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RESPONSE TO DONOR CONCERNS REGARDING LLIN DURABIILITY AND LONGEVITY
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The recent publication Allan *et al.* 2012[1] has created concerns in the donor community regarding the durability and serviceable life of LLINs. The Allan *et al*. study is the first to compare performance of different types of LLINs under field conditions in Africa. Results indicate a very rapid physical deterioration of both 75 denier polyester and 150 denier polyethylene LLINs in the study site in semi-arid eastern Chad, where less than a third of LLINs observed were found to be in serviceable condition after an average of only 14 months of use. Based on this rapid deterioration, the study suggests that changes in LLIN procurement and distribution may be necessary in semi-arid regions given the rapid acquisition of holes, and in light of the differential acquisition of holes between polyester and polyethylene nettings. The authors call for increasing the minimal RBM/WHO specification for polyethylene and polyester LLINs for use in semi-arid regions. An alternative solution proposed by the authors would be to change budgeting and procurement to replace LLINs in semi-arid regions and to more frequently replace LLINs rather than following the speculated 3 to 5 years currently used as the serviceable life of LLINs.

The present document seeks to expand the context of these observations and place the conclusions into a larger perspective.

Other studies, including both published and unpublished data, underscore the complex intrinsic and extrinsic factors that determine LLIN durability.

- Allan *et al*. cite a study from Liberia that found 70% of the 75 denier polyester Interceptor LLINs recovered after 12 months had no holes,[2] indicating that in wetter climates LLINs may have longer expected serviceable life than in semi-arid regions.
- Studies of the PermaNet and Interceptor in Uganda suggest a life span of polyester nets approaching three years[3,4] and in India 81% of Interceptor nets were still in use three years after delivery. At 18 months 20% had holes with an average of 2.7 holes per net and at three years 74% had holes with an average of 7.3 holes per net. The mean hole index increased from 13.2 at 18 months to 252.2 at three years. [5]
- A study in Benin compared the effectiveness of ITNs in areas of pyrethroid susceptible and resistant An. gambiae. In the susceptible area the protective effect of treated nets was 66%, with no significant difference in protection for nets with larger combined hole area (>15 cm^2) than those with a smaller combined hole area (<15 cm^2), indicating that moderately damaged nets are still effective.[6]
- Unpublished studies supported by PMI comparing several different types of nets in Kenya and Malawi also highlight the dramatic differences that occur in different socio-economic settings. While nets in Malawi acquired more holes than observed in Kenya, they were in better condition than in Chad, even after 3 years of use. In Kenya, after 2 years of use, many nets had no holes at all.

Defining when a net is unserviceable - a failed net - remains a challenge. While Allan *et al*. classified nets as poor, very poor or unserviceable, there is little evidence available currently to define when a net "fails". In WHOPES lab studies with untreated nets, mosquitoes may enter holes but the frequency is low and dependent on the size and location of the holes. With insecticide treated nets, entry rates and exit rates of mosquitoes through holes are likely to be lower and blood feeding reduced.

- Allan *et al*. found that the proportionate hole index was significantly higher among polyester compared with polyethylene nets in a random sampling of net of the same age and in the same communities.
- Unpublished data in studies supported by PMI in Kenya, Malawi and Mozambique point to a different conclusion with higher frequencies of holes, as well as larger holes, on some polyethylene nets. These preliminary field findings are supported by laboratory studies which indicate that damaged polyethylene rapidly lose their physical durability as measured by burst strength or other tests.

In sum, the durability of LLINs is highly influenced by a number of factors, which include but are not limited to: the strength and quality of the netting material, quality of fabrication, environmental conditions, and social settings and norms, and individual behaviors around care of nets. Allan *et al*. have made a significant contribution to understanding the constraints for LLINs in semi-arid regions, particularly eastern Chad, but it is not possible to extrapolate from the results of that study to determine policies and approaches in other settings. There is insufficient evidence available at this point to warrant a change in costing models that are generally based on RBM guidelines of loss of LLINs at a rate of 50% between 25-36 months[7].

Innovative efforts to develop LLINs that are inherently more durable are stymied by the current emphasis on purchasing based solely on price. LLIN suppliers have little incentive to develop more durable nets with higher initial costs, even if lower replacement costs mean they are less expensive in the long run. Program and research partners must cooperate to ensure the development of innovative technologies that will provide long-term benefits to LLIN users, programs, and donors alike.

References

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3 Kilian A, Byamukama W, Pigeon O, Atieli F, Duchon S, Phan C. 2008. Long-term field performance of a polyester-based long-lasting insecticidal mosquito net in rural Uganda. *Malar J,* 7:49.

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6 Asidi A, N'Guessan R, Akogbeto M, Curtis C, Rowland M. 2012. Loss of household protection from use of insecticide-treated nets against pyrethroid-resistant mosquitoes, Benin. *Emerging Infectious Diseases*, 18:1101-6

7 RBM Support to Global Fund Round 10 Malaria Proposal Development, accessed at: http://www.rbm.who.int/docs/round10/LLINquantifyingNeeds.pdf

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