# **Monitoring of LLINs**

### How long do bednets last?

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AMI/Bolivia: 03/03/2010

# **Importance of net integrity**

- Current understanding of net integrity not based on sound evidence but influenced by opinions and lobby groups
- Based on an average of 3-5 years:
  - 3 year net (75 denier polyester) ???
  - 5 year net (180 denier polyethylene) ???
  - material strength???
- How does this impact:
  - procurement
  - replacement of LLIN
  - calculation of LLIN needs to sustain high coverage

# Life and Death of a Net Are the nets still there? - Retention



A. Kilian, Malaria Consortium

Time

### **Issues of Wear and Tear**

• Current product specifications based on:

#### - WHOPES

- focus on insecticide activity
- WHO Specifications for Netting (2007)
  - Burst Strength: 250 kPa, minimum

### Laos and Ghana Studies

- Lao PDR
  - Shirayama et al., Public Health (2007) 121, 122-129.
  - Olyset nets, 2-3 years in the field.
  - 40% had holes and tears.
- Ghana
  - Smith et al., AJTMH (2007) 77, Suppl. 6, 243-248.
  - PermaNet 1.0, 3 years in the field.
  - Nearly all had holes and tears.
- Challenged our assumptions about bed net lifetimes.
- Physical deterioration is an important issue.
- Repairs are uncommon.
- Burst strength is a questionable indicator.

## Possible causes of deterioration

- Possible Causes
  - Snagging on sharp objects
  - Washing/scrubbing
  - Burns / Hot surfaces
  - Rats and other animals (drawn to food stains?)
  - Children
- Initiation vs. worsening of damage
- Repairs could slow deterioration

# **Monitoring of LLINs**

Two elements that need to be considered

1. Physical integrity (the netting material)

2. Insecticide content (protection against vector)

### **Objective of LLIN Monitoring/Evaluation**

To provide reliable data that can be used for as a basis for decisions on procurement, replacement and product improvement.



### **Specific Aims**

In order of priority:

- To assess the net loss under regular use (i.e. was the net lost, stolen, destroyed or abandoned)
- To measure the <u>integrity</u> of the nets when used under use conditions
- To determine the <u>residual insecticidal</u> <u>activity</u> under use conditions
- To determine insecticide content

### <u>Methods</u>

- Net loss
  - Bednet ownership coverage surveys
- Net integrity
  - Hole counting
- Residual insecticidal activity
  - WHO cone bioassay or other assays (e.g. colorimetric assays)
- Insecticide content
  - High performance liquid chromatography (HPLC) and gas chromatography

### <u>Methods</u>

- Bednet ownership coverage
  Surveys (not the focus of my talk today)
- Bednet integrity and insecticide content
  - Collect a sample of bednets from the field
  - Possible to do this retrospectively or prospectively
  - 'Process' bednets

#### Implementation: Retrospective vs. prospective

#### Retrospective cross-sectional

- Advantage provide information 'immediately'
- Possible for:
  - nets that can be identified to a distribution campaign
- Becomes increasingly difficult with longer time periods, beyond 2-3 years
  - significant portions of the population may have moved, nets cannot be traced
  - labels on nets tend to fade or fall, can make identification of nets difficult
  - Information on what happened to a net more than 12 months ago are likely to be biased

#### Implementation: Retrospective vs. prospective

#### Prospective longitudinal

- Suitable method to determine the decline of the physical integrity of a net over time
- Identification of nets may be easier
- Limitations for assessment of net survivorship:
  - Takes longer to get information
  - Bias when nets are marked and followed up in regular intervals and net owners are aware of the monitoring activity (Hawthorne effect)
  - Care must be taken to determine the reason for the attrition. A high proportion of nets being given away/moved to other locations when still intact can seriously bias results.

#### Implementation: Retrospective vs. prospective

#### Prospective longitudinal

- Consider inclusion of bednet evaluation as part of bednet distribution efforts
  - This requires planning and budgeting ahead of time
  - How often needs to be done still to be decided case by case

### **Implementation**

Methods of site selection:

- areas where nets have been distributed as part of campaigns, health days, etc
- select sites of typical epidemiological settings specifically for net-comparison
  - Some ecological/epidemiological settings to consider: geographic ecotypes, ethnic groups, affluence, and rainfall/seasonality

### **Implementation of Prospective Strategies**

- Having a way to identify the nets is crucial
  - manufacturer using batch numbers
  - > attaching barcodes
  - making the net with a distinguishing mark e.g. using car paint



#### <u>Methods</u>

- Houses mapped, geo-referenced with GPS
- Number, types of nets distributed recorded in PDAs or paper
- Data then transferred to central a database





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## **Methods**

- Nets assessed yearly for 3-5 years after distribution
- Nets selected at random from sites
- A questionnaire/survey to monitor the net usage and washing practices
- Collected nets labeled and bagged individually in polyethylene bags
- Nets taken to laboratory for assessment



#### Net Integrity

- Use a cube-shaped frame suitable for the net
- Frame constructed from commercial PVC pipe and fittings
- Black plastic sheeting hung from the top rail of the frame
- Provides contrasting background and facilitates the examination of the nets.
- The nets draped over the frame for examination.



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### Net Integrity

#### Nets are scored for:

- Number and size of holes <0.5 cm in size</li>
- Hole locations measured as vertical distance from the bottom edge of the net
- Condition of the seams (presence of a 1-cm open length along the seam considered a failure)
- Evidence of repairs to the net fabric, type of repair (knots, stitched, patched)
- For sewn repairs measure length of stitching on repair









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• Measure the size of the hole along its long axis

 Measure the position of the hole from the bottom of the net to the middle of the hole



### Insecticide residual testing

- •Collecting LLIN samples for bioassays and chemical analysis.
- •Use a 30 cm X 30 cm cardboard template to guide the sample removal.
- •Cut the sample by leaving a generous amount of material around the edge of the cardboard template.
- An example of the comparison of size of LLIN removed to size cardboard template.





# Insecticide residual testing

• WHO cone bioassay

Colorimetric assays

 Chemical analysis by high performance liquid chromatography (HPLC) or gas chromatography (GC)





#### WHOPES/CDC LLIN meeting February 2010

- **To draft:** "Guidelines for monitoring performance of long-lasting insecticidal mosquito nets under operational conditions"
- Operationalize field assessment on yearly basis
- Count the number of holes in the nets and the size of the holes will be classified into:
  - number of holes greater than the size of a person's index finger, but smaller than their fist;
  - number of holes greater than the size of a person's fist.
  - number of holes larger than the size of a person's head

\*\* This methodology has not yet been validated

# **Questions?**





#### Example : Angola – informal preliminary survey May 2009

- July 2006 >800,000 PermaNets distributed in the nationwide measles immunization campaign to 7 provinces (Cabinda, Zaire, Malange, Moxico, Luanda Norte, Luanda Sur and Uige)
  - Key issue Correctly identify nets that were distributed in this campaign
  - 1. Net distribution carried out over a one year period, from approximately November 2006 to August/September 2007
  - 2. Therefore the nets were between  $1\frac{1}{2}$   $2\frac{1}{2}$  years old
  - 3. Since 2006 continuous distribution of nets at Health Centers and Health Posts to pregnant women and children <5, during immunization visits.
  - 4. With ongoing routine distribution difficult to correctly identify the 2006 campaign nets.
  - 5. Dependent on the ability of the household to recall which nets they received during the campaign and when they discarded the nets

# Angola (May2009): Results of informal preliminary survey of LLINs distributed in Malange and Uige in 2006.

	Malange Province		Uige Province (Puri Municipality)		Total (%)
	Cangandala	Caculama	Quimalundo	Calanda	
Total houses surveyed	14	30	16	14	74
No. houses received net(s) but never used any of the net(s)	0	0	2	0	2
No. houses received 1 net	8	29	9	12	58
No. houses received >1 net (2-5)	6	1	7	2	16
No. houses using the net since 2006 (continuous/year-round use)	6	12	2	7	27
Total number of nets	21	31	29	17	98
No. of nets still in use	12	13	2	7	34 (34.7)
No. of nets discarded (torn/burnt)	8	18	14	6	46 (46.9)
No. of nets discarded since Jan 2009	4	5	8	2	19 (19.4)
No. of nets discarded before Dec 2008	1	6	5	7	19 (19.4)

# Angola (May2009): Results of informal preliminary survey of LLINs distributed in Malange and Uige in 2006.

#### Notes:

- In some houses, the team was able to verify the presence and the condition of the bed net.
- Houses that received more than one net often stored one the nets and only started to use the other net(s) when the first net was no longer usable. So not all the nets reported to be in use have been continuously used since 2006.
- In Malange both PermaNets and Olyset Nets found in the villages and were reported to have been obtained in the 2006 campaign. 10 nets were confirmed in Malange to be Olyset nets. In Uige, only PermaNets were found.
- Some households could not remember when they stopped using or discard the bednet.
- No houses reported lost or stolen nets. The reason that the net was no longer used was mainly because they were torn or accidentally burnt.
- Number of nets reported burnt: 1 in Quimalundo, 1 in Calanda and 1 in Caculama
- Some Cangandala households reported that nets were destroyed by rats.
- 41/74 of the household reported that they washed their nets between 1-5 times during the last 2-3 years or during the lifetime of the net.

# How to monitor life of net?



### **LLIN Studies & Evaluation - PMI**

- A multicountry Operational Research project to study all 5 current LLINs under field conditions in Senegal, Malawi and Kenya
- Evaluation of LLINs as part of the National Malaria Control Program in Angola, Mozambique, Liberia, Rwanda, Zambia