Minutes of the 1st Meeting of Durability of LLINs in the Field Work Stream

Wednesday 9th February 2011
IFRC, Geneva, Switzerland

Work stream leader: Albert Kilian (Malaria Consortium)
Rapporteur: Sarah Hoibak
Number of participants: 39

Summary of the Outputs of the Meeting

Major agreements and recommendations

1. Use of a proportionate Hole Index (HI) to standardize categorization of LLIN physical condition.
2. Improved methods to test textile performance in lab.
3. Testing field-used Long Lasting Insecticidal Nets (LLINs) in hut trials to observe protection as function of insecticide and holes.
4. Incorporate hole measure in large surveys to establish epidemiological effects.
5. Explore potential of care and repair Behavior Change Communication (BCC) to prolong durability.
6. Explore how to influence perceptions of durability.

Work ahead

1. Review of existing literature (published and grey).
2. Make current tools available on Roll Back Malaria (RBM) website.
3. Consensus statement on HI.
4. Organize meeting on new methods of textile testing.
5. Propose durability questions to Monitoring and Evaluation Reference Group (MERG) for Malaria Indicator Survey (MIS)/Demographic and Health Surveys (DHS).

Presentation 1: LLIN Durability – Construction and Application of a Proportionate Hole Index (Albert Kilian)

Suggestion of a proportionate Hole Index (pHI) calculation to determine “net integrity” and which can be used with preliminary cut-off levels to categorize “good” or “serviceable” and nets “too torn”. Something we can use to contribute to assessment of “useful life” of LLINs in the field through surveys. This can be done in two ways:
1. Cross-sectional retrospective surveys: limited by attrition of nets in a certain state, and what remains are only surviving nets. Unable to evaluate those discarded.
2. Longitudinal: preferred to show attrition and condition of surviving nets and to follow those that leave their intended purpose as an LLIN.

Ideally net assessment could be done at the lab level, however taking nets into a lab a draping them over a frame (like work of Stephen Smith – CDC) is labour intensive, and not feasible at field level, so we move to the possible use of ranking holes by size that can be easily measured. Taking three sizes of holes we are able to calculate an index that is proportionate to the approximate surface area on the net based on:
size 1: 0.5-2cm; size 2: 2-10 cm; size 3: >10 cm
Then we are weighting the summary of holes to approximate ratio of hole surface of the different hole sizes for a total hole index which is then proportionate to the total hole surface of the net: pHI= (1 x # size 1) + (9 x #size 2) + (56 x # size 3)

From there we are able to create categories of nets (these categories can change based on available information on epidemiology etc. that comes in the future and data can be reanalyzed retrospectively), but at the least now a standard comparable way of collecting data across surveys. Several options are available for setting thresholds and different nomenclature: serviceable to very torn (unusable).

Discussion
- How do we consider the repairs of holes when counting the holes in the nets? Does this matter?
- Weight given to bigger holes. Some papers recommend measuring the linear length of the hole.
- In terms of the weighting are there other categories?
- Does is matter where the holes are on the nets and how that related to the bionomics of mosquitos? Lack of data on just how a mosquito gets into a net.
- Will we need to factor in the “shape” of the net?
- Do we need to factor in “where the holes are on the net”?
- What about insecticide resistance issues?
- Behaviour component. How to properly maintain their nets to maximize their life span? (Could manufacturers put additional scrap fabric with nets to use as a patch kit?)

Presentation 2: Determination of Strength of Mosquito Nets – Influence of Knitting Pattern, Square Meter Weight and Denier (Ole Skovmand)
Current laboratory tests on strength of nets do not reflect how nets have performed in the field. Tests were done to look at additional measures on several model nets with different yarn patterns, square meter weight and denier. Tests performed at CITEVE (Technology Center for Textile Industry).
1. Bursting strength, push object through a net.
2. Tension strength: nail in net and pull down (one grab/one hook).

Results show:
- As a class Polyethylene (PE) is stronger than Polyester (PET) in tension strength
  grab and hook.
- Tighter knitting with 75 denier yarn. Density of holes (mesh) does not improve
  the tension strength grab and hook.

Discussion
- Important to consider the length and width of material. Yarns currently are
  woven such that come down in parallel fashion which makes the net more
  elastic, yet weaker. Can just make stronger nets by turning them.

Presentation 3: Type of Alternate Tests (Gerhard Hesse)
There are two textile institutes in France and Germany that Bayer has been working
with for alternative net durability testing from a “textile” point of view. Real life
measurements on all three current fabrics (Polyethylene, Polyester, and Polypropylene)
- Abrasion tests, marindale test. Movements (random) on the surface fabric,
  fraying until there is a hole (automobile and textile industry).
- Attrition. Filaments getting thinner and lighter (all three materials are the same).
- The slow nail test. Pull it to the point of rupture. Resistance of fabric to ripping
  breaking after foreign object enters (length and width–polyethylene and
  polypropylene. Same in length but different in width.
- Rapid movement. Dynamic nail test, really close to ripping. Typical movement
  (like you pull your mosquito net aside).
- Ball bursting/punching test. Physical test during all its lifetime. Stress the net and
  then relax. Metal ball punching the same side of the mosquito net. Fatigue
  effect. Accelerated aging–fatigue effect after daily use of the net. Cyclic bursting
  test. In cycles to show fatigue.
- Tensile cycling. Pulling at a point until fatigue.
- Polypropylene and PET quite similar in pure physical testing and stronger than
  PE.
- These are all ISO tests and results will be published.

Discussion
- If we succeed in persuading donors and agencies to include durability criretia for
  large procurements of LLIN, we will have data sets which combine different lab
  measures (holes and insecticide availability) for different environments as a
  reference for specifications.
- CDC study: 7 brands in 3 locations (Malawi, Kenya, and Senegal) and Malaria
  Consortium (Western Uganda) randomly distributed 7 brands. So there is data
  being captured on durability and attrition rates.
Is it easy to determine how the holes are created: burn holes, tears, seem holes, rat holes? Seems easy to identify the burns and animal chewing.

**Presentation 4: Testing in Huts of Field used LLINs (Mark Rowland)**
Effectiveness is related to the number of holes and amount of insecticide on the net. Over course of use insecticide concentration will fall away and over that same period number of holes will accumulate, but not just a function of holes and insecticide.

- WHOPES – bioassay – 80% kill.
- Actual chemical content.
- Proportion of holes.
- What does it mean in practice to functional efficacy of a net?
- Personal protection from these nets.
- Experimental hut: mortality and blood feeding able to achieve through feeding through the holes.

Use standard WHO technique. Certain insecticide level is killing or protecting at 1, 2, 3 years of field use and assess by taking samples from the field. This going forward will help to make an accurate assessment.

**Discussion**
- What does this mean in terms of resistance? Are these nets protective against resistance?
- Should we be asking MIS to record hole size, shape and type of net in their surveys, as an opt in/opt out module?
- Are there ethical implications? When do you put someone in a net like that? WHO standards with subjects on prophylaxis and access to treatment.
- Comment on where risk of arboviruses circulating, then that would make a difference.

**Presentation 5: Survey Data on Holes and Protection (Immo Kleinschmidt)**
- Net use, net condition and infection with malarial parasites from population surveys (Equitorial Guinea (Bioko Island and mainland), Malawi).
- Not a sophisticated hole index. Simple classification, any holes, A size battery, and larger than D size. Crude categories. Presence or absence of holes.
- Categories of nets following MERG recommended definitions: LLIN, ITN, untreated.
- Those who slept under nets with no holes or small holes odds ratio [OR] =0.65 for parasitemia.
- Overall coverage at the site, coverage <60% no protection gained if you were not under a net. No protective community effect seen.
- Need to generalize a standardized way to look at the condition of net used and infection status. Multiple countries with susceptible mosquitoes.
Discussion

- Adjust for Socio-Economic Status (SES) was done in the analysis.
- Do the experimental hut studies fit these outcomes?
- Could the MIS/DHS opt in for an extended bednet component?
- Western Uganda, a large survey midterm evaluation of Integrated Community-based Case Management (ICCM) coming up on parasitaemia and anemia. If an assessment of holes were included, data could be analysed for possible associations between physical condition and infection parameters.
- Community protection needs to play back into the model. We do need to/want to keep the population level control. Modeling options with Tom Smith’s group (Swiss TPH) could vary by the level of transmission.
- BCC issues, take forward in countries, net use. Net repair, net conversion, measuring how to track how they are changing their habits.
- Care and Repair kits will be used in Equatorial Guinea (Immo Kleinschmidt can share with work stream).
- Modeling larger data sets critically needed at higher coverage and also with heterogeneity of coverage.
- Density of the population. Can be done with GPS coordinates.

Work Stream Products for 2011
Expect continued data collection on durability in the field, hut trials (with resistance), epidemiological impact in field studies (holed nets) and behavior change activities to improve net maintenance.

What potentially can be done?
2. Consensus statement from work stream.
3. A collection of tools for measuring durability housed on the RBM website.
4. Durability module, suggested questions that can be added into MIS/DHS proposed to MERG.
5. Standard Operating Procedure (SOP)/Guidelines for how to measure durability (WHOPES/WHO for part of work).
7. Measuring the different decay/attrition rates in different contexts with different products.
8. Net manufacturers and textile testing institutes, should have a workshop with WHO in an official frame (CropLife, IIC, CITEVE) WHOPES and GMP for testing methods to discuss new methods for testing physical strength.
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ACRONYMS
BCC: Behavior Change Communication
CDC: Centers of Disease Control and Prevention
CITEVE: Technology Center for Textile Industry
DHS: Demographic and Health Surveys
GPS: Global Positioning System
HI: Hole Index
ICCM: Integrated Community-based Case Management
IIC: Intelligent Insect Control
ITN: Insecticide Treated Net
LLINs: Long Lasting Insecticidal Nets
MIS: Malaria Indicator Survey
MERG: Monitoring and Evaluation Reference Group
OR: Odds Ratio
pHI: proportionate Hole Index
PE: Polyethylene
PET: Polyester
RBM: Roll Back Malaria
SES: Socio-Economic Status
SOP: Standard Operating Procedure
WHOPES: WHO Pesticide Evaluation Scheme