Insecticide resistance of malaria vectors in Africa: Implications and challenges for vector control interventions, and role of ANVR

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Spread of insecticide resistance in Africa

- Pyrethroid-treated Materials are the best tools available today for malaria prevention;
- Unfortunately, the emergence and spread of pyrethroid resistance are reported in Africa;
- One of the consequences of this resistance is the decrease of the effectiveness of treated materials;
- In addition to PyR, VR is now extended to Carbamats, and OP.
Practices of susceptibility test

WHO susceptibility test is available in all entomological research centers
The CDC bottle test is used at CREC in collaboration with CDC/Atlanta in addition to WHO method in case of suspicion of vector resistance.
Map of the distribution of vector resistance in Africa (ANVR)

Monitoring of insecticide resistance performed by ANVR in 364 sites from 30 countries

Vectors implicated in the monitoring of insecticide resistance

Legend:
- Red circle: Anopheles Melas
- Green triangle: Anopheles Arabiensis
- Yellow circle: Anopheles gambiae
- Black line: Country limit
Map of the distribution of vector resistance in Africa (ANVR)

Spread of DDT resistance from West to East

Legend
Anopheles gambiae s.s. fato
DDT
- Red: Resistant (<90% Mortality)
- Orange: Resistance to be confirmed (90 to 98% M)
- Green: Susceptible (98 to 100% mortality)

Spread of permethrin resistance from West to East

Legend
Anopheles gambiae s.s. fato
Permethrin
- Red: Resistant (<90% Mortality)
- Orange: Resistance to be confirmed (90 to 98% M)
- Green: Susceptible (98 to 100% mortality)

Country limit
Map of the distribution of vector resistance in Africa (ANVR)

Spread of Deltamethrin resistance from West to East

Legend
- Anopheles gambiae sensu lato
  - Deltamethrin
    - Resistant (<90% Mortality)
    - Resistance to be confirmed (90 to 98% M)
    - Susceptible (98 to 100% mortality)
  - Country limit

Spread of Lambdacynhalothrin resistance from West to East

Legend
- Anopheles gambiae sensu lato
  - Lambdacynhalothrin
    - Resistant (<90% Mortality)
    - Resistance to be confirmed (90 to 98% M)
    - Susceptible (98 to 100% mortality)
  - Country limit

Kilometers
Emergence of Carbamate resistance in West Africa

Map of the distribution of vector resistance in Africa (ANVR)

Emergence of OP resistance in West Africa

Legend:
- **Anopheles gambiae sensu lato**
  - **Bendiocarb**
    - Resistant (<90% Mortality)
    - Resistance to be confirmed (60 to 98% M)
    - Susceptible (98 to 100% mortality)
  - **Fenitrothion**
    - Resistant (% Mortality <50)
    - Resistance to be confirmed (% Mortality 50-99)
    - Susceptible (% Mortality 98-100)

Legend:
- **Anopheles gambiae s.s.**
  - Resistant (<90% Mortality)
  - Resistance to be confirmed (60 to 98% M)
  - Susceptible (98 to 100% mortality)

Kilometers
Some operational implications of VR

- Limited effectiveness of Indoor Residual IRS and LLINs;
- Difficulties when choosing an insecticide for the implementation of a vector control intervention.
What is ANVR Strategy against VR

- Yearly Monitoring and mapping of VR
- Monitoring the evolution in sentinel sites selected in various ecological areas (e.g. urban and rural areas, irrigation zones, public health and agricultural areas……..)

  If resistance detected, determine:

  - Extent
  - Distribution
  - Mechanisms (Kdr L1014F/S, Ace-1, esterases, oxydase, GST) involved
  - Operational impact
What ANVR recommends for Resistance management

4 potential methods

- **Rotation**
  - Different classes of insecticides sprayed in rotation annually
  - Rotate more than 2 insecticides

- **Mosaic**
  - Different classes of insecticides sprayed in different houses of a same village

- **Mixture**
  - Different insecticides mixed in a spray pump are sprayed (or co-formulated)
  - Combination of interventions with different insecticides
    - E.g. LLINs and IRS with carbamat or organophosphate
Conclusions/Recommendations

- West Africa is the region where VR is the highest in Africa;

**For countries**
- Monitor VR at country level
- Develop a strategy of management;
- Data obtained must be used to guide and improve the implementation of vector control at country level;
- In addition to chemical methods, associate Larval source Management (Ministries, Municipalities, Communities).
- In case of lack of skill, ANVR can help

**For industrials**
- Study the possibility of a combinaison based on the synergy from the association of 1 Py+1 non-Py for LLINs;
- Improve the formulation of existing insecticides for IRS to reinforce their lethal action against resistant mosquitoes and their residual effect.
THANKS FOR YOUR ATTENTION