Weak surveillance gives resistant parasites the edge

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Antimalarial drug resistance surveillance

Surveillance should be easy to implement

and

Highly sensitive to detect emerging event(s)

1. *In vitro*
2. Therapeutic efficacy surveillance (TES)
   - "the gold standard"
3. Molecular surveillance

In vitro surveillance

- Require sophisticated equipment and skills personal
- Highly specific but expensive
- Reproducibility challenging
- 3-4 active laboratories on the African continent
- Needed to validate molecular markers

Jacques Le Bras

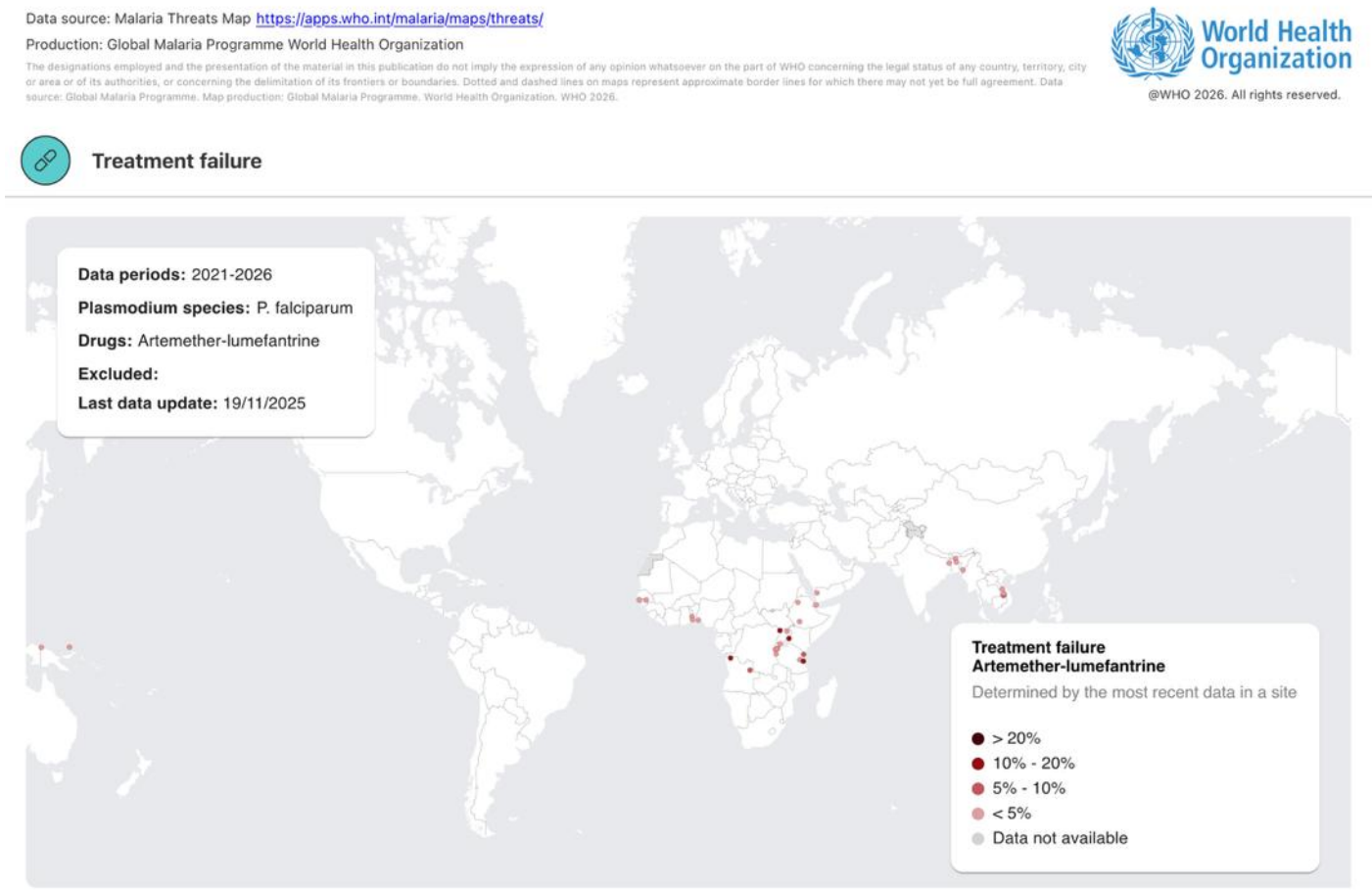
Therapeutic efficacy surveillance (TES) “the gold standard”

- Clinical trial
  - Expensive
  - Skill personal
- Day 28 follow up
  - Appropriate for partner drugs with short ½ life, not for the others
- Challenging to differentiate recrudescence to reinfection in high transmission areas
- Day 3 threshold poorly sensitive in high transmission setting
  - Especially in Africa

Correlation between Kelch13 mutations and clinical phenotype Study Group - update

Active | In progress

Therapeutic efficacy surveillance (TES) “the gold standard”



- Rarely have PK measures to confirm appropriate drug exposure

- Highly specific to confirm resistance but challenged by
  - Cost
  - Speed of analysis and dissemination
  - Quality

  → to trigger policy changes

Molecular surveillance

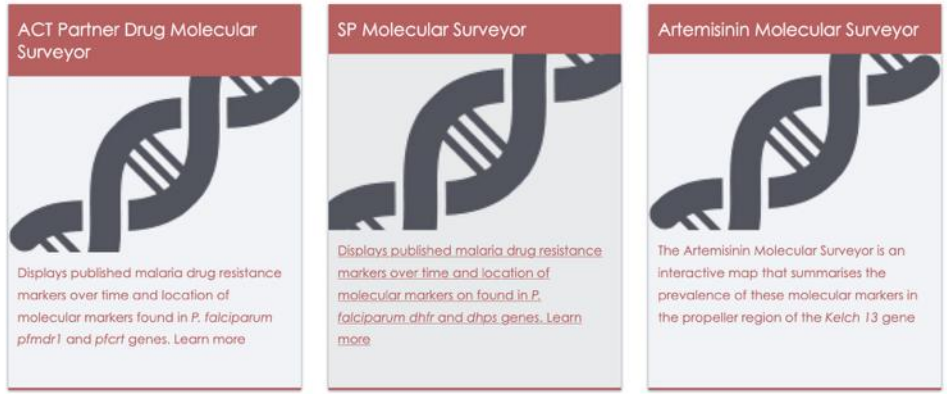
- Relatively expensive equipment
  - Cost and maintenance
- Require skill personal
- Scalable
- Highly sensitive and specific for know markers of resistance
  - Lacking a marker(s) of resistance for lumefantrine and amodiaquine

IDDO Molecular Surveyors:

Bringing cumulative evidence together

https://surveyor.iddo.org/map/k13

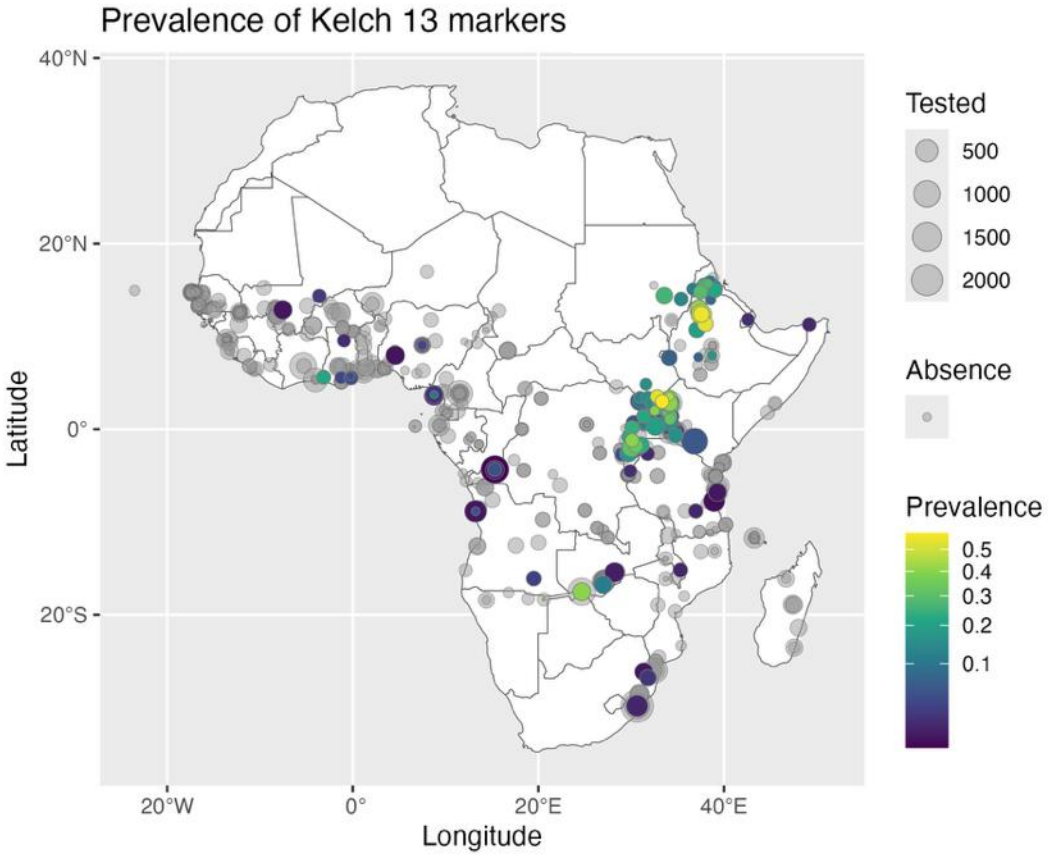
Aggregated to
- Mutation
- Site
- Year
- Number of samples positive
- Number of samples tested

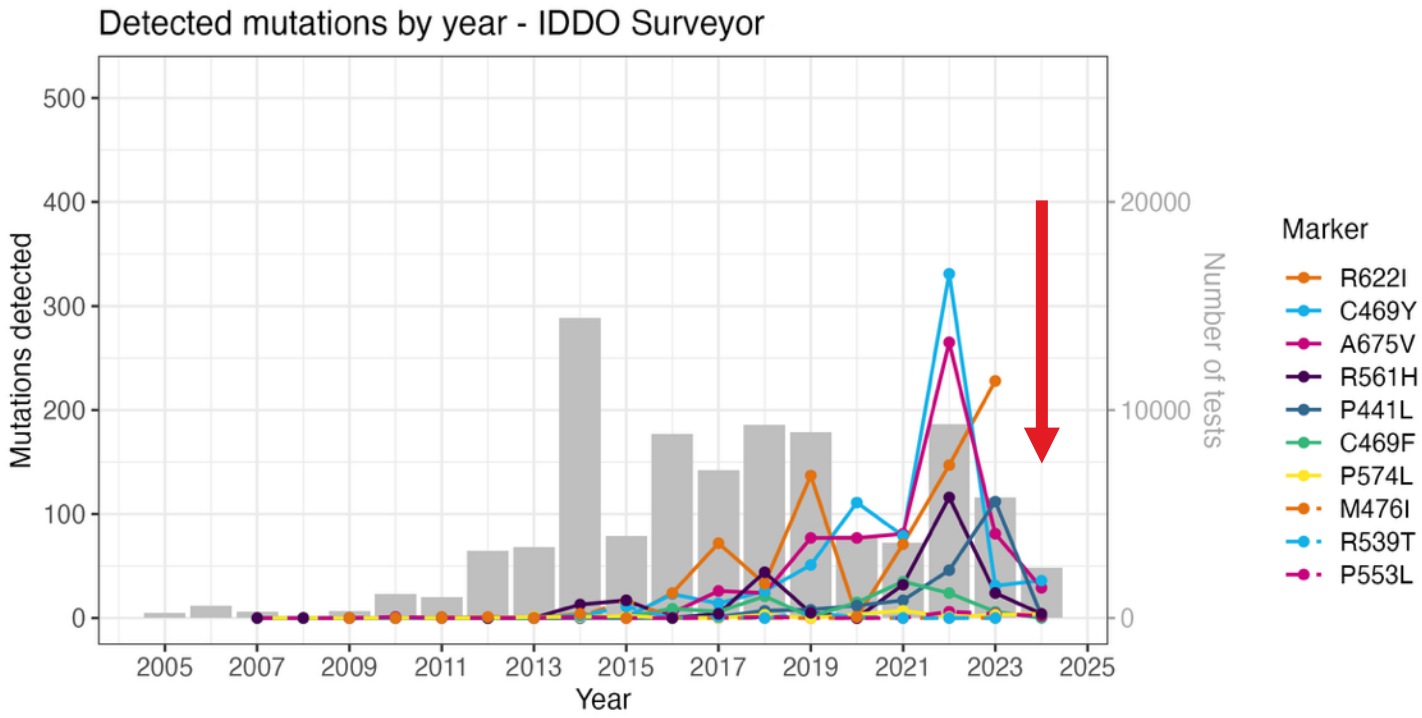


Challenges


IDDO
Charts
Map
All Projects
Start Tour
Login
Artemisinin Molecular Surveyor
Filter: Filtered
Year of Sample Collection
1980
2021 - 2025
Edit Filter
Map Filters
Country of Sample Collection
Select
Continent of Sample Collection
Select
WHO Marker classification
Select
Sample size
20
4000
Edit Filter
Clear
Reports & Downloads
Locations: 64
Legend:
Prevalence of a validated and or a candidate marker: 0%
Prevalence of a validated and or a candidate marker: >0% & <5%
Prevalence of a validated and or a candidate marker: >=5% & <10%
Prevalence of a validated and or a candidate marker: >=10%
North Atlantic Ocean
South Atlantic Ocean
Indian Ocean
Arabian Sea
Norway
Estonia
Denmark
Lithuania
Moscow
Kazan
Yekaterinburg
United Kingdom
London
Germany
Poland
France
Austria
Ukraine
Moldova
Kazakhstan
Mongolia
Serbia
Italy
Istanbul
Spain
Greece
Türkiye
Azerbaijan
Uzbekistan
Kyrgyzstan
Turkmenistan
Beijing
North Korea
South Korea
China
Shanghai
Tunisia
Syria
Iran
Afghanistan
Morocco
Cairo
Kuwait
Pakistan
Nepal
Bhutan
Bangladesh
India
Taiwan
Algeria
Libya
Egypt
Saudi Arabia
Oman
Mumbai
Laos
Western Sahara
Mauritania
Mali
Niger
Chad
Sudan
Yemen
Vietnam
Philippines
Nigeria
Central African Republic
Sri Lanka
Maldives
Malaysia
Brunei
Indonesia
Jakarta
Fortaleza
Brazil
Salvador
Bolivia
Belo Horizonte
Paraguay
Rio de Janeiro
Uruguay
Malawi
Zimbabwe
Madagascar
Mauritius
Namibia
South Africa
Cape Town
Perth

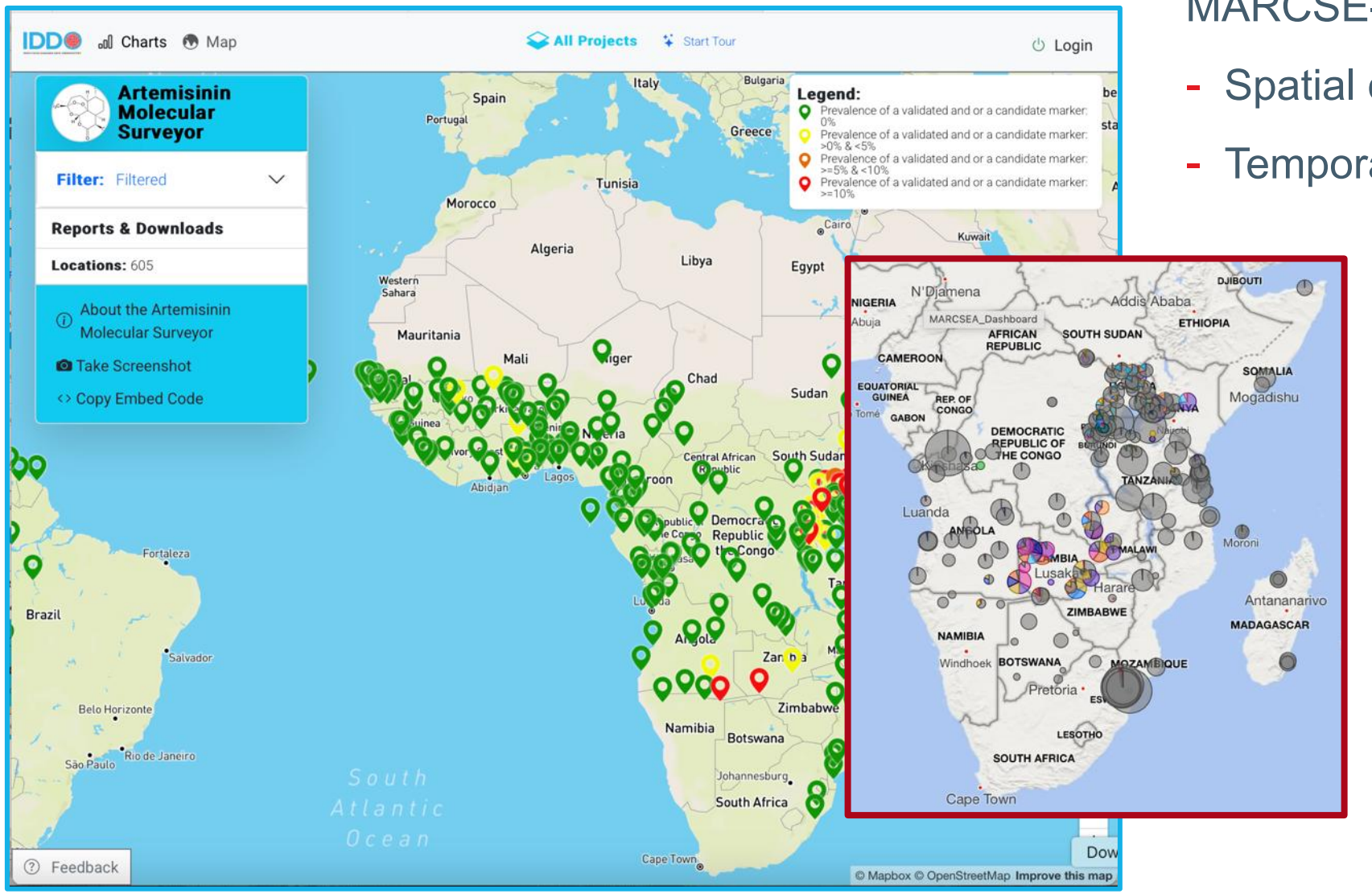
Dataset: IDDO Surveyor





MARCSE-Africa:

Data shared early powers decisions



Unpublished data shared with MARCSE-Africa consortium assists with:

- Spatial coverage in SE-Africa
- Temporal coverage post-2020

MARC SE-Africa

Van Wyk et al., 2026

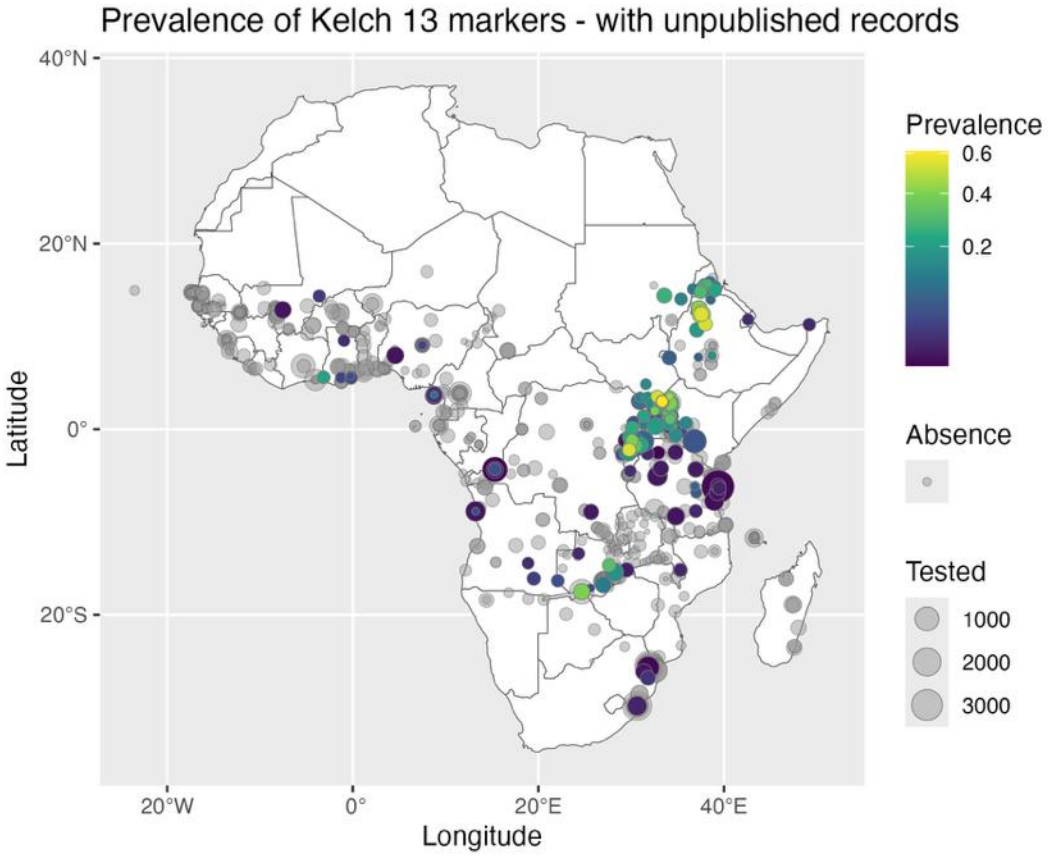
PLOS Digital Health

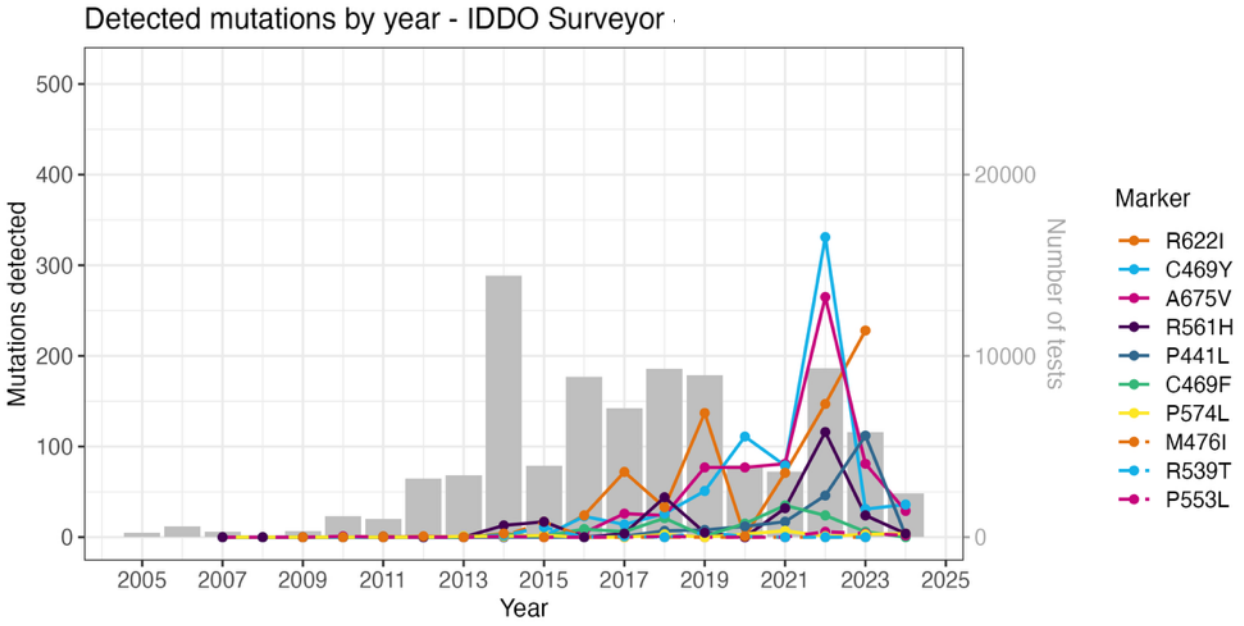
https://doi.org/10.1371/journal.pdig.0000743

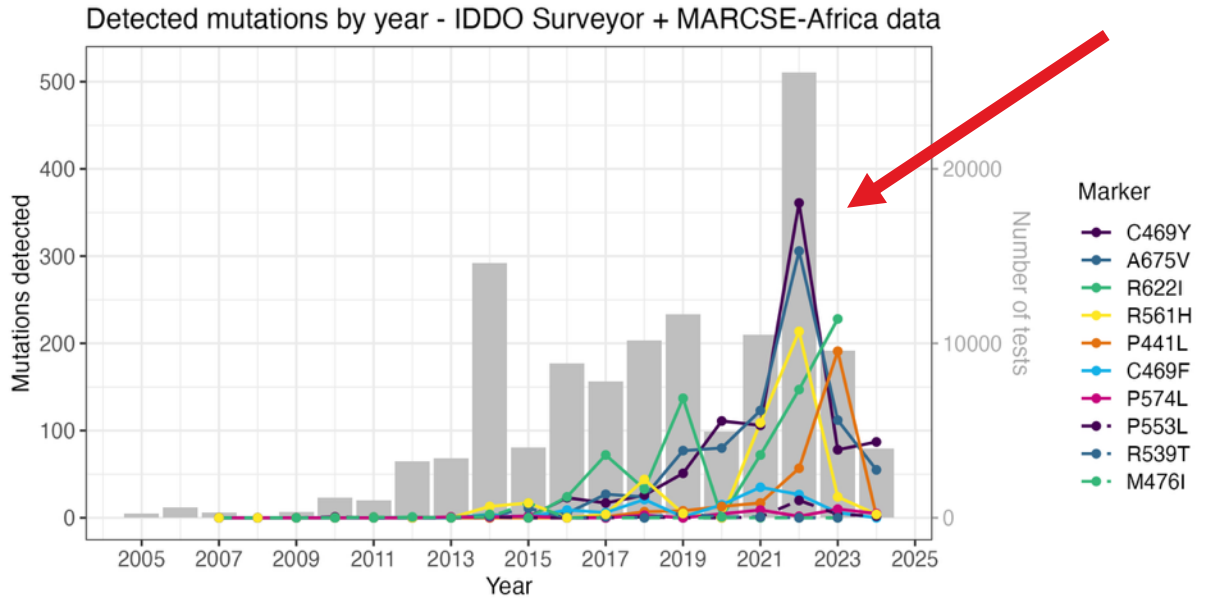
EDCTP

Supported by the European Union

Dataset: IDDO Surveyor + MARCSE-Africa







Utility of Surveyor Dataset

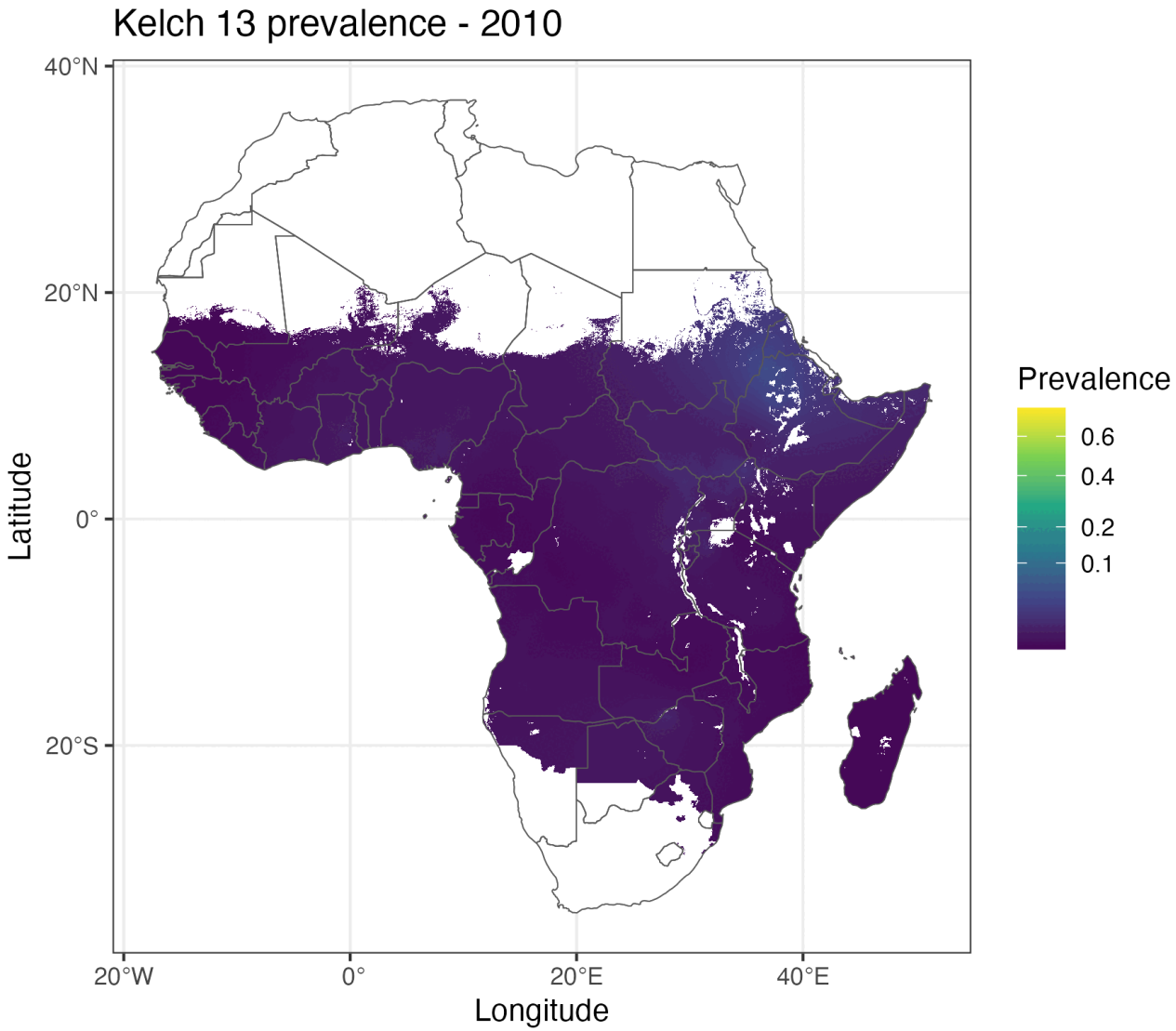
- Policy-makers can use treatment efficacy and molecular surveillance data to respond to drug resistance, **but**
  - Dataset is subject to sampling bias in space and time
  - Dissemination of the information (academic metrics vs public health needs)

- **How can we best use the data we have to support decision-making?**

Spatiotemporal models

- We use spatiotemporal Gaussian Process models to:
  - Estimate variance in observed marker prevalences
  - Predict marker prevalence where we have no data
- The models can …
  - Estimate spatial + temporal covariance between observations
  - Make forecasts based on current trends
- The models can not …
  - Predict the emergence of mutations if there is no data to suggest mutations have emerged
  - Tell us anything about the mechanisms causing mutations, e.g. selective pressures

Kelch 13 in Africa



(All ART-associated markers)

medRxiv
THE PREPRINT SERVER FOR HEALTH SCIENCES

Estimating the changing prevalence of molecular markers of artemisinin partial resistance in *Plasmodium falciparum* malaria in Sub-Saharan Africa

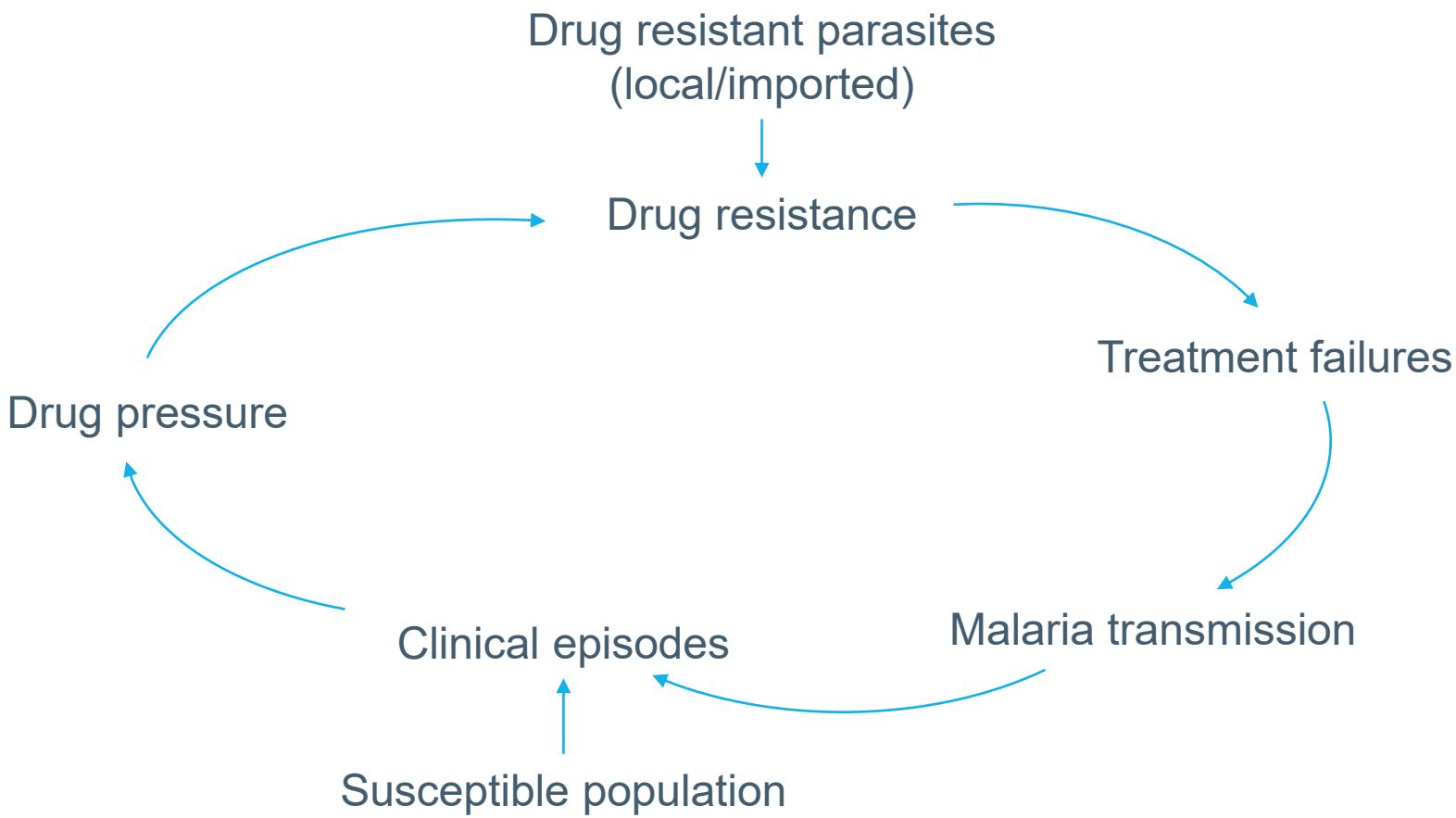
Lucinda E. Harrison, Nick Golding, Tianxiao Hao, Imke Botha, Stephanie van Wyk, Donnie Mategula, Prabin Dahal, Jaishree Raman, Daniel J. Weiss, Karen I. Barnes, Philippe J. Guérin, Jennifer A. Flegg

doi: https://doi.org/10.64898/2026.03.03.26347488

https://bit.ly/4rKxuSN

Drug pressure: A key unknown

Assumption: drug pressure gives rise to drug resistance



Adapted from Björkmann, *Int. J. Parasitol.*, 2002

Drug pressure: A key unknown

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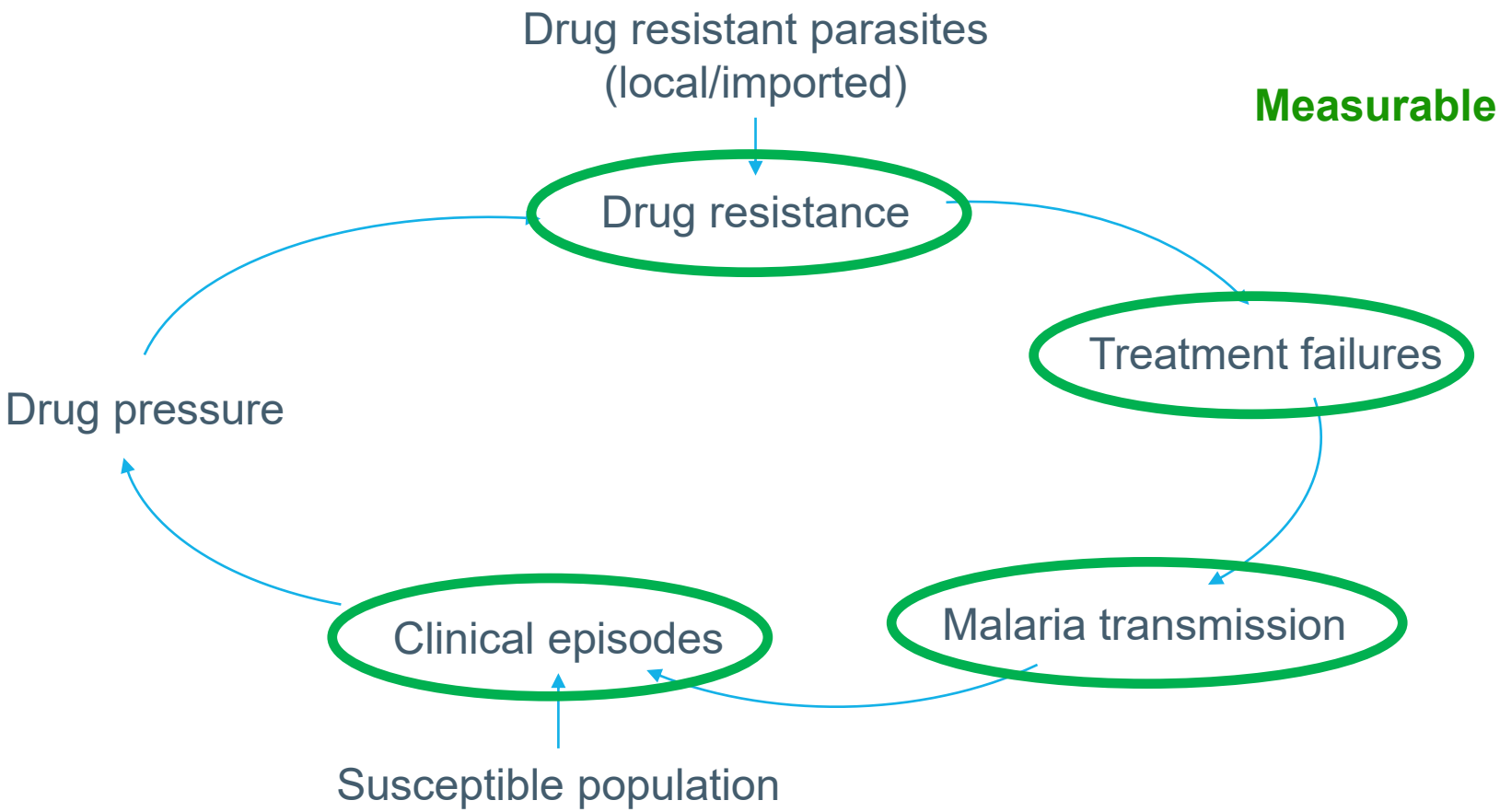

Measurable / data available

Adapted from Björkmann, *Int. J. Parasitol.*, 2002

Drug pressure: A key unknown

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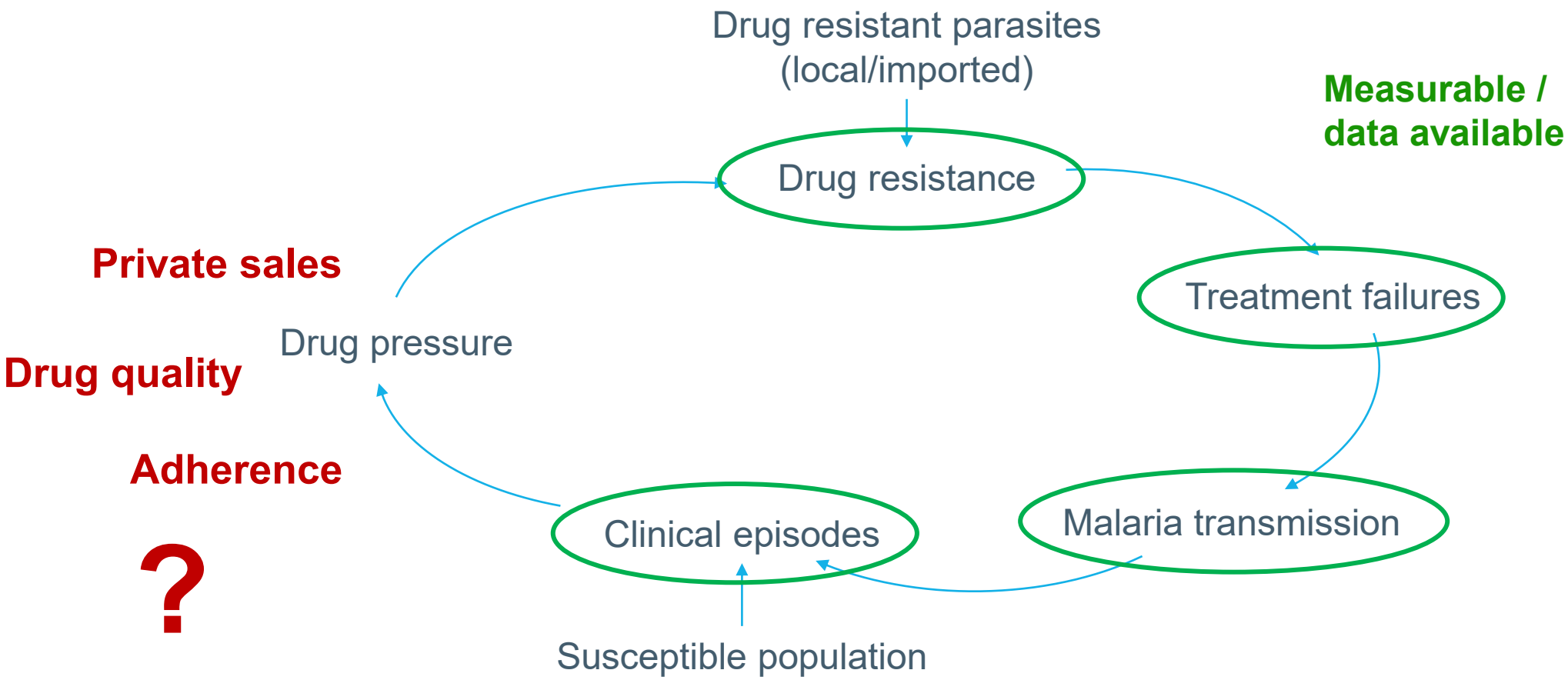
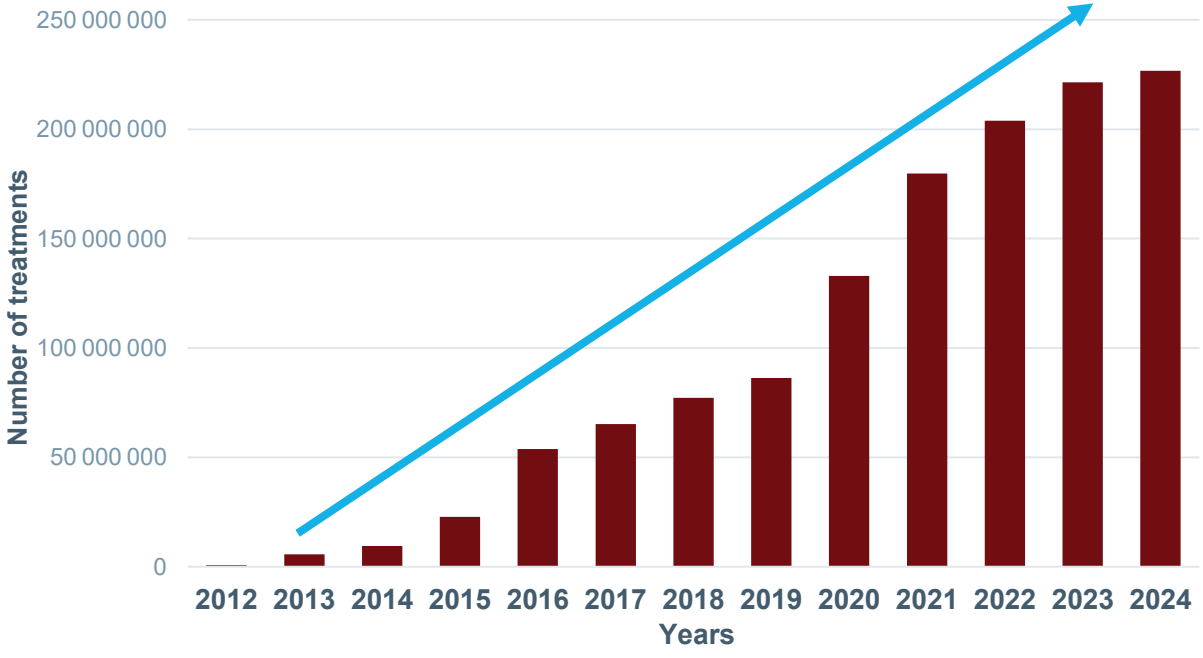


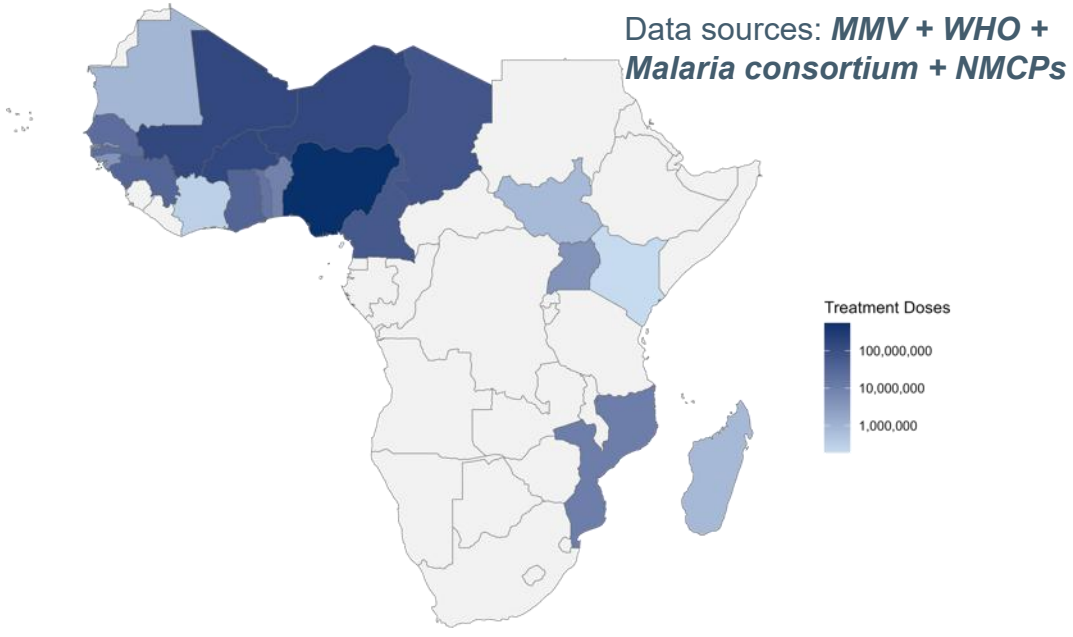
Adapted from Björkmann,
Int. J. Parasitol., 2002

Drug pressure: A key unknown

Chemoprevention: 1.3 billion treatments administered **across 900 districts**



Total number of SMC doses delivered per year



Total number of SMC doses delivered by country

Zinsou et al., unpublished

Weak surveillance gives resistant parasites the edge

- Geographical gaps for in-vivo or molecular surveillance
- Need high quality TES, not simply ticking the box
- Open science principles to be enforced
  - Dissemination in a timely manner

  →MARC-SE model

  →Other incentives… in time of data sovereignty debate
- Funding surveillance to maximise investments

“Absence of evidence is not evidence of absence”

Carl Sagan

MARC SE-Africa

WORLDWIDE ANTIMALARIAL RESISTANCE NETWORK

WWARN

IDDO
INFECTIOUS DISEASES DATA OBSERVATORY

Thank you

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