Use of Long Lasting Insecticide Technology in controlling vector borne diseases

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Vector Borne Diseases prevalent in India

<table>
<thead>
<tr>
<th>Diseases</th>
<th>Vectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaria</td>
<td>Anopheles spp.</td>
</tr>
<tr>
<td>Filariasis</td>
<td><em>Culex quinquefasciatus</em></td>
</tr>
<tr>
<td>Japanese Encephalitis</td>
<td><em>Mansonia</em> spp.</td>
</tr>
<tr>
<td>Dengue/DHF</td>
<td><em>Culex</em> (Vishnui group)</td>
</tr>
<tr>
<td>Kala-azar (Leismaniasis)</td>
<td>Anopheles spp.</td>
</tr>
<tr>
<td>Chikungunya</td>
<td><em>Aedes</em> spp.</td>
</tr>
<tr>
<td></td>
<td><em>Phlebotomus argentipes</em></td>
</tr>
</tbody>
</table>
Methods of vector control

1. Anti adult measures
   - Prevention of man-vector contact (Personal protection)
   - Repellents
   - Insecticide treated mosquito nets
   - Destruction of adults (Adulticides)
   - Selective indoor residual spraying
   - Space spraying

2. Anti larval measures
   - Destruction of immatures (Larvicides/Bio-control)
   - Elimination of breeding habitats
INDOOR RESIDUAL SPRAY

- Feeding and resting behaviour
- Target population taking village as unit.
- Current susceptibility status
- Spray timings.
- Coverage particularly room coverage/Duration of spray.
- Entomological indicators.
- Epidemiological indicators
- Sustainability
- Cost effective ratio
PROBLEMS RELATED TO IRS

- Resistance and cross-resistance.
- Staining of walls
- Objections on religious grounds.
- Replastering of walls.
- Reluctance to allow strangers.
- Inadequate collateral benefits.
- Highly operational & insecticide cost.
- Environmental degradation.
To overcome these kind of problems in IRS recently new technologies have come up in to the picture which is long lasting insecticidal net technology.

Such new technologies are:-

- Insecticidal paints
- Insecticidal impregnated ropes
- Insecticidal treated curtains/fabrics
- Insecticidal plastic sheeting
- Insecticidal durable linings
- Insecticidal nets(LNs)- most widely used method
Mozzi-Mort™ is a revolutionary lifesaving and clinically approved insecticidal coating specifically developed to eradicate insect pests and thus restrict the diseases they carry. Simply apply to surfaces where insects fly or crawl and they will be affected quickly become paralyzed and die within minutes. The efficacy of this paint will last up to 2 years.
Insecticide impregnated ropes as mosquito repellent.

Ropes can be impregnated with different dosages of deltamethrin and burnt throughout the night in human dwellings and cattlesheds. Smoke from smouldering ropes treated with various dose levels gradually saturated rooms and prevented the entry of mosquitoes. This method provided very good protection from mosquito bites including the principal vector of malaria, *An. culicifacies*. Results of ropes impregnated with 80 ppm deltamethrin were more consistent than at the lower dosage. The technique is indigenous, cost-effective, simple and appropriate for rural areas and does not require any special skills in its application.
• PermaNet® Curtains which remain effective for up to 2 years and/or 6 standard washes assuming up to an average 1½ hours direct sunlight. UV exposure and washing frequency are the two main factors influencing the lifetime of the PermaNet® Curtains.
ZeroFly® insecticidal plastic sheetings

ZeroFly® Shelter is constructed of a woven centre fabric, with lamination on both sides. Insecticide is incorporated in the woven centre fabric. The insecticide will over time migrate through the laminates to the surface of the plastic sheeting, giving the product vector control abilities.

- In the lamination there are chemicals that control the migration of the insecticide, leading to a slow release and securing an adequate concentration of insecticide on the surface at all times.

- The UV protectors that protect the insecticide have the ability to migrate with the insecticide to prevent degradation throughout the migration process.
Long lasting insecticidal durable linings

The product ZeroVector® Durable Lining is simple - a thin sheet of woven shade cloth impregnated with insecticide is installed on the walls of a house to offer protection against diseases like malaria and dengue.

Apart from inhibiting the spread of disease-transmitting vectors like mosquitoes and flies, it also controls other nuisance pests such as ants, cockroaches, termites and bedbugs.

ZeroVector® Durable Lining has been designed to remain efficacious for minimum three years. It can be applied in rural settings with minimal supervision.
Long lasting insecticidal nets

- Long lasting insecticidal net commonly abbreviated as (LLIN or LN by WHO) is “A net treated at factory level with insecticide either incorporated into or coated around fibers resisting to multiple washes and whose biological activity last as long as the net itself” (3/5 years) for polyester/polyethylene nets (WHO, 2001, 2003, 2004, 2007).

- The efficacy of LN can be expressed in terms of wash resistance for maintaining sufficient insecticide concentration for more than 95% of knockdown of target mosquito vector species and more than 80% mortality for at least 20 serial washings in laboratory. The insecticidal efficacy of the nets should persist for at least 20 WHO standard washes. (WHO, 2005).
WHO recommended long-lasting insecticidal mosquito nets (LLINs)

- **Olyset®** Permethrin incorporated into polyethylene Full Published
- **PermaNet® 2.0** Deltamethrin coated on polyester Full Published
- **Yorkool® LN** Deltamethrin coated on polyester Full Published
- **DawaPlus® 2.0** Deltamethrin coated on polyester Interim Published
- **Duranet®** Alpha-cypermethrin incorporated into polyethylene Interim Published
- **Interceptor®** Alpha-cypermethrin coated on polyester Interim Published
- **LifeNet®** Deltamethrin incorporated into polypropylene Interim - Published
- **Netprotect®** Deltamethrin incorporated into polyethylene Interim Published
- **PermaNet® 2.5** Deltamethrin coated on polyester with strengthened border Interim Published
- **PermaNet® 3.0** Combination of deltamethrin coated on polyester with strengthened border (side panels) and deltamethrin and PBO incorporated into polyethylene (roof) Interim Published
Net ageing 1-5 years: Olyset Net vs. Coated Polyester Net

**Olyset Net**

Above: For Olyset Net, permethrin migrates to the surface of the net fibre over a five year period, maintaining a constant surface concentration. This technology enables Sumitomo Chemical to guarantee Olyset’s insecticidal performance for five years.

**Coated Polyester LLIN**

Left: For coated polyester LLINs, the surface concentration of insecticide declines over a three year period.

Polyester net surface coated with insecticide particles
The present study is on Olyset® nets which were distributed in Khandera village in August 2004 by NIMR. The present study was continued to assess its efficacy after 5 years of distribution till August 2011 (up to 7 years of distribution) against An. culicifacies rural malaria vector in District Gautam Budh Nagar, U.P, India.

Field evaluation of Olyset® was done for year (2008-2009), (2009- 2010), (2010- 2011) and the data on various entomological and parasitological parameters were compared with the pre-distribution data to evaluate the efficacy of LN in the concerned village and also with the data of control villages.
Study Areas

Rural area in western UP:

Three villages, with similar malaria endemicity, topography and mosquito prevalence in the district G.B.Nagar were selected where malaria is transmitted mainly by *Anopheles culicifacies* have been selected for the present study named Khandera (Olyset® net distributed in August 2004) and Beel Akbarpur where untreated nets were distributed and Anandpur where no nets were distributed.
## Study Area & Target population

<table>
<thead>
<tr>
<th>Study villages</th>
<th>Type of Net</th>
<th>Population</th>
<th>No. of houses</th>
<th>Net distributed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Khandera</td>
<td>Olyset ®Net</td>
<td>2000</td>
<td>265</td>
<td>701</td>
<td>502</td>
</tr>
<tr>
<td>Beel Akbarpur</td>
<td>Untreated plain net</td>
<td>1800</td>
<td>214</td>
<td>719</td>
<td>570</td>
</tr>
<tr>
<td>Anandpur</td>
<td>No net</td>
<td>2000</td>
<td>213</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Mosquito nets were distributed to the villagers in August 2004*
Map showing the location of different study villages in Dadri CHC Gautam Budh Nagar U.P

Khandera - Olyset® net, Beel Akbarpur - untreated net, Anandpur - no net
Material and Methodology

- Cone bioassays
- Ring net bioassays
- Tunnel bioassays under laboratory conditions
- Percent reduction in average density
- Entry and landing rates
- Parity rate
- Durability and net retention under field conditions
- Mass blood survey
- Community acceptance
Percent mortality of *An. culicifacies* against Olyset® nets collected randomly from Khandera village after 5, 6 and 7 years of use under field conditions in comparison to fresh unwashed Olyset® net.
Median knock down time of *An. culicifacies* against Olyset® nets collected randomly from Khandera village after 5, 6 and 7 years of use under field conditions in comparison to fresh unwashed Olyset ® net

![Graph showing median knock down time of An. culicifacies](attachment:graph.png)
Total mortality, entry rate and feeding success of Olyset® collected randomly from Khandera village after 7 years of continuous use in the field against *An.stephensi* in comparison with Fresh unwashed Olyset® nets tunnel test.

Total 10 replicates were used and 100 mosquitoes were tested against each net (100x 10= 1000 mosquitoes).
Percentage reduction in Average density of *An.culicifacies* and total mosquitoes in Olyset® net village compared to untreated net village and without net village.
Percentage protection from entry of *An. culicifacies* and other mosquitoes in Khandera village and untreated net village as compared to without net village

![Bar chart showing percentage protection from entry of *An. culicifacies* and other mosquitoes in Khandera village and untreated net village as compared to without net village. The chart compares the percentage protection after 1 year of distribution in 2004 and after 7 years of distribution in 2011 for *An. culicifacies* and total mosquitoes, with data presented for Olyset® net and untreated net.](chart.png)
Percentage protection from landing of *An. culicifacies* and other mosquitoes in Khandera village and untreated net village as compared to without net village.

<table>
<thead>
<tr>
<th></th>
<th>After 1 year of distribution 2004</th>
<th>After 7 year of distribution 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>An. culicifacies</strong></td>
<td><img src="#" alt="Graph showing percentage protection for An. culicifacies" /></td>
<td><img src="#" alt="Graph showing percentage protection for An. culicifacies" /></td>
</tr>
<tr>
<td><strong>Total mosquitoes</strong></td>
<td><img src="#" alt="Graph showing percentage protection for total mosquitoes" /></td>
<td><img src="#" alt="Graph showing percentage protection for total mosquitoes" /></td>
</tr>
<tr>
<td><strong>Olyset®net</strong></td>
<td><img src="#" alt="Bars for Olyset®net" /></td>
<td><img src="#" alt="Bars for Olyset®net" /></td>
</tr>
<tr>
<td><strong>Untreated net</strong></td>
<td><img src="#" alt="Bars for Untreated net" /></td>
<td><img src="#" alt="Bars for Untreated net" /></td>
</tr>
</tbody>
</table>
Parity rate of *Anopheles culiciifacies* in villages with Olyset net or untreated net or without net from August 2008 to July 2011
Net survivorship (net retention) of Olyset® Nets (distributed originally in 2004) after 5, 6 and 7 years of use in Khandera village of Dadri CHC, Distt. Gautam Budh Nagar, U.P.

(Number of Olyset® net issued in Aug 2004 – 1203 nets)
Criteria used for classifying the nets
Good condition - if the net has < 5 small holes/net.
Partially torn if the net has 5-15 thumb size holes or < 5 fist size holes/net
Completely torn out if the net has > 15 thumb size holes and 5 fist size holes/net or larger than a head >25 cm
Durability (physical condition) of Olyset® net distributed in the year 2004 in village Khandera P.H.C Dadri, District Gautam Budh Nagar (U.P.) after 5, 6, 7 years of use.

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total no of holes</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Average number of holes/net</td>
<td>20</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Mean hole index</td>
<td>40</td>
<td>50</td>
<td>60</td>
</tr>
</tbody>
</table>

**Graph Description:**
- The graph shows the total number of holes, average number of holes per net, and mean hole index for Olyset® nets distributed in Khandera P.H.C Dadri after 5, 6, and 7 years.
- The data indicates an increase in the number of holes and a decrease in the mean hole index over the years of usage.
Results of mass blood surveys regardless of fever in the Olyset village, untreated net village and without net village from 5th year of distribution to 7th year of distribution (October 2008 to October 2011) in comparison to Oct 2004 (after 1 year of distribution)
### Specifications of LLINs/bed nets distributed in LLIN villages/untreated net villages

<table>
<thead>
<tr>
<th>LLIN villages &amp; name of nets distributed</th>
<th>Population</th>
<th>Number of net distributed</th>
<th>Month &amp; year of distribution</th>
<th>No. of people interviewed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khandera (Olyset®)</td>
<td>1800</td>
<td>1203</td>
<td>August 2004</td>
<td>102</td>
</tr>
<tr>
<td>Dairykoat (PermaNet®2.0)</td>
<td>1187</td>
<td>1084</td>
<td>May 2007</td>
<td>394</td>
</tr>
<tr>
<td>Gulawati Khurd (Icon® Life)</td>
<td>1381</td>
<td>1233</td>
<td>May 2008</td>
<td>100</td>
</tr>
<tr>
<td>Total number of respondents</td>
<td></td>
<td></td>
<td></td>
<td>596</td>
</tr>
</tbody>
</table>

*Untreated net villages*

<table>
<thead>
<tr>
<th>Untreated net villages</th>
<th>Population</th>
<th>Number of net distributed</th>
<th>Month &amp; year of distribution</th>
<th>No. of people interviewed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beel Akbarpur</td>
<td>1800</td>
<td>1289</td>
<td>August 2004</td>
<td>87</td>
</tr>
<tr>
<td>Phoolpur</td>
<td>1155</td>
<td>1052</td>
<td>May 2007</td>
<td>100</td>
</tr>
<tr>
<td>Nangla Chamru</td>
<td>1840</td>
<td>1600</td>
<td>May 2008</td>
<td>120</td>
</tr>
<tr>
<td>Total number of respondents</td>
<td></td>
<td></td>
<td></td>
<td>307</td>
</tr>
</tbody>
</table>
Respondents perceptions on percent reduction in target and non-target pests

- Mosquitoes: 98.8%
- Bedbugs: 96.6%
- Head lice: 91.9%

The chart compares perceptions between LLIN villages and untreated net villages.
Respondents willingness and recommendations for buying LLINs

<table>
<thead>
<tr>
<th>Willingness to purchase (% yes)</th>
<th>Recommend others to purchase bednets (% yes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LLIN villages</strong></td>
<td><strong>Untreated net villages</strong></td>
</tr>
<tr>
<td>93.2</td>
<td>65.7</td>
</tr>
<tr>
<td>93.9</td>
<td>72.3</td>
</tr>
</tbody>
</table>
Conclusions

- Long lasting insecticidal products are gaining popularity in terms of their efficacy against the vector borne diseases.

- LLINs are widely used method against vector borne diseases.

- Long lasting effect of Olyset® against malaria vectors was observed even after 5 years of recommended period of use by WHO.

- In this study Olyset® undoubtedly proves to be effective vector control option against malaria vectors even during 7th year of use under field conditions.

- Community members showed their willingness to buy Olyset® if available at nominal prices.

- Overall there is a very promising future ahead in relation to these new technologies if community members made aware about these technologies.

- IEC activities may be encouraged more to inform the community members about the potential benefits of these technologies against vectors which lead to more awareness and acceptability.
Thank you