

## Editorial

### The Hygienic House: Mosquito-Proofing with Screens

Ned Walker\*

Department of Microbiology and Molecular Genetics, Michigan State University, East Lansing, Michigan

Several years ago, members of ASTMH debated whether to remove the “H” word from the society’s name. The stimulus for the debate was that modern, molecular biology and its ramifications for control of tropical infectious diseases lead away from such antiquated traditions as environmental hygiene toward a more sophisticated, biotechnological future. Ultimately, the membership decided to keep the “H.” In this issue of the *Journal*, Matthew Kirby and others of the London School of Hygiene and Tropical Medicine (note: the “H” word comes first at the LSHTM) report on the social acceptability and durability of untreated screening to keep malaria-carrying mosquitoes out of peoples’ houses, a decidedly hygienic endeavor.<sup>1</sup> Working in The Gambia, and building upon their own extensive previous research, the researchers showed that house screening (by either of two methods: ceilings only; or eaves, doors, and windows) was viewed as highly acceptable and was overwhelmingly welcomed by the human population under study, was durable with only minor damage to screening material, and did not uncomfortably increase indoor temperature. One participant enthusiastically noted that “screened (ceilings) are a bed net for the whole house....” Another participant observed that “if it would cost a goat to repair our screening(s), we would do it as we know they are very useful.” Respondents to a questionnaire found their indoor environments freer of invertebrate and vertebrate pests and less dusty, perceived fewer mosquito bites, and reported sleeping better at night. A potentially negative outcome was that fewer people in houses fitted with screens tended to use their bed nets, finding them unnecessary; and indeed both screening systems equally reduced indoor mosquito density compared with controls. The authors cited several old papers, including one from 1912, which provide the justification and background for this kind of research. Others have recently reported public acceptance and implementation of similar house modifications.<sup>2,3</sup>

In a closely related study published in *The Lancet* in 2009, the same research team reported that children living in screened houses had significantly reduced prevalence of anemia, an important marker of malaria’s effects, besting even the RTS,S/AS02A vaccine.<sup>4</sup> Crude mortality rate was also lower in screened houses, but it was not statistically significantly different from controls ( $P = 0.18$ ). Indoor *Anopheles* density was markedly reduced by either screening type, but full screening did a better job of keeping out the nuisance *Culex*. Two other publications round out this four-paper series.<sup>5,6</sup> Dr. Steven Lindsay (formerly of Durham University, now at the LSHTM) was the principle investigator. The Medical Research Council of the UK provided funding.

This research topic, on the one hand, seemingly quaint and a throw-back to less sophisticated times, on the other hand

ought to reorient our thinking about malaria control in important ways, ones that have implications for policy, research agendas, developmental aid, and potential for regional malaria elimination. Apparently and to my astonishment, there had never previously been an appropriately designed and randomized, prospective trial of the effectiveness of house screening in reducing malaria related illness. Yet, as the authors point out, historically malaria went away in places where housing improved to the extent that host-seeking mosquitoes could not access sleeping humans indoors at night; but proof of causation was lacking. Importantly, this series of four papers (one of which regards the protocol and structure of the study itself, another on mosquito house-entering behavior) depended upon a carefully crafted epidemiological analysis that allowed quantification of the house screening effects, which heretofore had only been inferred anecdotally. An invited editorial written in response to the 2009 publication took note of this extraordinary fact.<sup>7</sup> Studies like this one could be replicated in several endemic settings in sub-Saharan Africa in a manner similar to the multiple site trials of insecticide-treated nets conducted in the 1990s, which overwhelmingly showed effectiveness in reducing malaria-related illness in children. The question further arises as to how house screening could become elevated as a primary intervention in malaria control programs, or one integrated with others, such as bed nets, indoor spraying, or spatial repellents. Obviously screening houses cannot be a panacea for malaria in Africa or generally, given natural variation in behavior of vectors and epidemiology, but it could apply in many settings where vector endophily is common, and is attractive for its simplicity, additive effects, effectiveness, and popularity. Ogoma and others<sup>3</sup> observed that 80% of houses in Dar-es-Salaam already had various configurations of house screening even without government subsidization or programmatic impetus, a figure that exceeds the 2010 target levels for bed net coverage set by Roll Back Malaria.

As the call for regional malaria elimination continues from international agencies and donors, one can hardly imagine that a mosquito-proof house, designed and constructed cheaply but durably, would not play a primary role in the process and would have to be, ultimately, an end goal. One model is to modify current housing designs with screens that effectively block mosquito entry.<sup>8</sup> It involves modest costs but ones that some home owners can bear, while others likely cannot without donor assistance.<sup>1,2</sup> Another model is a new house design. The globalist and anti-poverty activist Dr. Paul Polak advocates a “\$100 house” (the dollar figure is rhetorical) to replace the typical mud and wattle style dwelling that is so common in impoverished, rural areas of the tropics, particularly Africa.<sup>9</sup> Such a house, based upon a simple design and with modest materials, would accrue equity, have re-sale value, and could be used as collateral for small loans. His concept could easily incorporate elements that would impede entry by mosquito vectors, and accommodate other sustainable elements

\*Address correspondence to Ned Walker, Department of Microbiology and Molecular Genetics, Michigan State University, East Lansing, MI. E-mail: walker@msu.edu

of an anti-vector nature, such as bed nets, treated wall hangings, and the like. However, such an expanded vision would have to receive the overt support of major donor agencies, the approval of developmental advisors, and the scrutiny of expert house builders and field biologists. The hard science in such an endeavor would not at all be what the tropical disease research community is used to doing. Rather, it would require consideration of durable construction materials (including termite resistance), passive ventilation systems, micro-economics, community participation, structure of the human living environment, and sustainability. If we can sequence the human genome and clone sheep, surely we can design and implement an affordable, well-ventilated, screened house that keeps the mosquitoes out. The end users certainly want one.

#### REFERENCES

1. Kirby MJ, Bah P, Jones C, Kelly A, Jasseh M, Lindsay SW, 2010. Social acceptability and durability of two different house screening interventions against exposure to malaria vectors, *Plasmodium falciparum* infection and anemia in children in The Gambia, West Africa. *Am J Trop Med Hyg* 83: 965–972.
2. Atieli H, Menya D, Githeko A, Scott T, 2009. House design modifications reduce indoor resting malaria vector densities in rice irrigation scheme area in western Kenya. *Malar J* 8: 108.
3. Ogoma SB, Kannady K, Sikulu M, Chaki PP, Govella NJ, Mukabana WR, Killeen GF, 2009. Window screening, ceilings and closed eaves as sustainable ways to control malaria in Dar es Salaam, Tanzania. *Malar J* 8: 221.
4. Kirby MJ, Ameh D, Bottomley C, Green C, Jawara M, Milligan PJ, Snell PC, Conway DJ, Lindsay SW, 2009. Effect of two different house screening interventions on exposure to malaria vectors and on anaemia in children in The Gambia: a randomized controlled trial. *Lancet* 374: 998–1009.
5. Kirby MJ, Milligan PJ, Conway D, Lindsay SW, 2008. Study protocol for a three-armed randomized controlled trial to assess whether house screening can reduce exposure to malaria vectors and reduce malaria transmission in The Gambia. *Trials* 9: 33.
6. Kirby MJ, Green C, Milligan P, Sismanidis C, Jasseh M, Conway DJ, Lindsay SW, 2008. Risk factors for house-entry by malaria vectors in a rural town and satellite villages in The Gambia. *Malar J* 7: 2.
7. Gimnig JE, Slutsker L, 2009. House screening for malaria control. *Lancet* 374: 955.
8. Lindsay SW, Emerson PM, Charlwood JD, 2002. Reducing malaria by mosquito-proofing houses. *Trends Parasitol* 18: 510–514.
9. Polak P, 2008. *Out of Poverty: What Works When Traditional Methods Fail*. San Francisco, CA: Berrett-Koehler Publishers, Inc.