IVM Challenges and Impact in Tented Camps of South Sudan

A summary of evolving IVM approaches on malaria incidence in tented camps for displaced population since 2013-2019
Displacement in South Sudan

- After a brief period of peace after South Sudan gained independence from Sudan, civil war broke out in 2013 based on inter-ethnic fighting.
- As of December 2019, nearly a third of South Sudanese population are displaced:
  - 2.2 million South Sudanese refugees in neighbouring countries
  - 1.7 million are internally displaced
  - 298k refugees are living in South Sudan
- 103 IDP sites and 9 refugee camps (mainly for Sudanese refugees)
- Malaria is highly endemic, transmission season April-November in the northern areas
- Despite repeated mass distributions of LLINs, malaria caseload and deaths continue to increase nationally
- Resistance to pyrethroid class of insecticides found in LLINs has spread rapidly across the Sahel region and confirmed in localities of South Sudan
Camp Conditions and Malaria

- When camps form, populations with varying immunities rapidly mix together in a new environment increasing incidence and deaths in those with naturally low immunity.
- Populations seeking refuge in shelters are traumatised with low nutritional status and high susceptibility to other communicable diseases. This increases incidence of severe malaria, complicates treatment, and increases mortality.
- Sanitation infrastructure is usually weak with little to no drainage and frequent flooding increasing number and size of mosquito breeding sites during rainy season.
- Without mass vector control interventions, malaria epidemics are sustained with high caseloads extending for months.
- Temporary structures increase entry of the endophagic and night-biting Anopheles mosquitoes.
Integrated Vector Management

- MENTOR have implemented IVM in refugee and IDP camps since 2013
- IVM aims to protect communities from malaria / other VBD epidemics: by targeting vectors at different stages of life:

**Indoor Residual Spraying:** Spraying of all walls of sleeping rooms with insecticide before rainy season

**Larval Source Management:** Treatment of mosquito breeding sites with larvicide with liquid Abate

**Fly Control:** Treatment of fly breeding sites with pyriproxyfen powder

**LLIN Distribution:** Mass distribution to all households

**IEC/BCC:** Ongoing messaging to communities for proper usage/care of LLINs, increase IRS acceptance, increase health-seeking behaviour
Maban county has four refugee camps holding Sudanese populations fleeing armed conflict in Sudan’s Blue Nile and South Kordofan states.

UNHCR constructed standard emergency tents or wooden frames with plastic sheeting initially.

As the sites have become more established due to low numbers of refugees returning, more shelters are now converted to clay / mud walls fortified with sticks.

Sporadic fighting and insecurity regularly breaks out within camps and between refugees and host communities.

<table>
<thead>
<tr>
<th>Camp</th>
<th>Population (2019)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gendrassa</td>
<td>17,455</td>
</tr>
<tr>
<td>Doro</td>
<td>59,700</td>
</tr>
<tr>
<td>Batil</td>
<td>36,754</td>
</tr>
<tr>
<td>Kaya</td>
<td>22,903</td>
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</tbody>
</table>
Epidemiological data shows clear seasonal malaria outbreaks
Mass larviciding campaign in Maban using 3 tonnes of Abate helped curb an outbreak
Larviciding in future years is used as monthly supplementary vector control tool at the end of the rainy season when breeding sites are easily identified
ICON (pyrethroid class) may provide some protection although little impact on the seasonal caseload implying there is vector resistance to local mosquito populations
In 2016, insecticide was switched to Actellic (organophosphate class) although funding approval was delayed resulting in an intervention after the main peak of the epidemic

= Monthly larviciding

Maban Refugee Camps: 2013-2016

Incidence/1000 pop
2017: IRS campaign was completed before transmission season began and using Actellic with a significantly high impact in preventing an outbreak.

2018: To avoid organophosphate resistance, Ficam (carbamate class) was used. Unfortunately, targeted attacks (week 29-36) on NGO compounds caused complete shutdown of all humanitarian activities resulting in deterioration of environmental conditions (sanitation) and inaccessibility to health services.

Ficam has a shorter residual lifespan (3-6 months) which may account for the slightly higher outbreak.
Camp Setting: Bentiu PoC

- Biggest camp in South Sudan containing IDPs from surrounding counties
- Highly fluid and mobile population: over 160,000 are registered although population counts are fluctuating at approx. 120,000
- A significant proportion of the camp are children under 5 at 36% (over 40,0000)
- Camp experiences extensive flooding in rainy season as it is in a natural low-land
- Soil consistency does not soak water effectively leading to rapid formation of large breeding sites particularly in the channels around each block
Bentiu PoC: 2015 - 2017

- 2015 suffered major epidemic despite high LLIN coverage and IRS using ICON which was then switched to Actellic for 2016
- In 2017, Sector 1 received LLINs containing PBO with remaining sectors receiving IRS with Ficam
  - PBO lost almost all residual bioefficacy after 9 months
  - Despite full-time IEC campaigns for 9 months, only 35% of distributed LLINs remained in the intended household and large proportion were regularly washing and drying in sun
  - In 2018, LLIN distribution was still implemented by partners despite evidence of pyrethroid resistance
Camp Setting: Malakal PoC

- Population consists of mainly those from Malakal city seeking refuge
- Significant overcrowding with no regularised blocks or drainage system with extensive flooding in the rainy season
- Fluctuating population of 30,000 people
- Houses are a mixture of plastic sheeting and corrugated iron structures using materials from local populations
- Seasonal malaria is usually later in the year
Malakal PoC: 2015 - 2018

- In 2015, there was no IVM programme resulting in a major epidemic at the end of the year, despite LLIN distribution.
- In subsequent years, IRS, using rotation between carbamate and organophosphate was utilised preventing any further malaria outbreaks.
- With well-timed yearly IRS campaigns, intensity and size of outbreaks is
Entomological Indicators

- Entomological monitoring was conducted in Bentiu & Malakal PoCs using CDC light traps to measure effect of IRS.
- In Bentiu, high *Anopheles* vector density was detected even with a recent mass distribution of standard LLINs.
- Bentiu PoC has naturally high *Anopheles* density although this significantly drops after IRS campaign.
- IRS is highly effective at lowering vector density particularly *Anopheles*.

![Graph showing entomological indicators before and after IRS](chart.png)
Insecticide Resistance: South Sudan

- MENTOR have conducted two separate susceptibility tests on local mosquito populations using WHO standard methodology.
- Resistance to all classes of pyrethroids used in standard LLINs: lamda-cyhalothrin, permethrin and deltamethrin.
- In these settings and across South Sudan, LLINs are acting as a physical barrier only and not a means of controlling vector density.

### Insecticide Class 24 hr mortality

<table>
<thead>
<tr>
<th>Insecticide Class</th>
<th>24 hr mortality</th>
<th>Wunrok, Warrap State, 2015</th>
<th>Bentiu, Unity State, 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pyrethroid (type 2)</td>
<td>34%</td>
<td>3.7%</td>
<td>10%</td>
</tr>
<tr>
<td>Pyrethroid (type 2)</td>
<td>40%</td>
<td></td>
<td>94%</td>
</tr>
<tr>
<td>Carbamate</td>
<td>100%</td>
<td></td>
<td>99%</td>
</tr>
<tr>
<td>Organophosphate</td>
<td>100%</td>
<td></td>
<td>99%</td>
</tr>
</tbody>
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Conclusions

• Even with repeated mass distribution of LLINs (Bentiu PoC), these are not the most effective tool for controlling vectors in this setting:
  – High insecticide resistance to pyrethroids
  – Rely heavily on human behaviour

• IRS, with the right timing and correct insecticide, is the most impactful at preventing / curbing epidemics for this environmental setting
  – High acceptance from the communities, does not rely on behaviour change or continual use
  – Provides protection for duration of transmission period
  – Insecticides can be rotated to avoid resistance
  – More cost-effective

• Larviciding used as supplementary tool at the end of rainy season to protect throughout dry season
  – More impactful when breeding sites are more fixed