LLIN Durability Assessments: What have we learned, and what’s next? Evidence-based results from 8 countries

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Introduction: PMI durability studies

• From 2009–2015, PMI has funded a number of LLIN durability studies
• Current project: analyzing all data from 8 countries
• 21,000 LLINs monitored in 37 sites
Varied methodologies

- prospective vs. retrospective
- cross-sectional vs. longitudinal
- different household survey questions
- lab and/or field hole-counting
- different categories for hole sizes
- different approaches for insecticidal content testing
- differing levels of (non)randomization
Results overview

• Causes of net loss
• Survival/Attrition
• Physical durability/hole counting
• Bioefficacy
• Chemical content
• Household questionnaire data
• Net use
Results: Attrition

• Graph shows proportion survival (1-attrition due to being destroyed (not those lost due to being given away))

• While there is some variation by brand within a country study (possibly due to confounding with study population), there is wider variation in the same brand across different country studies
Results: physical durability: by brand

- Holes were counted by size categories, data was used to calculate a proportionate hole index (pHI), shown on a log scale with 95% CI
- Generally, most brands performed equally
Results: physical durability: by country

- Holes were counted by size categories, data was used to calculate a proportionate hole index (pHI), shown on a log scale with 95% CI
- Variation between countries was much greater than variation by brand
Hole counting methods

• Laboratory and field hole-counting data on the same nets were roughly correlated, but with some wide variation
Bioefficacy

- Proportion of mosquitoes killed in a WHO cone test, from nets sampled at different time points
- Same method used in all countries (although strains differed)
Chemical content

- Total active ingredient content in the net, measured by GC or HPLC
- Dotted line = target dose based on specifications
- Again, more variation by country than by brand
How well do bioassays relate to chemical content?

• Ongoing debate over how best to measure insecticide content:
  • Total chemical content by HPLC/GC includes active ingredient that is within netting fibers, may or may not be bioavailable on the surface
  • Cone bioassays can have high variation when done by different labs
  • As this is possibly the largest field data set comparing bioassay results and chemical content, we wanted to do a comparison of these two methods of measuring efficacy
Bioassay vs. chemical: examples from 4 brands

bioassay – proportion dead

chemical content – mg/m²
Questionnaire data

• All countries asked at least some questions on social, behavioral, socio-economic status, but little agreement between studies

• Even for the same questions, potential answers varied, limiting comparability
Major reasons nets were absent:

- moved to another location
- lost/stolen/sold
- discarded due to damage

Discarded due to damage was <50%; all-cause attrition isn’t a good measure of loss due to damage
Use of study nets:
Use*Survival
Conclusions

• Site variability > brand variability
  • Remaining questions: what are the major drivers?

• While some previous studies have shown worryingly short median lifespans, the data from Kenya and Senegal show that under good conditions, it is possible for nets to last the estimated 3 years between mass campaigns
  • need for better SBCC for net care?
  • effect of repeated visits in longitudinal design?

• Need for a better gold standard to measure bioefficacy/surface insecticide

• Potentially worrying cone bioassay results in some countries
Future Directions

• Final cleaning and re-running analyses
• Combine effects of holes, insecticide and use to estimate impact on transmission over time from distribution to replenishment in malaria model.
• Present final results at ASTMH & publish
• Long term: follow up with analysis of PMI durability monitoring data
PMI durability monitoring

- Prospective, longitudinal cohort design of nets distributed in mass campaigns
- Data collected on attrition, physical integrity, insecticidal activity, chemical content
- Questionnaire on behavior, household use, attitudes about net care, and socioeconomic status
- 12 countries currently carrying out monitoring, 15 funded for 2017
- Currently collecting 6-24 month data
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Questions and Discussion