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# Malaria Control in the Highlands of Burundi: An Important Success Story

**John C. Beier**
Department of Epidemiology and Public Health and the Abess Center for Ecosystem Science and Policy, University of Miami, Miami, Florida

Throughout Africa, successful high-impact malaria control programs are being implemented that emphasize sound vector control as an essential component of integrated national malaria control programs. Most programs are using insecticide-treated bednets (ITNs) and/or indoor residual spraying with insecticides (IRS). There are important considerations regarding which technique or combinations of the two work best for different epidemiologic situations and whether additional vector control measures are necessary to achieve significant reductions in malaria morbidity and mortality.

In this issue, Protopopoff and others present their paper on "Spatial targeted vector control is able to reduce malaria prevalence in the highlands of Burundi." This is a landmark paper because it describes how fundamental information on key differences in patterns of transmission within the highland environment in Karuzi Province should be used to plan and guide appropriate targeted interventions. Given that > 90% of malaria transmission occurs in the low-lying valleys, the 4-year study targeted all control vector control measures to these areas, covering ~90% of the houses with an annual round of IRS and one round of bednet distribution. Significantly, after the targeted intervention was compared with control valleys, this study showed a marked reduction in three important malaria indicators: malaria prevalence, high parasite density, and clinical malaria. A companion paper by Protopopoff and others,[2] published in the *Malaria Journal*, describes the impact of the intervention on reductions in vector populations and malaria transmission. *Anopheles* vector densities were reduced by 82% and transmission intensity was reduced by 90% in the intervention areas.

Together, these two integrated studies[1,2] show the potential value of targeted vector control for addressing the problem of malaria in highland areas of Africa. A strong case is made that epidemics can be managed and even prevented if continuous vector control interventions, in combination with effective case management, are applied to areas within the highland environment where transmission is most intense and focally distributed. Interestingly, the studies showed that the IRS component of the intervention had the most dramatic impacts on vector densities, malaria transmission intensity, and corresponding epidemiologic indicators of malaria infection and disease. Although the bednets served to reduce vector densities, there was no additional reduction in transmission intensities. Similar findings have been reported in Eritrea.[3] The absence of additional impact of nets over IRS is probably because of the high coverage achieved with IRS. The combination of both methods should not be excluded when full coverage with IRS is not optimal or difficult to sustain over time. Given relationships between intensities of transmission and malaria prevalence in Africa,[4] at least for the findings in Karuzi Province, Burundi, it seems that the strategy of using IRS as the predominant method for vector control served to reduce transmission intensity to levels less than one infective bite

Author's address: John C. Beier, Department of Epidemiology and Public Health University of Miami, South Campus, 12500 SW 152nd Street, Building A, Miami, FL 33177, E-mail: E-mail: jbeier@med.miami.edu.

per person per year for most of the populations covered by the intervention. Otherwise, the marked reductions in malaria prevalence would not have been seen.

The scientific findings for the highland malaria control interventions in Burundi are yet another good example of malaria control success stories. Barat[5] provides an account of four other recent and highly notable malaria success stories, in Eritrea, Brazil, India, and Viet Nam. According to Barat,[5] successful malaria control programs share the following characteristics: "conducive country conditions, a targeted technical approach using a package of effective tools, data-driven decision-making, active leadership of the government, involvement of communities, decentralized implementation and control of finances, skilled technical and managerial capacity at the national and sub-national levels, hands-on technical and programmatic support from partner agencies, and sufficient and flexible financing." In the long road ahead for effective malaria control, it is vitally important that national malaria control programs make their findings known through peer-reviewed publications. Success stories at the national levels, especially dramatic findings from environmentally specific results such as the highland areas in the reports by Protopopoff and others,[1,2] make a valuable contribution to the global fight against malaria. In perspective, malariologists should not have to keep referring to the Garki Project[6] as the hallmark of malaria control. There are plenty of recent successful national malaria control program accomplishments that need to be documented and publicized so that we can all learn what works and what does not under the diverse environments in which malaria still thrives.

Are malaria vector control approaches involving IRS and ITNs sufficient? Even after the intervention in the study by Protopopoff and others,[1] malaria prevalence was still > 30% in the intervention areas. By all public health standards, this high prevalence is still unacceptable. If IRS and ITNs cannot do a better job of reducing transmission, this begs the question of what additional vector control measures need to be considered? There is a very strong case for implementing larval control through environmental management and the use of bio-insecticides to treat those larval habitats that cannot be eliminated. However, there are too few demonstrations that the additional measures, beyond IRS and ITNs, to target immature stages of anopheline mosquitoes have a substantial impact on malaria transmission and resulting morbidity and mortality. This is one reason why integrated vector management strategies (IVMs) have not been fully embraced and implemented in public health–driven malaria control programs. Clearly, more comprehensive IVM strategies and tools are going to be required as successful malaria control programs in Africa and elsewhere transition their program objectives to strategies for country-wide malaria elimination.

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