



WHO Guidance Note for Estimating the Longevity of Long-Lasting Insecticidal Nets in Malaria Control

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This technical document has two main purposes: to provide guidance to countries to track LLIN durability in order to support management of resupply; and to inform at global level procurement decisions in conjunction with urgently needed new, more predictive textile laboratory testing.

The document is aimed at malaria program staff and researchers who are directly involved in the collection and analysis of data on LLIN durability in the field in order to allow standardization of procedures and analysis of LLIN durability estimates across countries.

This guidance note complements the existing documents, namely *Guidelines for laboratory and field testing of long-lasting insecticidal mosquito nets, 2005*,¹ and *Guidelines for monitoring the durability of LLINs under operational conditions, 2011*,² and should always be considered in conjunction with these documents.

LLIN durability and survival depend on two factors: net attrition (complete loss of nets) and physical integrity (holes and tears in nets still existing in households). Net attrition from households includes both LLINs that are potentially still in use elsewhere (given away for others to use, stolen) and nets that are no longer usable or available (discarded, destroyed, used for other purpose etc.).

For WHOPES recommended nets, insecticidal effectiveness is currently not included in the estimation of LLIN survival, since these nets have already passed WHOPES phase III testing criteria.³ This does not apply if non-WHOPES nets are used, but there is currently no widely applicable field test for insecticide on LLINs. WHO recommends the exclusive use of LLINs that have received WHOPES recommendation.

Key recommendations

- Country programmes should initiate studies of net survival after each campaign that uses a new product.
- Studies should be done in several locations with varying household socioeconomic and environmental conditions.
- For prospective studies, a sample of marked nets should be given to known households, and a subsample of these nets sought and collected each year thereafter, to assess net attrition and physical integrity.

¹ *Guidelines for laboratory and field testing of long-lasting insecticidal mosquito nets* WHO/CDS/WHOPES/GCDPP/2005.11. Geneva: World Health Organization. 2005.

² *Guidelines for monitoring the durability of LLINs under operational conditions* WHO/HTM/NTD/WHOPES/2011.5. Geneva: World Health Organization. 2011.

³ WHOPES criteria: after three years of field use 80% or more of LLIN have proven high level of effectiveness against susceptible vectors in standard WHO cone or tunnel tests. (see ref 2)

- Retrospective studies may be conducted in a sample of houses during household surveys, when net physical integrity can be observed and attrition assessed by questionnaire.
- The recommended measure of physical integrity² is the proportionate Hole Index (pHI), categorized based on recommended cut-off points into the following three groups:
 - LLIN in “good” condition (pHI 0-64): no reduction of efficacy compared to an undamaged net;
 - LLIN in “acceptable” condition (pHI 65-642): effectiveness somewhat reduced but still provides significantly more protection than no net at all;
 - LLIN “torn” (pHI 643+): protective efficacy for the user is in serious doubt and the net should be replaced urgently.
- The number of LLINs in “good” and “acceptable” condition combined represents those in “serviceable” condition. This is the **numerator** for estimating net survival.
- The **denominator** for assessing net survival is the number originally distributed to households, excluding a portion (those that may be still in use by others) of the number lost by attrition.
- The proportion of LLIN surviving to time x (where x is the time in years since distribution) is estimated as the **numerator** (nets still in serviceable condition) divided by **denominator** (nets originally distributed and kept by households).
- Median LLIN survival is estimated as follows:
 - Plot the “proportion of LLINs surviving to time x” against “time of follow-up” and compare against the hypothetical survival curves which are included in this guidance note.
 - If at least two data points in time are available for “proportion of LLINs surviving to time x” and the first is 85% or lower, a “median LLIN survival” can be calculated using a formula and tool that are provided with this guidance note.
 - If at all possible, more than two data points in time should be used to estimate “median LLIN survival” in order to obtain more reliable estimates; this is particularly important for retrospective surveys.
 - For all LLIN survival estimates, appropriate confidence intervals should always be calculated to provide a measure of uncertainty and allow an assessment of whether observed differences between products or time points are statistically significant.

Priorities

For WHO

- Develop standard operating procedures (SOP) for all steps of LLIN survival estimation surveys, make available tools and templates and establish strict norms of quality control in order to ensure a high level of standardization.

For academic and research institutions

- Conduct studies on the relationship between hole size and position on an effective LLIN and the influence of total net size compared to the size of the hole, in order to understand better the determinants of mosquito entry into a damaged net and to improve – if needed – the weighting system for hole counts in the proportionate Hole Index.

- Explore the relationship between net damage, remaining insecticide and feeding inhibition in susceptible and resistant vectors in hut trials, to define a) the cut-offs to be used to determine “end of useful life” and b) how the cut-offs need to be adjusted with increasing vector resistance.
- Study the impact of damage, age and insecticide levels of LLIN on malariometric parameters in children and adults (malaria incidence, prevalence and anemia) in order to establish the epidemiological impact of damaged LLIN.

For industry/research institutes

- Accelerate the development of field tests that reliably predict protective effectiveness of the LLINs, in order to include insecticidal effectiveness as a factor in future net durability assessments.

Next steps

Countries

- Include in country work plans the collection and analysis of data on LLIN survival according to these recommendations and guidance.
- Analyze available data according to the methods described in this document, where feasible if compatible data items were collected.
- Share the results from LLIN survival analyses with other countries and partners so that a better understanding of the dynamics of LLIN survival can be obtained.
- Where sufficiently reliable information exists, include median LLIN survival estimates in planning for LLIN replacement to maintain and maximize malaria prevention using LLINs.

Partners

- Support countries to conduct studies and build capacity in the collection and analysis of LLIN survival data.
- Undertake or support research to address the outstanding issues identified in this guidance document.
- Actively contribute to improving these methods in the future.

To support countries and partners, WHO will disseminate and promote this guidance note on estimating LLIN longevity and accompanying tools; facilitate the collection, analysis and sharing of results of comparable LLIN survival data by providing training and technical support; review these methods as new information emerges; consider including minimum requirement of “x% of LLIN that survive to three years of field use in ‘serviceable’ condition” as part of WHOPES recommendations; and use existing policy setting mechanisms to regularly review this guidance – including the possibility of ranking LLINs according to their performance.

Further information

Vector Control Technical Expert Group. *Estimating functional survival of long-lasting insecticidal nets from field data. Report to MPAC September 2013.*

http://www.who.int/malaria/mpac/mpac_sep13_vcteg_llin_survival_report.pdf