The broad objectives and mandate of the Institute are:

• To conduct research into health problems of Public Health importance in Ghana.
• To provide training opportunities for postgraduate students in medical research.
• To provide specialized laboratory diagnostic and monitoring services in support of public health programmes.
Entomological and Epidemiological monitoring of Indoor Residual Spraying program in Northern Ghana

Noguchi Memorial Institute for Medical Research, Legon
Presentation outline

• Introduction
• Activities
• Overview of data from 2009 – 2012
  – Vector Abundance and biting behavior
  – Vector indoor resting density
  – Insecticide susceptibility and residual effect
• Impact of IRS on malaria vectors
  • Malaria transmission (July 2010-Dec2012)
• Observations
• Recommendations
• Conclusions
Why do we have to control mosquitoes?

**Malaria**

*Malaria* is estimated to cause over one million deaths *each* year in the world.

*Every 30 seconds, a child* somewhere *dies of malaria* *(Source: www.malaria.org)*

Severe anaemia

Severe malaria
- Mosquitoes transmitted **Elephantiasis**
Introduction

• Vector control remains the main strategy for controlling vector-borne diseases globally

• Indoor Residual Spraying (IRS) is one of such vector control interventions

• Mosquitoes are the direct target of the intervention and successful implementation will require monitoring of the impact of the program on vectors
Activities

• Insecticide Susceptibility test (WHO test kit)
• Monitoring of vector densities, age (parity) and behaviour—July 2009 – April 2012
  – Landing catches
  – Pyrethrum Spray catches
  – Parity estimation
• Residual activity of IRS operations (Cone assays) - August 2009 – December 2012
• Transmission studies
• Operational research in Bunkpurugu-Yunyoo district
In 2012, communities under Savelugu/Nanton were sprayed with Actellic 300CS, a long-acting formulation of Pirimiphos methyl (an organophosphate), whereas sentinel communities under TKD were sprayed with Alphacypermethrin (a pyrethroid).

Bunkpurugu yunyoo has 2 year history of using alphacypermethrin (a pyrethroid) for the IRS program since it was selected as beneficiary of the IRS program in 2011.
IRS entomological sentinel sites

• Communities selected within three of the districts chosen for IRS
  – (Savelugu district); Diare, Nanton and Tarikpaa
  – (Tolon district); Dimabi, Gbullung and Woriborgu
  – (Tamale Control district); Kulaa, Tugu and Yong

• Operational Research - Bunkpurugu-Yunyoo district
  – Bunbuna
  – Yunyoo,
  – Nasuan
  – Kpemale/Sambiruk
Relatively more outdoor biting observed in Tolon. Trend has not changed over years of IRS.
More indoor biting observed in control district
Room density of vectors

Room density in IRS and Non-IRS areas

- Reduction in room density compared to last year 2012
Monthly trends in Parity rate of vectors in IRS areas

- General reduction in parity in IRS areas compared to Non-IRS areas
Reduction in mosquito sensitivity to pyrethroids in 2012
Relatively high resistance to Alpha and deltamethrin in Gbullung
Quality of spraying in Savelugu district

Tarikpaa- Sprayed on 9th May 2013 and tested on the 13th June 2013 (Pattern the same in Choguni and Kambontuni)
Evaluation of the quality of spraying in Bunbuna - B-Y (2013)

Used wild susceptible mosquitoes 4 days after spraying with Pirimiphos methyl (sprayed on 19th June 2013 and tested on the 23rd June 2013).
Efficacy of insecticide on different wall surfaces

- Cement surfaces have much longer residual activity than mud and wood.
Frequency of kdr gene in M and S forms

![Graph showing the frequency of kdr gene variants in M and S forms.](image)

**Legend:**
- Tolon
- Savelugu
- Tamale
- B-Y

**Data:**
- 2011:
  - RR: [Index]
  - RS: [Index]
  - SS: [Index]
- 2012:
  - RR: [Index]
  - RS: [Index]
  - SS: [Index]
Indoor and outdoor malaria transmission in IRS and control areas

- Yearly variation in EIR in IRS and non-IRS areas.
- Relative outdoor transmission in IRS areas.

- Yearly variation in EIR in IRS and non-IRS areas. Relative outdoor transmission in IRS areas.
Seasonal transmission

- **Dry season (January to April)**
- **Rainy season (May to August)**

<table>
<thead>
<tr>
<th>Season</th>
<th>Tolon (IRS)</th>
<th>Savelugu (IRS)</th>
<th>Tamale (Non-IRS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EIR (Infective bites/man/night)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dry season (January to April)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rainy season (May to August)</strong></td>
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</tr>
</tbody>
</table>

The graph shows a significant increase in EIR during the rainy season for Tamale compared to the dry season. Tolon (IRS) and Savelugu (IRS) show lower EIR levels across both seasons.
Monthly distribution of sporozoite positive mosquitoes

Districts:
- Tolon (IRS)
- Savelugu (IRS)
- Tamale (Non-IRS)

Month-wise sporozoite rate distribution:
- January: 0.01
- February: 0.02
- March: 0.03
- April: 0.04
- May: 0.05
- June: 0.06
- July: 0.07
- August: 0.08
With the exception of Bunbuna, there was a general reduction (92%) in malaria transmission in all the sentinel sites.
Observations

- *Anopheles gambiae s.l.* remained the predominant species in both the old and B-Y districts.
- The S-Form of the *An. gambiae* predominates in all the areas especially in Tolon.
- There was a significant reduction in indoor resting mosquitoes in IRS areas compared to the control.
- Relatively high pyrethroid resistance to pyrethroids detected in *Anopheles* populations in Tolon and Savelugu.
- Marginal resistance to pyrethroids detected in *Anopheles* vectors in B-Y.
- There was relative increase in outdoor biting in Tolon – use of repellents will be appropriate.
- The parity rates of vectors was reduced after spraying in both the old and B-Y districts.
- There was a reduction in malaria transmission compared to the non-IRS areas.
- Relatively high transmission in Tolon – Alphacypermethrin used in the presence of resistance and or outdoor biting.
Recommendations

• The presence of \textit{kdr} and the marginal resistance detected in the vector populations led to the change of insecticide for the current round of spray
• The trend will be continuously monitored.
• We intend to monitor other resistance mechanisms that may be involved in the development of resistance.
• Investigate outdoor resting behavior of vectors in Tolon
• Change of pyrethroid in B-Y to non-pyrethroid next year
• Investigate the impact of unsprayed surfaces inside rooms
• Investigate the movement of mosquitoes in and outside rooms
Conclusion

• The current data showed that IRS has had impact on the age (parity) of the mosquitoes.
• Parity rate is an important component of the ability of a vector to efficiently transmit parasites.
• This reduction in parity may have led to the reduction in transmission in both the old districts and in the B-Y district.
MALARIA PARASITAEMIA AFTER ANNUAL IRS IN BUNKPURUGU-YUNYOOO DISTRICT, NORTHERN GHANA
Survey design

• Series of cross-sectional surveys (peak and trough transmission seasons)
  ✓ Pre-IRS
  ✓ One year post-IRS
  ✓ Two years post-IRS

• Multi-stage sampling approach used
  ✓ Population proportional to size estimates (PPES) to select 36 communities
  ✓ List of compounds with children < 5 years as sampling frame for selection of 17 compounds
Survey design (cont’d)

✓ All caregivers of children < 5 years in selected compounds interviewed and their children tested for malaria parasitaemia and anaemia

✓ All survey microscopy slides read by 2 independent microscopists and discordant readings read by 3rd independent senior microscopist
Prevalence of malaria parasitaemia after Annual IRS in Bunkpurugu-Yunyoo district, Northern Ghana

<table>
<thead>
<tr>
<th>Season</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-IRS</td>
<td>53.9</td>
</tr>
<tr>
<td>Post-IRS Year 1</td>
<td>52.3</td>
</tr>
<tr>
<td>Post-IRS Year 2</td>
<td>44.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Season</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trough</td>
<td>31.7</td>
</tr>
<tr>
<td>Post-IRS Year 1</td>
<td>26.2</td>
</tr>
<tr>
<td>Post-IRS Year 2</td>
<td>24.1</td>
</tr>
</tbody>
</table>
Conclusions

• Two years of annual IRS has shown significantly moderate decline of malaria parasitaemia in northern Ghana

• Continuous annual IRS in combination with other interventions (such as ITN campaign) will reduce malaria parasitaemia in northern Ghana
Acknowledgements

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