RBM Vector Control Working Group

Durability of LLINs in the Field Work Stream

Progress on 2012 Work Plan – Albert Kilian, TropHealth, Spain

The 2012 Work Plan included the following objectives:

- To hold a follow-up textile meeting.
- To improve field methods for specifying the cause of holes in nets.
- To explore the potential of Behavior Change Communication (BCC) interventions.
- To encourage studies investigating the level at which the number of holes with given concentrations of insecticide protection fails.

No funding was received from RBM. In 2012 there were six publications contributing to existing knowledge on LN durability; four on attrition and integrity, one on the efficacy of holed ITNs and one on the cost savings of nets with a longer life.

Future plans and issues include the publication of the WHOPES 'Guidelines for Monitoring the Durability of LLINs under operational conditions', together with the development of guidance on how to use attrition, integrity and insecticide functional data to calculate 'net life'.

Discussion

Making generalizations about nets having a three- or five-year life span may not be sensible since the way nets are treated varies dramatically. Every program should measure durability within their own contexts. There was some discussion of the ethics of conducting prospective studies; study participants will need to be informed that study staff will return, hence it is not possible to get reliable attrition data. The concepts of cohort service time (e.g. how much time will elapse before x% nets are no longer effective) and half-life are important. The environment in which the net is used should be considered when deciding which type of net is most appropriate (e.g. type of mattress or mat, proximity to fires).

4th Durability of LLINs in the Field Work Stream Meeting
13.00-15.00, Tuesday 29th January 2013
Auditorium, IFRC, Geneva

Chairs: Albert Kilian and Steve Smith
Rapporteur: Lucy Tusting

Ongoing and planned durability work: field work

Uganda and Nigeria– Albert Kilian, Trop Health, Spain

A prospective LN study is underway in four villages near Kyenjojo, Western Uganda. Seven LLIN brands (150 per brand) are being tested, all 100-150 denier. The study is ongoing however preliminary data indicates that a 12% attrition rate after 24 months, with 6% loss to damage. In terms of physical integrity, there is ≈90% survival after three years and little difference between brands to date.

Multiple cross-sectional surveys are being conducted to determine the physical survival of LLINs from campaigns in three ecologically different states in Nigeria. Imbedded into this is an intervention-control study to evaluate the impact of improved care and repair on deterioration of the nets. This is a three-year study with 20 clusters in each of 4 sites, with 15 households per cluster. A care and repair of nets BCC campaign was conducted at one site. Another site in the same state serves as control. All nets distributed were 100 denier. Year 1 data from 900 households and 2,028 nets indicates little difference between intervention and control sites with little or no repair of holes.

PMI studies – John Gimnig, Centers for Disease Control and Prevention (CDC), USA

The President's Malaria Initiative (PMI) has made significant investments in LLINs with 22.5 million procured in 2012 and US$120 million set aside for procurement and US$30 million for delivery in 2013. Durability studies have been established in eight countries: Angola, Benin, Kenya, Malawi, Mozambique, Rwanda, Senegal and Zambia. Insecticidal activity and content, physical integrity and attrition are all being assessed. In the Kenya and Malawi studies, 600-800 nets of each brand were distributed and revisited every 6 months. In addition, 30 nets of each type are randomly sampled and replaced every 6 months, to allow for analysis of holes and biological efficacy.

Preliminary data from Kenya indicates that a large proportion of nets were lost after 24 months, the most common reason for attrition being that nets were moved or taken from the house, lost or stolen, sold or given away. After 24 months, there is a range of 1 to 4 holes per net across all brands and large differences in the median hole area between brands. In Malawi, more holes have been observed earlier, and these holes are larger. There are differences in socio-economic conditions between Kenya and Malawi and the types of sleeping place differ, with palm and reed mats more common in Malawi which may cause damage. In Mozambique, a study was conducted to assess differences in LLIN durability by fabric type. Polyethylene LLINs had significantly more damage than polyester nets. To conclude, many nets last less than three years, although insecticidal activity may last longer. Polyester nets may be more durable physically. Durability is most likely linked to

environmental or socio-economic factors. Further work should include defining a threshold for 'net failure' (at what point do nets cease to provide a physical barrier?), defining the useful life of a cohort of nets and fine-tuning BCC after establishing a scientific definition of net failure.

ABCDR study, Tanzania – Hans Overgaard, Norwegian University of Life Sciences, Norway

The objective of this new study is to determine the useful life of LLIN products through (1) a retrospective study of Olyset nets distributed by the Tanzanian government in 2009 and (2) a prospective study. The study aims to evaluate attrition (A), biological efficacy (B), chemical residue (C), physical degradation (D) and insecticide resistance (R). The retrospective study will enrol 100 villages with 45 household per village and use a three-stage random sampling survey to assess ABCD components for Olyset nets. The prospective study will enroll 100 villages with 45 household per village, with households randomly assigned different brands of net (Olyset, Permanet 2.0, LifeNet). Follow-up will be conducted at 12, 24, 30 and 36 months to assess overall attrition and deterioration. A further sub-sample of nets will also be assessed for BCD components using WHO recommendations for testing. A spatial analysis will be conducted to identify potential risk factors for net loss or loss of effectiveness.

Ongoing and planned durability work: laboratory work

Development of laboratory tests for the physical durability of LLINs – Steve Smith, CDC, USA

Work conducted at North Carolina State University was presented. Textile structure affects durability of nets. Net fabric is manufactured through warp knitting, with different knitting patterns for polyester, polypropylene and polyethylene. Severing one or more yarns leads to raveling in parallel to the yarn orientation hence oval holes in the warp direction. Potentially useful tests include susceptibility to initial hole formation, strength loss after hole formation and resistance to raveling. These properties were tested in a variety of net brands. Olyset and DuraNet performed best in a test of resistance to tearing by snagging, building on methods developed by Skovmand and Bosselmann (2011). In a test of strength loss after yarn severing, polyester and polypropylene nets perform best. An abrasion tester was used to assess raveling resistance using was also conducted with inconsistent results. To conclude, multiple tests are required to predict durability. Users should be encouraged to repair even small holes. Correlation with field results is needed.

GMP/WHOPES project on LLIN fabric strength – Morteza Zaim, WHO, Switzerland

WHOPES currently recommends 13 LLINs. The current WHO specifications for quality control of nets currently list one marker of net strength only and it is therefore necessary to revisit WHO criteria and specifications for quality control. There is also a lack of comparative data on durability of LLINs in different settings to support procurement decisions. To address this, a GMP/WHOPES project on LLIN fabric strength is planned as a medium-term solution. As part of this study, WHO invites all manufacturers of nets to submit three intact nets from separate batches for an evaluation of fabric weight per unit area, tear strength, bursting strength, tensile strength and flammability. A standard form will also be required to be submitted alongside the nets. The deadline for registering interest is the end of January. A WHO consultation with LLIN industry partners and textile research institutions will review the outcomes of the study.

Causes and modes of deterioration – Albert Kilian, Trop Health, Spain

Guidance on the expected performance of LLIN products is required. It is also necessary to develop a test battery that can predict expected performance, and for that a better understanding of 'modes of failure' is needed. Current field tests do not correlate well with laboratory textile tests. In a project funded by the Bill and Melinda Gates Foundation, LLIN samples aged 1-2 years will be collected and analysed, with findings submitted to WHO to update procurement guidance. 500-600 net samples will be collected from existing CDC/PMI studies, from active sample in Nigeria and Cambodia and from ongoing WHOPES Phase III studies. Laboratory forensic textile analysis will include visual inspection and microscopy. The textile testing data will be combined with household and environmental data. Field work will commence in March and Phase I will be complete by October 2013. It will then be decided whether the study will move to Phase II in November/December 2013, to develop a suite of suitable textile tests which better reflect expected LLIN performance in the field and which can be used by WHO to develop a procurement guidance of LLIN durability.

Mosquito entry, effects of hole size and location – Robert Wirtz, CDC, USA

A project was conducted to analyse mosquito entry into failed bednets with holes. First, the interaction of mosquitoes with holes was assessed. It was found that there is a fringe area 2.6mm wide around the edge of a hole, where mosquitoes are likely to come into contact with the net. This fringe area therefore reduces the effective size of the hole, with longer, thinner holes having a greater fringe effect. It was also investigated how mosquito pressure varies across bednets, i.e. at what points does a mosquito attempt to enter a net with a CO2-baited light trap. It was found that holes in the net roof had a disproportionately high impact on mosquito entry. Results also varied depending on mosquito species used. Different individuals catch different numbers of mosquitoes. These findings were used to analyse whether the WHO hole index is a sufficient metric to describe net failure. Field tests in CA and FL were conducted. In FL, of a total mosquito pressure of 2637, a 10cm hole diameter allowed 639 (24%) adults to enter and a 25cm hole diameter allowed 888 (33%) to enter. Work is also underway to develop a SOP for use in endemic settings to evaluate a new attractant mixture with CO_2, to assess hole size and location, untreated and treated nets and resistant vectors.

Discussion - All

It was suggested that more tests may need to be considered (e.g. an alternative to the hook test for susceptibility to hole formation), and the standards for assessing nets clearly laid out. There have been two WHO consultations on this to date, and WHOPES would like to work with industry experts to clarify the tests used. It was suggested that it may be better to postpone the re-analysis of different net brands until the test procedures have been finalised. Given the importance of holes, it would be valuable to increase BCC efforts to encourage the repair of nets.

Actions and 2013 Work Plan

In 2013, clear guidance from WHO is needed on analysing and combining data on attrition, integrity and insecticidal protection into an estimate of 'net survival'. An inventory of ongoing field and lab studies will be drawn up to aid future data dissemination.

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Agenda	
12:00 – 13:00	Lunch
	Poster viewing
13:00 – 13:06	Welcome and introductory remarks
Presentation on ongoing and planned durability work: Field work	
13:06 – 13:18	Nigeria and Uganda (Kilian)
13:18 – 13:30	PMI studies (Gimnig)
13:30 – 13:42	Tanzania ABCDR study (Overgaard)
Presentation on ongoing and planned durability work: Laboratory work	
13:42 – 13:54	Lab test development, CDC/NCState (Smith)
13:54 – 14:06	Lab testing of WHOPES recommended brands (Zaim)
14:06 – 14:18	Causes and mode of deterioration (Kilian)
14:18 – 14:30	Mosquito entry, effects of hole size and location (Wirtz)
Way forward and the role of the LLIN Durability Work Stream	
14:30 – 15:00	Discussion
15:00 – 15:30	Afternoon break/coffee and tea
	Poster viewing