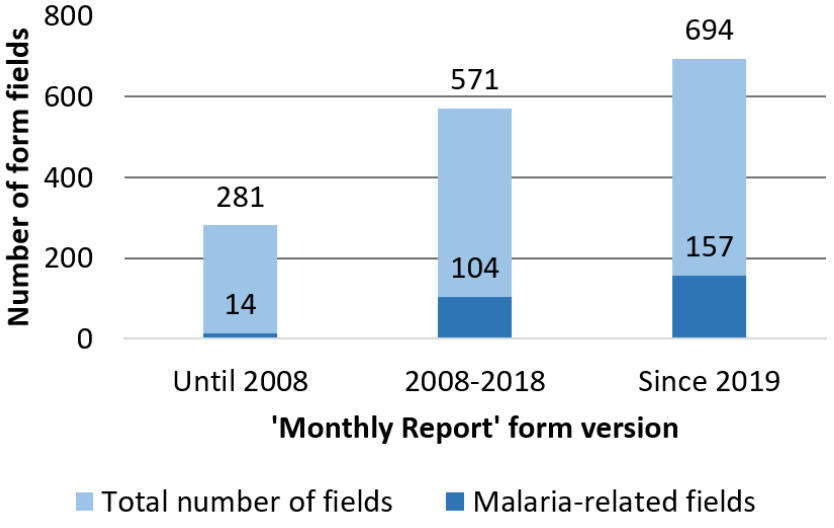
Minimal essential data

- Which information is required for **decision-making**?
- Avoid excessive collection of data that is not used!



Outpatients (male)

Outpatients (male)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Suspected Measles													
Pertussis													
Simple Cough													
Pneumonia < 1 Yr													
Pneumonia 1 - 4 Yrs													
Pneumonia 5 Yrs+													
Cr. Obst. Pulm. Disease													
Asthma													
Other Respiratory													
Diarrhoea < 1 yrs													
Diarrhoea 1 - 4 yrs													
Diarrhoea 5 yrs+													
Malaria Clinical Diagnosis 0 - 4 yrs													
Malaria Clinical Diagnosis 5 - 14 yrs													
Malaria Clinical Diagnosis 15 yrs+													
Malaria Clinical Diagnosis Pregnant													
Slide or RDT Diagnosis 0 - 4 yrs													
Slide or RDT Diagnosis 5 - 14 yrs													
Slide or RDT Diagnosis 15 yrs+													
Slide or RDT Diagnosis Pregnant													



Papua New Guinea

National Health Information System

Monthly Report

https://devpolicy.org/pngs-health-data-too-much-of-a-good-thing-part-one-202000610-1/

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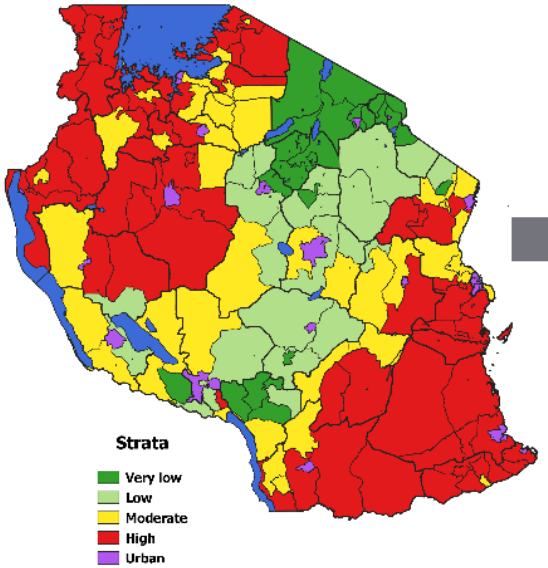
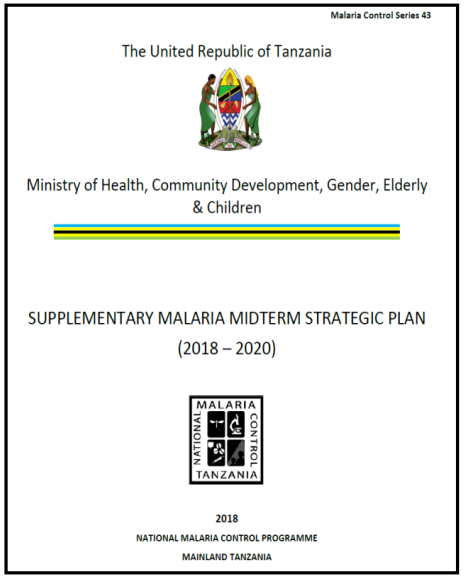
PAPUA NEW GUINEA INSTITUTE OF MEDICAL RESEARCH

Bringing it all together at country level: Epidemiological stratification of malaria risk + modelling the best combination of interventions



Mathematical Modelling

STRATA	INTERVENTIONS FOR MALARIA CONTROL		
	Case management (CM)	Preventive therapies	Vector control
VERY LOW (<1% *pfpr*)	-Primaquine -Increase testing rate (facility & community)	Case based surveillance & Foci identification	LLINs for vulnerable groups
LOW (1-<5% *pfpr*)	-Increase testing rate (facility & community)	Intermittent Preventive Treatment of Malaria in Pregnancy (IPTp)	- LLINs mass campaign followed by continuous distribution - Targeted Larval Source Management (LSM)
MODERATE (5-<30% *pfpr*)	-Access to testing and treatment – iCCM	- Seasonal Malaria Chemoprevention (SMC) - IPTp	- LLINs mass campaign followed by continuous distribution - Targeted LSM
HIGH (>30% *pfpr*)	- Access to testing and treatment – iCCM	- SMC - IPTi - IPTp - IPTsc	- LLINs mass campaign followed by continuous distribution - Targeted LSM - IRS
URBAN	-Improve CM in private sector	Depending on Epidemiological Strata	- LLINs mass campaign or continuous depending on epidemiological strata - Blanket LSM


Malaria Control Series 43

The United Republic of Tanzania

Ministry of Health, Community Development, Gender, Elderly & Children

SUPPLEMENTARY MALARIA MIDTERM STRATEGIC PLAN (2018 – 2020)

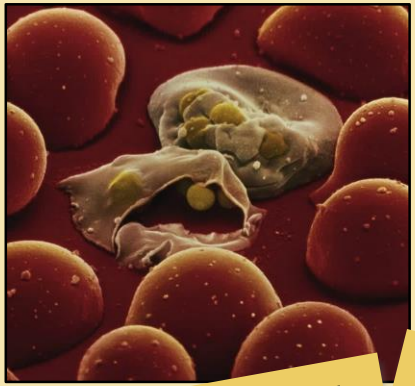
2018

NATIONAL MALARIA CONTROL PROGRAMME

MAINLAND TANZANIA

Thawer, S.G., Chacky, F., Runge, M. et al. Sub-national stratification of malaria risk in mainland Tanzania: a simplified assembly of survey and routine data. Malar J 19, 177 (2020)

Public Health Science for malaria elimination



Public Health Science

Parasitology

Genetics

Entomology

Immunology

Sociology

Cell biology

Biostatistics

Health economics

Medical anthropology

Epidemiology

Demography

Health systems research

Understanding of parasite, mosquito, human

Development of interventions

Strengthening of systems that deliver interventions

Accurate and timely real-world data

Empowering people to develop and implement strategies

Swiss TPH

Thank you for your attention

Manuel Hetzel
manuel.hetzel@swisstph.ch

Christian Lengeler
christian.lengeler@swisstph.ch