LLIN DURABILITY
Objectives

• Monitor durability of LLIN distributed through mass campaigns in 2-3 sites per country
  – Compare same brand – different place
  – Compare two brands – same place
• Better understand determinants that drive LLIN durability
• Strengthen capacity
  – To undertake DM and other surveys
  – Specific DM skills
VectorWorks produced:

- Standard protocol for prospective cohort approach
- Complete suite of tools for data collection, analysis and reporting
- [www.durabilitymonitoring.org](http://www.durabilitymonitoring.org)
LLIN Durability Monitoring supported by VectorWorks

- Nigeria
- DRC
- Zanzibar (TZ)
- Mozambique
- Zambia
- Myanmar
- Liberia
- Ghana
- Kenya
# LLIN Durability Monitoring Designs

## Different socio-ecological environment - Same/similar LLIN brand

<table>
<thead>
<tr>
<th>Location</th>
<th>Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mozambique</td>
<td>Royal Sentry/MagNet</td>
</tr>
<tr>
<td>Nigeria</td>
<td>DawaPlus 2.0</td>
</tr>
</tbody>
</table>

## Same socio-ecological environment - Two LLIN brands

<table>
<thead>
<tr>
<th>Location</th>
<th>Brand 1</th>
<th>Brand 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zanzibar</td>
<td>PermaNet 2.0</td>
<td>Olyset</td>
</tr>
<tr>
<td>DRC</td>
<td>DawaPlus 2.0</td>
<td>DuraNet</td>
</tr>
<tr>
<td>Myanmar</td>
<td>Dawa Plus 2.0</td>
<td>Permanet 2.0</td>
</tr>
</tbody>
</table>
LLIN Durability Monitoring Designs

- VectorWorks supports new LLIN durability monitoring activities in 4 countries starting in 2018, handed over at the end of VectorWorks to VectorLinks

Different socio-ecological environment - Same/similar LLIN brand

Liberia
- DuraNet

Same socio-ecological environment - Different LLIN brands

Kenya
- DawaPlus 2.0
- DuraNet

Ghana
- DawaPlus 2.0
- Olyset
Design

- Representative, prospective cohort study of campaign LLIN
Physical Durability - Outcome

• Combining attrition (nets lost) with integrity (physical condition of net)

\[
\text{% surviving to time } x = \frac{\text{# of LN present and “serviceable” at time } x}{\text{# of LN originally received and not given away at time } x} \times 100
\]
Insecticidal Durability - Bioassay

• Insecticidal effectiveness measured by standard WHO cone test
• Also tunnel test for Olyset if failed in cone test

Optimal effectiveness:
KD60 ≥ 95% or 24h functional mortality ≥ 80%

Minimal effectiveness:
KD60 ≥ 75% or 24h functional mortality ≥ 50%
What we found – physical durability

- Comparing same or similar LLIN brands in different settings

- Survival analysis confirms:
  - Nampula lower than Tete or Inhambane
  - Zamfara higher than Ebonyi and Oyo
What we found – physical durability

• Comparing two different LLIN brands in similar settings

- DRC: DuraNet vs. DawaPlus
  - 2.7 yrs
  - 1.7 yrs

- Zanzibar: PermaNet vs. Olyset
  - 2.9 yrs
  - 2.2 yrs

• Survival analysis confirms:
  - DuraNet in DRC better than DawaPlus 2.0
  - Olyset in Zanzibar worse than PermaNet 2.0
What we found – physical durability

• Comparing two different LLIN brands in similar settings

- 94% of households had non-cohort nets (56% untreated)
- Of cohort nets 81% ever used
- But at each time point only 43% to 53% hanging
- Ever hanging nets were only found hanging 60% of times seen

• Survival analysis shows:
  - Some evidence of difference between brands
  - Estimated median survival 4.2 and 3.9 years

Myanmar: PermaNet vs. DawaPlus
What we found – physical durability

- **Two different LLIN brands**
- **Same LLIN brand**

### Kenya: DawaPlus vs. DuraNet
- 2.1 yrs
- 1.6 yrs

### Liberia: DuraNet
- 4.6 yrs
- 3.7 yrs
What we found – physical durability

DawaPlus 2.0

DuraNet

Nets surviving in functional condition in %

Years since distribution

Nets surviving in functional condition in %

Years since distribution
What we found – physical durability

Some differences between brands
Huge differences between sites

DawaPlus 2.0

DuraNet, Royal Sentry, MagNet

Nets surviving in functional condition in %

Years since distribution

1-year
2-year
3-year
4-year
5-year
6-year
7-year
Nigeria Ebonyi
Nigeria Zamfara
Nigeria Oyo
DRC Mongala
Kenya Busia
Myanmar Tamu 2

1-year
2-year
3-year
4-year
5-year
6-year
7-year
DRC Sud Ubangi
Liberia Lofa
Liberia Grand Gedeh
Kenya Kwale
Mozambique Inhambane Royal Sentry
Mozambique Nampula Royal Sentry
Mozambique Tete Magnet
Key determinants

• Factors of net use environment and net handling were explored
• Variables were assessed across follow-up surveys
• Composite “net care attitude” score calculated
• There was some variation of the combination or intensity of determinant factors between countries
• But some clear trends across the four African countries emerged
Net Attitude and Net Durability

Household recorded very positive net care attitude score across surveys.

Adjusted Hazard Ratio for failure to survive in serviceable condition

- never
- once
- twice or more
Key determinants

- A very positive attitude towards net care is preventive
- A net only used by adults “lives longer”
- Never folding up the net during the day is a bad idea
- Having more than two children under 10 year in your HH increases risks to the net
- Type of sleeping place may be important but can be overcome by “good care behavior”
- In some settings female headed households do a slightly better job of protecting their nets
Risk Index

- Can we predict the physical durability from knowing the constellation of risk factors at baseline?

<table>
<thead>
<tr>
<th>Element and indicator</th>
<th>Sub-category weight</th>
<th>Within category weight</th>
<th>Category weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Net handling factors</strong></td>
<td>100</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Ever store food in sleeping room</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever cook in sleeping room</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net hanging</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net NOT tied/folded when hanging</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net dried on fence/bush</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Environment factors</strong></td>
<td>100</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>House walls grass/mud</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooking fuel firewood</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rodents seen around house</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleeping place</td>
<td>100</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Bedframe</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mattress</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mat or ground</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net care and repair (risk)</strong></td>
<td>100-x</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Net care and repair</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recalls &quot;care for your net&quot;</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recalls &quot;repair your net&quot;</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net care attitude score &gt;1.0</td>
<td>90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Risk Index

- $R^2=0.53; \ p=0.004$
- A reduction of the risk index by 10 points could extend medium survival by 0.5 years
Hanging of nets

- Initially many nets were still in the package
- Some were never hung
Hanging of nets

• We found that use was closely linked to hanging
• And hanging dependent on three major factors
  – Availability of other nets in the household
  – Overall net supply situation in household
  – The physical condition of the net
Hanging of nets

- Torn and very torn nets were still used, but increasingly less.
- Good nets seemed to be hung less.

But only at baseline.
Hanging of nets

- Two pattern emerged:
  - High supply level and non-cohort nets were used first
  - Declining supply and cohort nets used quickly but as need arises use of non-cohort nets increased
Hanging of nets

- What impact has delay of hanging on survival estimates?

Adjusted parametric survival model

Differences 0.2 to 1.0 yrs
Pooled: 0.85 yrs
Repairing damaged nets

- Level of repairs varied but seemed to only increase when damage was already significant
Survival analysis starting risk of “failure” at time of first hole shows absolutely no impact of repairs on survival in serviceable condition.
Insecticidal effectiveness

• At 36 months of follow up DawaPlus had >80% optimal effectiveness in Nigeria but failed in DRC and Kenya (after only 12 months)
• Also good results for PermaNet in Unguja
• Ambiguous results in Myanmar for DawaPlus and PermaNet as low bio-assay results at all time points
  – Chemical residue at 36 months >80% with >25mg/m² deltamethrin and in total >50% of target dose
Insecticidal effectiveness

- At 36 months follow-up DuraNet in DRC and Olyset in Pemba had >80% optimal performance.
  - Also acceptable after 12 months in Kenya and Liberia
- Royal Sentry and MagNet in Mozambique had >80% up to 24 months, then declined.
  - Still >80% minimal effectiveness
  - Chemical residue by CDC shows median alphacypermethrin of
    Inhambane: 4.7 g/kg (81% of target)
    Nampula: 1.9 g/kg (32% of target)
    Tete: 2.4 g/kg (41% of target)
So what does all this mean?
Do we need to replace nets more frequently

• In some places such as DRC probably, at least temporarily

• In others a longer interval could be considered
  – If we have sufficient evidence that the insecticidal effectiveness keeps up
Would it help to have ‘more durable nets’

• Certainly, but how do we make them more durable (what do we need to change) and still be cost-effective?

• How do we provide the evidence that a product will perform better in a “standard” use environment and incorporate that into the procurement process?
  – A problem left hanging in 2014
  – “Resistance to Damage” textile Index
  – Semi-field standardized rapid testing of promising new products
Is there room to improve net care

• Definitely, but we also need to better understand the dynamics and interactions at play
• Definitely should focus on preventive behaviors and not repair