

**Conversation between Steve Lindsay (Durham University) and GiveWell (Holden Karnofsky) November 2, 2012**

**Summary:** GiveWell spoke with Steve Lindsay to learn about the longevity of long-lasting insecticide treated nets, mosquitoes' resistance to insecticides, the effectiveness of bed net distributions at reducing malaria burden, promising areas of malaria control research, and malaria mortality rates.

**Note:** This is a set of summary notes compiled by GiveWell in order to give an overview of the major points made by Steve Lindsay in conversation.

### **LLIN Longevity**

The question of how long the long-lasting insecticide treated nets (LLINs) are effective for is a central issue that the WHO is concerned with.

### **Insecticide resistance**

The current data on insecticide resistance, including that in Ranson (2011), refers to resistance that is measured by putting mosquitoes into a tube and seeing how many die after a set period of time, in a laboratory.

I don't believe there is a more recent review of the state of resistance than Ranson 2011, though another important recent document is the World Health Organization's Global Plan for Insecticide Resistance Management.

Mosquitoes have been developing resistance to the insecticides that are used on bed nets, as is inevitable. Though it isn't always clear whether the data are showing an increase in resistance or simply better data collection on resistance.

It is unclear whether the mosquitoes' resistance is having a negative impact on malaria control. So far there is no evidence that resistance is interfering with malaria control, although it may be happening. The only studies that I'm aware of demonstrating that resistance can have negative impacts on malaria control are the one from the South Africa-Mozambique border and some experimental hut studies; there are also multiple studies showing continued effectiveness of nets in areas with confirmed resistance. Bed nets can be effective even against mosquitos that are resistant to insecticides.

Some possible approaches to mitigate against the possibility of reduced malaria control due to insecticide resistance are the creation of bed nets treated with new insecticides, combining indoor residual spraying with bed net distribution, combining several insecticides on bed nets, and rotating the use of different insecticides. In the long term what is required is Integrated Vector Management that does not rely so heavily on insecticides.

In order for combining several insecticides on bed nets to be effective, it's important that:

- The mosquitoes in the region where the bed nets are distributed are not already resistant to one of the insecticides.
- Nets are replaced when any one of the insecticides has lost effectiveness (to avoid situations in which a net's effectiveness is reliant on only one insecticide).

### **Behavioral resistance**

There are indications that mosquitoes are developing behavioral resistance. This phenomenon could be as important as physiological insecticide resistance, but is harder to monitor because not many field workers record biting patterns.

### **Evidence of bed nets reducing malaria burden**

The literature over the past few years summarizing data on malaria prevalence across Africa has shown a decline in malaria. The data are piecemeal, but through a combination of formal and informal evidence the picture is pretty strong. There have been some major authoritative reviews of the subject and all point towards declining malaria in many parts of Africa. Then there is hard evidence from specific sites in Africa like The Gambia in West Africa and Kilifi in East Africa. The drop in malaria burden has coincided with a large-scale increase in bed net distribution and indoor residual spraying. The scaleup in nets has been unprecedented. Treatment of clinical cases has improved and increased too, but this change took place later, and wouldn't reduce biting rates. And there are still plenty of people with parasites.

### **The importance of bed net distribution**

Even though insecticide resistance is developing, it's important to continue distributing bed nets, because bed nets are effective. Insecticides may still kill partially resistant insects. Resistant mosquitoes may rest longer on the nets, long enough to pick up a killing dose. Even if the insecticide is not effective, the nets themselves protect the users via blocking (if intact). I've been working on malaria for a long time, and for a long time it stubbornly did not decline, and now it's declining; this is an unprecedented success and we shouldn't abandon what's led to this progress out of the fear of resistance developing. Nonetheless we should be looking at new methods of control to manage insecticide resistance.

### **Promising areas of research**

More research is needed on whether strategies for mitigating insecticide resistance such as rotating insecticides actually work.

### **On the Against Malaria Foundation**

I'm pretty impressed with the Against Malaria Foundation and happy with what they're doing.

### **Measuring malaria mortality rates**

Malaria can cause death by exacerbating other health conditions such as other common childhood diseases, like acute respiratory infections and diarrhea, and malnutrition. Such deaths are not necessarily picked up by the malaria mortality statistics. The question of how to best count deaths from malaria is extremely difficult. There is not a consensus among experts on this point. One method is to use surveys, but the quality of the data from surveys is not necessarily high. One can try to extrapolate from the randomized control trials (RCTs) of bed net programs. However, some people would argue that this is not a good approach because

- The intervention in the RCTs is not necessarily representative of usual bed net distribution programs.
- Malaria is heterogeneous across Africa and there are too few data points coming from the RCTs to give a holistic assessment of malaria mortality in Africa.