Urban Malaria in Africa

Proceedings of a Technical Consultation on the Strategy for Assessment and Control of Urban Malaria
Pretoria, South Africa
02-05 December 2004

Eveline Klinkenberg, Martin Donnelly and P. J. McCall, editors

SYSTEMWIDE INITIATIVE ON MALARIA AND AGRICULTURE
LIVERPOOL SCHOOL OF TROPICAL MEDICINE
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Contents

Introduction

This document is a report of the technical consultation on strategy for assessment and control of urban malaria in Africa, held in Pretoria South Africa from 2nd to 5th December 2004. The workshop was organized by the Malaria Knowledge Programme of the Liverpool School of Tropical Medicine (LSTM) and the Systemwide Initiative on Malaria and Agriculture (SIMA) hosted by the International Water Management Institute (IWMI).

Malaria has long been considered a predominantly rural disease in Africa. Yet it is clear from a number of studies that the urban poor in many parts of Africa are at high risk of malaria. This is especially worrying because in Africa the current urban population growth rate of 3.5 percent is more than three times the rate of the rural population growth, and by 2015 there will be 25 countries in sub-Saharan Africa with higher urban than rural populations.[1] While the levels of transmission in urban areas may be lower than in contiguous rural areas, the high population densities and possible lower immunity could well lead to high disease burdens in urban settings. Conversely, the potential for greater success in malaria prevention and control may be greater in urban settings, if integration of the activities of municipal authorities, agriculturalists, health professionals and communities is achieved.

Clearly, malaria in Africa must no longer be regarded as a rural phenomenon. With this in mind, the overall aims of the workshop were to review and define the impact of malaria among urban communities, to develop an evidence-based approach for evaluating and controlling urban malaria and to develop strategies for implementing effective public health interventions. The intentions were threefold. First, case studies were presented to provide compelling evidence for autochthonous transmission of malaria in urban areas of Africa and to develop a methodology that would enable public health workers to assess the level of malaria transmission in urban settings and implement appropriate control measures. Second, issues emerging from the case studies were discussed in two working groups, Integrated Malaria Control and Integrated Case Management. The goal of these working groups was to identify knowledge gaps and to develop control strategies appropriate to the urban setting. Third, on the last day of the workshop, the main outputs of the workshop were presented to all participants and developed into the Pretoria statement on urban malaria and a policy briefing document. These two initial outputs have already been disseminated widely among scientific, NGO, development, government and donor communities.

Control or prevention of urban malaria will require the cooperation of health, agriculture and education sectors, among others. Workshop attendees were drawn therefore from research/ academic, NGO, development, policy-making and donor communities, in an effort to sensitize all parties to the importance of urban malaria in Africa and to ensure that the tools and policy conclusions would be disseminated to all relevant groups. The Malaria Knowledge Programme of the Liverpool School of Tropical Medicine initiated the workshop as part of its commitment to disseminate research results and to get research outputs into policy and practice.

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[1]UN-Habitat, *Cities in a Globalizing World, Global Report on Human Settlements* (Earthscan Publications, London, 2001).

This meeting constituted the second technical consultation on urban malaria. In 1999, EHP/USAID convened the EHP Urban Malaria meeting in Arlington, Virginia to discuss current knowledge and assess the magnitude of the urban malaria problem along with potential techniques and opportunities for assessing and controlling urban malaria. The outcomes of that meeting and a comprehensive literature review of urban malaria are available.[2] It is hoped that the objectives and outcomes of the second meeting complement and indeed progress from the first meeting and will help to highlight again the extent of urban malaria in Africa and to define methods for its investigation, control and prevention. An executive summary of the discussions of this workshop has already been published in *the Malaria Journal*[3] and is included here. The current workshop proceedings add to the list of documents produced by SIMA since 2001. The full list is available at www.iwmi.org/sima.

We are extremely grateful to the organizations that provided funding for the workshop and on behalf of all participants we thank them here:

- The DFID Malaria Knowledge Programme of the Liverpool School of Tropical Medicine.[4]
- The International Development Research Centre, Canada.
- The Environmental Health Project, USAID.

We also thank Mr. Tendani Nevondo, SIMA/IWMI, and Ms. Gwen Finnegan, LSTM, for their logistic support in ensuring the success of the meeting.

Finally, we received the sad news that Dr. Felix Amerasinghe passed away in June 2005 before this report was completed. Felix was instrumental in developing the studies in Ghana, from which this workshop arose, but was unable to attend due to illness. His loss will be keenly felt by his many friends and colleagues in the field. We wish to dedicate this report to Felix, in memory of his contribution to tropical medicine.

Eveline Klinkenberg
Martin Donnelly
Philip McCall

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[2]Warren, McW.; Billig, P.; Bendahmane, D.B.; Wijeyaratne, P. Malaria in urban and peri-urban areas in sub-Saharan Africa. August 1999. EHP activity report 71 (online via www.ehpproject.org).

[3]Donnelly, M. J.; McCall, P. J.; Lengeler, C.; Bates, I.; D'Alessandro, U.; Barnish, G.; Konradsen, F.; Klinkenberg, E.; Townson, H.; Trape, J. F.; Hastings, I. M.; Mutero, C. 2005. Malaria and urbanization in sub-Saharan Africa. *Malaria Journal* Feb 18, 4:12 (online via http://www.malariajournal.com/content/4/1/12).

[4]The Department for International Development of the UK government accepts no responsibility for any information or views expressed herein.

Summary of Conclusions

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Commentary

Malaria and urbanization in sub-Saharan Africa

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Abstract

There are already 40 cities in Africa with over 1 million inhabitants and the United Nations Environmental Programme estimates that by 2025 over 800 million people will live in urban areas. Recognizing that malaria control can improve the health of the vulnerable and remove a major obstacle to their economic development, the Malaria Knowledge Programme of the Liverpool School of Tropical Medicine and the Systemwide Initiative on Malaria and Agriculture convened a multi-sectoral technical consultation on urban malaria in Pretoria, South Africa from 2nd to 4th December, 2004. The aim of the meeting was to identify strategies for the assessment and control of urban malaria. This commentary reflects the discussions held during the meeting and aims to inform researchers and policy makers of the potential for containing and reversing the emerging problem of urban malaria.

Introduction

Africa's population will almost triple by the year 2050. This expansion will occur primarily in urban areas and by 2025, 800 million people will live in urban communities. Especially affected will be West Africa, where the urban population annual growth rate of 6.3% is more than twice the rate of the total population growth. Today in the humid forest zone, more people live in cities than in rural areas and in twenty years time, two out of three West Africans will live in urban centres. While many of Africa's health problems are common to both urban and rural environments, recognizing and meeting the public health challenges in these growing cities is becoming increasingly urgent. Malaria has been considered a predominantly rural disease in Africa, primarily because suitable vector breeding sites are scarce in highly populated areas. Yet, although studies have shown that *Anopheles* mosquito breeding decreases with increasing proximity to the centre

[5]This Commentary is reproduced with permission from the *Malaria Journal 2005, 4:12* (http://www.malariajournal.com/content/4/1/12)

of urban areas [1-3], transmission of malaria still occurs. Clearly, the complex factors contributing to malaria risk in urban areas are not fully understood [3] but evidence is rapidly accumulating that the urban poor are at far higher risk from malaria than previously acknowledged [4,5].

The Malaria Knowledge Programme of the Liverpool School of Tropical Medicine and the International Water Management Institute/ Systemwide Initiative on Malaria and Agriculture convened a meeting in Pretoria 2nd-4th December 2004 to develop an evidence-based approach for evaluating and controlling urban malaria. Participants were drawn from. seven sub-Saharan countries, Europe, North America and South Asia (see additional file). Recognizing the need for extensive cross-sectoral involvement and collaboration in dealing with the challenge of urban malaria, representatives from the research/ academic, NGO, development, policy-making and donor communities co-operated in the process to identify key knowledge gaps and opportunities for control. Included in the group were sociologists, clinical epidemiologists, entomologists and control specialists.

Discussion

Identifying the populations at risk in urban areas

Urbanization is a recent phenomenon in Africa: in 1960 there were no African cities with one million inhabitants, today there are forty. Has malaria become a serious problem within these huge cities and their peri-urban environs? Data presented from studies in a number of sub-Saharan African cities (Brazzavile, Congo; Dakar, Senegal; Abidjan, Cote d'Ivoire; Cotonou, Benin; Ouagadougou, Burkina Faso; Dar es Salaam, Tanzania, and Accra and Kumasi, Ghana) showed clearly that malaria is a considerable urban health problem in Africa. The studies demonstrated great heterogeneities in malariometric indices both between and within cities. It was recognized that not only the major cities of Africa, but also many medium sized regional towns, home to a large proportion of the Africa population, have considerable levels of malaria [5]. With malaria risk unevenly distributed across urban environments, interventions must be preceded by the identification and prioritization of the most vulnerable. Vulnerability is not simply the result of low socio-economic status [6], although this is often a major contributory factor, but reflects factors beyond the individual level such as the proximity of the household to sites of urban agriculture or environmental/cultural factors working at the community level. Discussion focussed on research to define this risk, to improve access to correct diagnosis and appropriate treatment and effective preventative measures, and to identify accurate monitoring and evaluation tools tailored to the urban context.

Prioritizing improved diagnosis and treatment for the vulnerable

Misdiagnosis of malaria is a serious problem everywhere, but in areas of low malaria endemicity presumptive treatment of all fevers as malaria can result in over 75% of cases being misdiagnosed as malaria [7]. The effect of malaria misdiagnosis on the vulnerable will result in more ill health due to delayed diagnosis and repeat visits, overburdened health services, more severe malaria, loss of faith in health services, increase in real and perceived malaria resistance, chronic disease secondary to untreated infection, increased cost to patient and to health facilities and consistent misdiagnosis that will encourage detrimental health-seeking behaviour [7].

Effective provision of appropriate treatment also remains a serious challenge in urban settings. The Abuja Declaration stated that by 2005 "At least 60% of those suffering from malaria have prompt access to and are able to use correct, affordable and appropriate treatment within 24 hours of onset of symptoms." Despite the fact that access to quality health care is better on average in urban compared to rural zones, the formal public health facilities are often the last source of treatment used along the pathway to cure. Often malaria care initially involves leftover medicines from the home (from previously incomplete malaria or other treatment regimes), the purchase of cheaper herbal medicines or unprescribed conventional medicines. The problems of obtaining treatment from a health facility may be exacerbated by the need to obtain permission from an authority figure, absence from work and loss of income, the need to raise money to fund both the treatment and associated costs such as travel [6]. As a result, in Africa over 70% of malaria episodes in rural and over 50% in urban areas are self-diagnosed and self-treated [8]. With Home Management of Malaria proposed as an integral part of the Roll Back Malaria strategy, the consequences of presumptive treatment policies for malaria in the context of the introduction of newer and more expensive anti-malarial drug combinations urgently require further investigation [9].

Ensuring malaria prevention measures reach the vulnerable

The highly focal nature of urban malaria requires targeting of interventions to specific urban districts, and therefore, requires detailed information on each area in advance. However, relationships between administrative boundaries, environment and population distribution are complex in urban areas, which makes them difficult to sample and characterize in a representative way. Strategies for population-representative sampling must incorporate a range of environments and populations to identify accurately environmental and other risk factors. This may be further complicated as urban populations can be highly

The Pretoria Statement on Urban Malaria

- Urban malaria in sub-Saharan Africa is a major health problem and is likely to increase in importance, unless addressed.

  A large and increasing proportion of the African population live in urban areas, where many vulnerable individuals are at significant risk of malaria.

  Strategies used to control malaria in rural areas cannot be directly transferred to urban settings, as they are likely to result in a significant waste of resources, mainly through misdiagnosis and inappropriate treatment.
- Protection of vulnerable people from the effects of urban malaria is essential to preserve their livelihoods, build conditions for economic growth and to avoid diversion of scarce resources away from rural areas.
- Although occurring in heterogeneous and rapidly changing environments that range from high-density neighbourhoods to peri-urban agricultural zones, urban malaria is amenable to cost-effective prevention and control by tailoring existing tools for the diagnosis and treatment of infection, and for vector control.
- The urban environment presents unique opportunities for the reduction of the malaria burden via community stakeholder participation, harnessing existing health planning and governance structures, and by involving the substantial private sector.
- There are important omissions in our knowledge of malaria in the urban context, including:

  Cost-benefit analyses of accurate diagnosis and targeted drug delivery.

  Cost-effectiveness of larval control and environmental management for vector control.

  Appropriate, practical and cost-effective tools for monitoring malaria in an urban context.

  The effect of urban-specific social structures and transmission patterns on disease burden and strategies for control.

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IWMI International Water Management Institute

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Malaria Knowledge Program

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Further information may be obtained from:
www.liv.ac.uk/lstm/majorprogs/malaria/outputs.htm
www.iwmi.cgiar.org/sima/index.asp

Figure 1
The Pretoria Statement on Urban Malaria.

mobile and in peri-urban areas there may be a high rate of turnover in groups of lower socio-economic status. Presentations from South, East and West Africa clearly demonstrated that Geographic Information Systems (GIS)-based approaches are valuable tools for assessing heterogeneities in risk factors for urban malaria, and for subsequent implementation and monitoring of interventions.

Experienced researchers believe that the urban environment has advantages for the effective delivery of appropriate interventions. A number of studies have demonstrated that higher rates of coverage with insecticide-treated bednets can be achieved in urban areas [10,11], although whether or not the most vulnerable groups benefit, remains to be confirmed. Moreover, there is a growing realization within the commercial sector of the need to engage in health and broader social issues. The management of malaria can bring economic benefits to both businesses and the communities in which they operate. This has been powerfully demonstrated in two public-private partnership programmes in southern Africa that utilised indoor residual spraying to control malaria [12,13].

Larval control, achieved either by source reduction or larviciding, can be community directed and may be feasible in certain settings as part of a comprehensive, integrated vector management strategy. There is optimism in some communities about its efficacy and the results of further research into the costs and benefits of such interventions are awaited with interest. Environmental modifications may also be feasible if partners from the community and outside the health sector are engaged. Work from Sri Lanka has demonstrated how a very effective scheme to control malaria by modification of irrigation structures was accepted by the agricultural community because of the financial and water savings that the scheme introduced [14]. However, it was clear that obvious benefits from the intervention must exist to attract the involvement of non-health sectors.

Conclusions

The conclusions of the meeting have been summarised in the Pretoria Statement on Urban Malaria (Figure 1). While it is clear that urban malaria represents a major challenge for public health in Africa, the statement highlights that the unique nature of the urban environment provides an opportunity for malaria control. There are a number of reasons for this: the high population density in urban areas may facilitate increased coverage and impact of both interventions and health education programmes; the activities of departments in urban municipal authorities are typically better resourced and more easily mobilized than in rural areas; the extensive private health sector found in urban settings can be engaged to improve diagnosis, treatment and prevention of malaria. Solutions to the urban malaria problem must include groups from outside the health sector. The disease burden in the most vulnerable communities is a major obstacle to the economic growth of sub-Saharan countries and the challenge is to engage stakeholders at all levels in effective and sustainable intersectoral collaboration [15]. Urban malaria is uniquely amenable to prevention and control as the existing health, urban planning, agricultural and governance structures present opportunities for collaborative approaches that can include both the community and the substantial private sector.

Authors' contributions

All authors participated as session chairs in the technical workshop and were instrumental in producing the summary conclusions. All authors read and approved the final manuscript.

Additional material

Additional File 1
List of attendees and affiliations
Click here for file
[http://www.biomedcentral.com/content/supplementary/1475-2875-4-12-S1.doc]

Acknowledgements

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Malaria Knowledge Programme **POLICY BRIEF** [6]

Urban malaria in Africa

High density population area in Accra, Ghana

Malaria can no longer be considered as just a rural issue in Africa. A significant and increasing proportion of the African population lives in urban areas. There are already 40 cities in Africa with over one million inhabitants and the United Nations Environmental Programme estimates that by 2025 there will be 800 million people living in urban areas of the continent. Urban malaria prevalence rates are highly variable, even within a single city. Prevalences are highest among the poorest sections of society, since they cannot afford protection from malaria through improved housing, and are particularly vulnerable to the impact of ineffective diagnosis and treatment.

As urban centres in Africa continue to grow, the scale and impact of urban malaria is increasing. Despite this threat, control of the problem is feasible: urban malaria is uniquely amenable to prevention and control as the existing health, planning, agricultural and governance structures present opportunities for collaborative approaches that can include both the community and the substantial private sector.

"It is possible that the disaster of urban malaria can be averted if we get the right structures in place.
Pretoria workshop participant

The Malaria Knowledge Programme convened a multi-sectoral technical consultation on urban malaria in Pretoria, South Africa from 2 to 4 December 2004. The aim of the meeting was to identify a strategy for the assessment and control of urban malaria. This policy briefing paper reflects the discussions held during the meeting and is aimed at informing decision makers of the potential for containing and reversing the emerging problem of urban malaria.

Recommendations are presented below, followed by key findings overleaf.

Recommendations

- Urban malaria is already a problem and is likely to increase as urbanisation continues. In order to avert an increase in disease burden, concerted action needs to be taken quickly.
- There is a need to target the most vulnerable sections of society who suffer a double burden of insufficient protection from malaria transmission due to inadequate housing and living conditions, and limited financial resources. These factors restrict their access to appropriate preventive and curative services.
- Inter-sectoral interventions are the key to successful urban malaria control and must include close collaboration between water, agricultural, urban planning, commercial, health and community players.
- Existing health and governance structures in urban environments need to invest in programmes to manage urban malaria effectively using established methods and tools for mosquito control and malaria prevention, diagnosis and treatment.
- Since most fevers in urban areas are not due to malaria, presumptive diagnosis and treatment of fevers as malaria will result in greater wastage of resources, ill health and loss of life. The need for accurate diagnosis is made more urgent by the fact that combination therapies for malaria are expensive.

www.liv.ac.uk/lstm/majorprogs/malaria/outputs.htm

[6]This is a Policy Brief of the Malaria Knowledge Programme of the Liverpool School of Tropical Medicine (http://www.liv.ac.uk/lstm/majorprogs/malaria/documents/urbanmalaria.pdf).

Malaria Knowledge Programme POLICY BRIEF

Key findings

There are several features that distinguish urban and rural malaria. Urban malaria occurs in a diverse and rapidly changing environment with high levels of human migration, high-density populations and expanding urban agricultural areas. Malaria transmission intensities in urban areas are different to those of peri-urban or rural areas.

In urban areas, risk factors that may be different to those in rural areas lead to different disease burdens. In areas with sedentary populations and lower levels of malaria transmission, all age groups, rather than just young children and pregnant women, may be at risk of severe malaria. Accurate assessment of malaria transmission rates across towns and cities is needed to facilitate targeted prevention and control. This will reduce ill health and save lives, preserve and build conditions for economic growth and avoid unnecessary diversion of resources away from rural areas.

"Inter-sectoral interventions are absolutely vital to tackling urban malaria."

Pretoria workshop participant

Opportunities for responding

There are important omissions in our knowledge of malaria in the urban context. The following areas were identified as priorities at the Pretoria meeting:

- **A cost-benefit analysis of diagnosis and drug delivery in urban settings is required:** There must be consistent and effective use of diagnostic tools and health systems to assess the proportion of fevers that are attributable to malaria infection. The potential cost savings of a shift from treating all fevers with anti-malarial drugs to treatment following confirmed diagnosis need to be clarified.
- **A cost-benefit analysis of larviciding (attacking mosquito larvae), source reduction (reducing breeding sites) and environmental management for control of mosquito breeding in urban settings is required:** Government, public-private partnerships and community-based responses to control of mosquito breeding are critical, yet unexplored in terms of the financial costs involved for urban communities, donors and government bodies.
- **Appropriate, practical and cost-effective monitoring tools for the urban context must be evaluated or developed:** As recognition of urban malaria is a relatively new phenomenon, the identification and promotion of effective ways to monitor and evaluate any progress made to combat the disease are vital. There is a need to measure levels of transmission and to determine malaria infection risk factors, in order to understand how the most vulnerable people can protect themselves and seek effective treatment in urban contexts.
- **The unique nature of social structures and their effect on disease burden and strategies for control remain unknown:** In urban settings, the dynamics of social relationships are relatively unexplored. The nature of social networks involving individuals, families and communities is likely to influence the success of prevention and treatment strategies.

This paper represents the consensus of participants in a cross-disciplinary conference on Urban Malaria in Africa, held at Pretoria, South Africa, December 2-4, 2004. Sectors represented at the conference were water, agriculture, eco-health systems, epidemiology, entomology, community health, NGOs and social sciences. The Malaria Knowledge Programme© key partners in the conference were the System-wide Initiative on Malaria and Agriculture (SIMA), the International Water Management Institute (IWMI), the Environmental Health Project (EHP, USAID) and the International Development Research Centre (IDRC).

A full report on the meeting will be available shortly and may be viewed and downloaded at www.liv.ac.uk/lstm/majorprogs/malaria/outputs.htm and www.iwmi.cgiar.org/sima/index.asp

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Abstracts of Presentations

Tyagi, Konradsen, Mutero, van de Berg, Okello-Onen, Bates, Barnish, Lengeler, Siri, D'Alessandro, and Hastings wrote their own abstracts; other presentations were abstracted by the editors.

Session 1

General Perspectives

Session chairs: Martin Donnelly and Jean Francois Trape

The session began with a historical overview followed by individual studies from Senegal, Congo, Ghana, Tanzania and India to show previous and ongoing work on urban malaria. The case studies were presented to provide insight into the question as to whether urban malaria is a real problem and what the characteristics of malaria epidemiology are in the urban setting.

Malaria and urbanization in tropical Africa: Historical overview

Jean-Francois Trape, IRD, Dakar, Senegal

Urbanization is a recent phenomenon in Africa. In 1960, for example, there were no towns with one million inhabitants, yet by 2004 there were 10 cities with over one million inhabitants. For the period 1900-1960 there are few publications specifically addressing urban malaria, although data can be found in unpublished reports and internal documents. In this period, however, major malaria control activities were underway in most capitals and main towns in west, central, east and southern Africa, the objectives of which depended on transmission intensity. In low/unstable transmission areas (highlands of east Africa, southern Africa and north Africa), the strategy aimed to reduce and then eradicate malaria both in urban and rural areas. In high transmission areas (west and central Africa) the aim was to protect administrative and European residential districts (e.g., Brazzaville, Kinshasa and Accra) and military areas (e.g., Freetown during World War II). The main methods used were vector control by reduction of *Anopheles* vector breeding sites via drainage schemes, water management and environmental sanitation, and destruction of mosquito larvae by larviciding, intermittent drying, sluicing and introduction of larvivorous fish. After the introduction of DDT in the 1940s, control of adult vectors by space spraying and residual DDT spraying was introduced. Results were often good, with many towns in north, east and southern Africa becoming malaria-free and residential and administrative areas of several west and central African towns having low or no transmission.

After 1960, the situation changed considerably; urban populations grew significantly with the population doubling every 6-12 years in most towns during the period 1960-1980 and vector-control programs were interrupted in many towns in tropical Africa leading to the resurgence of malaria. In the 1980s the first comprehensive studies of the impact of urbanization on malaria were carried out. A major study carried out in Brazzaville, Congo between 1982 and

1984[7] showed marked differences in malaria transmission in different districts with the EIR ranging from <0.3 in the center to >100 in recently urbanized suburbs. Parasite rates in schoolchildren of 6-14 years ranged from 3 to 82 percent. Although the transmission parameters differed highly, there were only minor differences in severe malaria attacks and malaria mortality was low in all parts of Brazzaville. A second major study in Dakar, Senegal during 1987-1988[8] highlighted the epidemiological importance of vector density gradients, with vector density, EIR and malaria incidence decreasing towards the center of town, and increasing with proximity to the large marsh at the edge of Dakar. The proportion of children with negative test titers increased from 17 to 73 percent in the same "transect." A review of EIR in relation to the level of urbanization[9] by Robert et al. shows a mean annual EIR of 7 in city centers, 46 in peri-urban and 168 in rural areas. Several conclusions can be drawn from these studies:

- While new human settlements promote *An. gambiae s.l.* breeding, urban growth later reverses this trend.
- Three mechanisms contribute to the reduction of vector density in urban areas:
  - Reduction of open space and pollution curtail anopheline breeding.
  - High human but low mosquito populations result in low biting rates per person.
  - Limited dispersal of *Anopheles* from breeding sites localizes biting.
- Considerable variations in the level of transmission exist between towns and within different districts of the same town.
- Massive urbanization implies lack of immunity, with high morbidity and mortality risk for infants, children and adults.

Urban areas are favorable environments in which to envisage efficient and efficacious antimalarial activities in Africa.

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[9]Robert, V.; Macintyre, K.; Keating, J.; Trape, J. F.; Duchemin, J. B.; Warren, M.; Beier, J. C. 2003. Malaria transmission in urban sub-Saharan Africa. *Am. J. Trop. Med. Hyg.* 68:169-76.

Malaria prevalence and irrigated urban agriculture in Ghana[10]

Eveline Klinkenberg, IWMI/LSTM, Ghana/UK

In the rapidly expanding cities of the developing world, urban agriculture (UA) can contribute to food security and alleviation of poverty. Although malaria transmission is relatively low in urban areas, there is a concern that the expansion of agriculture in cities could create "rural spots" where anophelines could proliferate. This project seeks to determine the risks to human health of UA in terms of increased malaria transmission and to develop, if necessary, appropriate measures to reduce this risk for the case of urban Ghana, West Africa. The centerpiece of the work was a house-to-house survey for malaria parasitemia and hemoglobin levels in children between 6 and 60 months old in various communities in Accra and Kumasi. The location of each house and areas of urban agriculture were determined using a hand-held Global Positioning System. The epidemiological data were related to proximity to sites of urban agriculture and various socioeconomic indicators obtained through questionnaires. Samples were available from 1,756 children in Accra and 1,791 in Kumasi. In Accra, malaria prevalence was high, ranging from 6 to 22 percent by community, and was significantly associated with low socioeconomic status, higher age and low hemoglobin concentration ($P < 0{\cdot}05$). Malaria was higher in communities with irrigated urban agriculture ($P = 0{\cdot}008$) and in some areas, malaria risk was inversely associated with distance from agriculture ($P < 0{\cdot}05$). In Kumasi, overall malaria prevalence was generally lower (2-10% by community); two communities had prevalence rates of 16 and 33 percent. Risk of infection was associated with low socioeconomic status, travel to a village (in some communities) and low hemoglobin (Hb) levels, and there was no difference between communities with and without irrigated agriculture.

A comparison between the two cities highlighted the large heterogeneity both within and between cities. In Accra, the data revealed no association between travel outside the urban area and malaria infection, strongly supportive of the conclusion that malaria transmission is ongoing within the urban area. These data, together with the significant risk factor of a low socioeconomic score, highlight the urban poor, particularly those living close to sites of urban agriculture, as a previously overlooked highly vulnerable group for malaria infection. Moreover, with urban populations growing rapidly, case numbers in cities could become substantial. Although urban agriculture seems to contribute to urban malaria transmission, more research on the interaction between urban agriculture and vector biology is needed, as irrigated agriculture in most African cities often uses polluted water sources that are generally not favored by malaria vectors. Although the advantages of urban agriculture for alleviating poverty are manifold, care must be taken that unregulated growth does not compromise its success. Integration of the activities of municipal authorities, agriculturalists, health professionals and communities is essential to reduce the existing burden of malaria and to prevent future increases.

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[10]Published in part as Klinkenberg, E.; McCall, P. J.; Hastings, I. M.; Wilson, M. D.; Amerasinghe, F. P.; Donnelly, M. J. 2005. Malaria and irrigated crops, Accra, Ghana. *Em. Infect. Dis* 11: 1290-1293. Klinkenberg, E.; McCall, P. J.; Wilson, M. D.; Akoto, A. O.; Amerasinghe, F. P.; Bates, I.; Verhoeff, F. H.; Barnish, G.; Donnelly, M. J. Urban malaria in sub-Saharan Africa: Heterogeneities in malaria prevalence in two cities in Ghana. Unpublished data.

Involving the community in malaria control: The Dar es Salaam Urban Malaria Control Program.

Khadija Kannady, City Council, Dar es Salaam, Tanzania

In 2004, the City Council of Dar es Salaam and collaborators[11] started the Dar es Salaam Urban Malaria Control Program (UMCP) with the specific goal of strengthening the ability of the municipalities to deliver interventions prioritized by the National Malaria Control Program (NMCP), and to provide support for adding further interventions focusing on larval control. At present, 15 wards (administrative units) in the three central districts of Dar es Salaam are enrolled in the pilot program. The UMCP is community based with 129 people directly employed, of whom 95 are from community groups:

- CORPS (Community Owned Resource Persons): Community members living in the area and selected by other community members to represent them; responsibilities include mapping breeding sites and conducting larval searches.
- 10 cell unit leaders (Supervisors): Local leaders manning a cluster of approximately ten houses and responsible for administrative activities in that particular area.
- CBHC (Community-Based Health Care) nurses who either live in that area or work in a nearby health facility.

The main control method of the UMCP will be targeted larval control, starting after the baseline data collection, now underway. Initial monitoring activities consist of mapping of breeding sites, larval searches, household surveys and collection of parasitological data via blood films within the 10 cell units. Sketched maps will be used as a reference during subsequent larval prospecting. Each month 3 wards (one in each district) undertake a household survey, which will be repeated every 6 months. A questionnaire will be used to collect information on characteristics of houses, socioeconomic and agricultural information and antimalaria measures used. Parasitological data are collected at the same time. A central computer, with restricted access, stores information for all the municipalities.

Although the program is still in its first year, achievements can already be reported:

- High levels of community participation, notably of women.
- Acceptance and responsibility of the community members who are the main stakeholders.

[11]Municipal Health Department of Ilala, Temeke and Kinondoni, Swiss Tropical Institute, Univ. of Durham (UK), Univ. of Princeton (USA), Univ. of Nairobi (Kenya), Univ. of Dar es Salaam, Ifakara Health Research Centre, National Institute for Medical Research and the National Malaria Control Programme (Tanzania).

- Householders have direct and efficient contact, so information flow is efficient.
- Political will: Initially councilors and local leaders were involved in the decision making.

The main lesson learned is that successes to date have been primarily the result of successful community involvement and participation.

Urban malaria on the Indian subcontinent

B. K. Tyagi, ICMR, India

Malaria is presently the single most important vector-borne infection in Africa and Asia. It is particularly important in South Asia, where it exacts high morbidity and mortality. Here, urban malaria is essentially a man-made problem; the outcome of rapid and haphazard expansion of cities, an inadequate piped water supply, storage of water in cisterns, disuse or scarce use of wells, unregulated developmental activities and aggregation of migrant labor forces, population movement and, notably, new avenues in peripheral agriculture through the introduction of canalized irrigation. In India, urban malaria, especially *P. falciparum*, has emerged as a major hindrance to progress. Tamil Nadu and Rajasthan states, located in vastly different ecological situations, offer a glaring example of the severity of the problem associated with urban malaria. In 1961, 50 percent of Tamil Nadu's malaria cases originated in urban areas; this soon rose to 95 percent in 1963 with the Chennai (formerly Madras) metropolis alone contributing almost half of this total. At present, though considerably reduced, it nevertheless contributes significantly to the annual malaria incidence in the state. In Rajasthan, especially in the Thar Desert region, malaria epidemiology has undergone a sea change, with more urban townships having become new strongholds for the disease transmitted by *Anopheles stephensi,* the major vector species. This vector, already adapted since yore to breed in underground domestic water reservoirs locally called "tanka," prospered ceaselessly in urban setups where "tanka" are built in every house, as an obligatory fixture. In addition, extensive quarry mines (approximately 10,000 km^2) in the vicinity of Jodhpur city produce *A. stephensi* prodigiously throughout the year, causing a continuous inflow of malaria cases to Jodhpur city. The "tanka lid," prototypically developed by this author in 1999 for the Thar Desert's urban habitats, is quite effective in preventing the entry of vectors into "tanka." The control of urban malaria demands knowledge of the epidemiological profile, skilful handling of the situation using appropriate technologies and legislative measures. The Government of India launched an urban malaria scheme in 1971-72 to tackle the growing problem. In spite of the enormous malaria-related disease burden, the malaria situation in the country in general, and that in the urban setup in particular, is being kept under appreciable control.

Session 2

Control Methodologies

Session chairs: Philip McCall and Christian Lengeler

The session examined those aspects of urban malaria that might differ from rural malaria and how the different experiences with malaria and its control illustrate both the challenges faced and the range of options available for prevention and control in the urban context.

Malaria: Urban-rural contrasts

Philip McCall, LSTM, UK

How new is malaria in urban Africa? Data from as far back as 1899 record malaria in Accra, Freetown and Lagos, but it is unlikely that these towns were truly "urban" in the contemporary sense. The transition from a rural to an urban area begins with a population increase in what is essentially a rural environment, leading to an increase in unmanaged peri-urban agriculture. Such areas maintain rural-type ecologies but with higher human densities; anophelines become plentiful while infrastructure and public health are usually poor or nonexistent. As the area becomes more established, denser more permanent housing leads to a reduction in available clean surface water; transmission is considered to be lower in such "fully" urban areas as a result of fewer available larval habitats, mosquito avoidance behavior (due to high nuisance biting by *Culex sp.*), and lower biting rates in the higher density human population. All of these factors have been considered to be the reason why less malaria occurs in urban Africa.

How does urban malaria differ from rural/peri-urban malaria? Are the same vectors involved in both rural and urban malaria and, if so, are vectors only found in islands of rural ecology in urban areas? There is some evidence for differences between urban and rural vectors:

- *A. gambiae s.l.* have been found in domestic water containers and polluted water.[12]
- Unusually high MOPTI/ SAVANNA heterozygote rates were found in Accra.[13]

[12]Chinery, W. A. 1984. Effects of ecological changes on the malaria vector Anopheles funestus and the Anopheles gambiae complex of mosquitoes in Accra, Ghana. *J. Trop. Med.Hyg.* 87, 75-81.

[13]Mbole, N. M.; Boakye, D. A.; Appawu, M. A.; Wilson, M. D. 2004. The distribution of chromosomal forms of Anopheles gambiae s.s. (Diptera: Culicidae) in urban, peri-urban and rural locations in greater Accra. 53rd Annual Meeting ASTMH. *Am. J. Trop. Med. Hyg.* 71S: 242 (abst. 815).

- Urban *A. gambiae s.s.* had lower longevity in Kinshasa.[14]
- In Cameroon and Burkina Faso, *A. gambiae s.l.* dispersed less in urban sites.[15]

Whether or not these observations are indicative of adaptation has yet to be proven. Importantly, in urban environments, vector populations may exhibit unknown or unpredictable behaviors (in host preference, biting or resting sites and seasonal abundance) determined by resource availability that might compromise the accuracy of measurements of entomological parameters.

There may also be different social parameters affecting urban malaria that should be taken into consideration in any comparison with rural populations.[16] Economic interdependencies exist between urban and rural areas, leading to frequent travel between both and high potential for importation of rural infections into urban sites. High unemployment among urban dwellers may mean that a few support many individuals, altering traditional extended rural dependency patterns with possibly greater stresses on the elderly or children. Notably, the perception by an urban population of what is important may not include malaria.

In terms of control, there are also some issues unique to the urban environment. The highly focal nature of urban malaria enables affected districts to be dealt with on an individual basis, and the high density of urban areas would enable efficient environmental management, education and other programs.

Given the complexities of the urban environment, an *integrated* approach, recognizing the many social and environmental settings, is essential to prevent and control malaria. Finally, while effective prevention and control of urban malaria appear feasible, sustaining such efficacy will not be simple under current conditions in sub-Saharan Africa.

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[14]Coene, J. 1993. Malaria in urban and rural Kinshasa: The entomological input. *Med Vet Entomol.* 7,127-37.

[15]Manga, L.; Robert, V.; Messi, J.; Desfontaine, M.; Carnevale, P. 1992. Le paludisme urbain à Yaoundé, Cameroun 1. Etude entomologique dans deux quartier centraux. *Mém. Soc. R. belge. Ent.* 35 : 155-162. Sabatinelli, G.; Rossi, P.; Belli, A. 1986. Etude sur la dispersion d' Anopheles gambiae s.l. dans une zone urbaine a Ouagadougou (Burkina Faso). *Parassitologia* 28:33-39.

[16]Harpham, T.; Tanner, M. 1995. Urban health in developing countries: Progress and prospects. Earthscan, London.

Public-private partnerships: Large-scale malaria vector control[17]

Brian Sharp, MRC, Durban, South Africa

The private sector appreciation of the need to engage in health and broader social issues is growing. It is recognized by many that the management of malaria is good for business and the communities in which it operates. To illustrate this, two cases of public-private partnership in malaria control programs that benefited communities, in addition to business development and its staff, are presented.

In the Zambian Copperbelt, Konkola Copper Mines (KCM plc) initiated a malaria control program based on effective case management, selective larviciding and IRS (2000-2002). All structures inside and within 10 km of two towns, Chililabombwe and Chingola, were sprayed, (an area of 2,704 km^2) at the start of the peak transmission period. Training and preparation for the operation took 3 months. There was a statistically significant reduction in malaria incidence recorded at KCM health facilities in the two towns after spraying. After one spraying round the protective incidence rate ratio was 0.65 (95% CI 0.44, 0.95). After two spraying rounds there was a further decrease in incidence and no deaths were recorded, and the lowest malaria figures in 10 years were observed. This house-spraying program was funded by KCM plc and the total population of both towns benefited (from Sharp et al. 2002 and GHI 2002).

The second example is the Lubombo Spatial Development Initiative (LSDI) between South Africa, Swaziland and Mozambique (1999-2004). In July 1999, President Mbeki of South Africa, President Chissano of Mozambique and His Majesty, King Mswati III of Swaziland signed the General Protocol, which put in place a platform for regional cooperation and delivery. In October 1999, the Lubombo Malaria Protocol was signed and a tri-national malaria program was launched, aimed at accelerating development, particularly with regard to tourism, within an area of approximately 50,000 km^2 in the border region of the three countries. A regional Malaria Control Commission to manage the program was established with representatives of the health departments of the three countries, malaria control program managers and scientific partners from the South African Medical Research Council and the University of Cape Town. At present, the contiguous malaria controlled area in the three countries extends over 100,000 km^2. The malaria control objectives of the LSDI are to:

- Develop a regional malaria control program.
- Develop a regional GIS-based malaria information system.
- Develop a regional monitoring and evaluation program.
- Provide updated tourist information booklets containing definitive malaria risk maps and prophylaxis guidelines.
- Ensure sustainability.

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[17]References: Sharp, B.; van Wyk, P.; Sikasote, J. B.; Banda, P.; Kleinschmidt, I. 2002 Malaria control by residual insecticide spraying in Chingola and Chililabombwe, Copperbelt, Zambia. *Trop. Med. Int. Health* 7 (9) 732-736. GHI (Global Health Initiative). 2002. Malaria Control in Chililabombwe and Chingola. KCM plc. Technical Report. Private sector intervention case example. www.weforum.org/globalhealth.

The area is divided into 5 zones, which are enrolled in the program, where a total of 134 sentinel sites have been set up for the monitoring of malaria vectors (species and relative density, and infectivity and insecticide resistance/susceptibility) and parasites (parasite prevalence in children, drug efficacy, ACT implementation and gene flow). A Malaria Information System database has been designed for monitoring activities. After the first spraying round in 2000 the vector density of both *A. funestus and A. arabiensis* was reduced to low levels and additional spraying rounds are keeping the densities at levels close to zero. In Mozambique, the malaria parasite prevalence in 2-15 year olds has been reduced from 64 percent to less than10 percent over 5 years in the zone where the program first started. The other zones are following a similar pattern showing a clear, reduced prevalence since the start of the program. Malaria case numbers show similar reductions after the introduction of IRS. In the first 3 years, 70 percent of funding was private while in the fourth year (2003) public and private sources each provided 50 percent of the funds for the program. In 2004, the program was funded by an allocation of the Global Fund for AIDS, TB and Malaria.

In addition to their demonstration of the success of the public-private partnerships, these two examples also show that IRS is an effective malaria vector control tool. It can be implemented at short notice, it protects all vulnerable groups and it is cost-effective. In order for it to be sustainable, there is a need for capable research capacity to support evidence-based decision-making (e.g., insecticide resistance). IRS is clearly an important component of the malaria control model that is increasingly being employed to assist economic development projects in Africa.

Urban agriculture and the occurrence of potential larval habitats for Anopheles mosquitoes in an urban area of coastal Kenya

Charles Mbogo, KEMRI, Kilifi, Kenya

In sub-Saharan Africa, most urban populations live in overcrowded and denuded areas without access to safe water and sanitation services, paved roads, and adequate housing or engineered drainage. Many continue to engage in rural-type activities to sustain themselves in an urban area via a semi-rural type of existence. These activities can result in an increase in anophelines in urban areas. Conversely, in wealthier areas, poor maintenance of recreational facilities such as swimming pools can also increase anopheline numbers. In both situations, the risk of malaria transmission is increased.

To investigate this in Malindi, Kenya, a geographic sampling strategy was designed using base maps prepared in ArcView 3.3, which were validated and improved using municipal maps and ground-truthing. A grid of cells of 270 m x 270 m was overlaid on the base map. Malindi then constituted 248 grid cells that were classified as well drained or poorly drained. A total of 50 grids cells (stratified by drainage) were randomly selected in which all aquatic habitats were visited to investigate breeding potential. In addition, a target sample of 900 households was interviewed. Hierarchical regression, to estimate risk of water body occurrence throughout Malindi town, showed that urban agriculture was not significant after controlling for other covariates. In Malindi, 93 percent of larval habitats were man-made; common types of water bodies occurring were road pools, agricultural wells, blocked drains, abandoned swimming pools, leaking water pipes, etc. *A. gambiae s.s.* was the predominant species found but *A. arabiensis* and *A. merus* were also recorded. The type of activity leading to increased availability of potential larval habitats can be separated into rural and urban type activities. Rural-type activities are commercial and household-level urban farming on small patches of cultivated land around the household uses shallow garden wells to provide water. Households without access to piped water also use similar shallow wells. Urban-type activities include recreation activities such as use of swimming pools, use of water in vases and pots for flowers, etc., and certain water storage and/or irrigation practices.

Modernizing old-fashioned malaria control: The potential of larval control in Africa[18]

Gerry Killeen, IHRDC/STI, Tanzania/Switzerland

Academics are not the persons to implement malaria control; community workers should carry out this work. Academics may assist and advise but probably should not carry out the actual control.

There was successful malaria control in post-independence Tanzania, but 1970 marked the end of the old malaria control program. New programs may permit new approaches. In Brazil in the 1930s and 1940s, *A. gambiae* was eradicated successfully from a large area of about 54,000 km^2 following an accidental introduction. Although this success was achieved through an integrated program, it relied overwhelmingly upon larval control in a setting that most likely was no easier than it would be in urban Dar es Salaam. Could larval control be possible in Africa today? Although it has to be taken into account that the vertical approach taken in the old days might not work in current day communities, larval-control methods should now be re-prioritized for research, development and implementation as an additional way to roll back malaria in an integrated program.

For that to work community participation is essential. We should realize that "If we have a problem with the community, the problem is with us" (M. Kiama). Health professionals tend to think only they know what is good for the community. In the new program in Dar es Salaam, there is major community involvement, and community health nurses, who are living in the community, increase compliance up to 95 percent (from only 30% previously). Why are we looking for experts to come in, if experts are already there? In the Dar es Salaam program the people who carry out control live in the community; they are the experts in their own community, they know the communities and if the communities don't like it they can tell them. For a program to be successful you have to go out in the community as "There are no larvae in meeting rooms" and "You will not meet the community in the Golden Tulip" (M. Kiama).

But larval control is intensive and for such a control program to work people need to be paid properly; otherwise it will not be sustainable. Also, it is important that people are assigned full time; otherwise, in emergency situations, they are withdrawn to assist elsewhere. As highlighted by Pontes et al. (2000)[19] one of the main factors explaining the dengue vector pattern is that during drought periods local health workers are called away for control of cholera outbreaks and thus diverted from routine anti-vector activities.

[18]Killeen, G. F.; Knols, B. G.; Gu, W. 2003. Taking malaria transmission out of the bottle: Implications of mosquito dispersal for vector-control interventions. *Lancet Infect Dis*. 3, 297-303. Killeen, G. F. 2003. Following in Soper's footsteps: Northeast Brazil 63 years after eradication of Anopheles gambiae. *Lancet Infect Dis*. 3, 663-6.

[19]Pontes, R. J.; Freeman, J.; Oliveira-Lima, J. W.; Hodgson, J. C.; Spielman, A. 2000. Vector densities that potentiate dengue outbreaks in a Brazilian city. *Am J Trop Med Hyg*. Mar; 62(3): 378-83.

Environmental management for malaria vector control in Sri Lankan streams and rivers

Flemming Konradsen,[20] *IWMI/University of Copenhagen/Mahaweli Authority of Sri Lanka, Sri Lanka/Denmark*

Numerous studies have identified pools formed in streams and rivers as key breeding sites for the principal malaria vector in Sri Lanka, *Anopheles culicifacies*. Water flow in many of these streams and rivers, located in the malarious dry zone of the country, can be managed either partly or fully by irrigation authorities when these streams act as conveyance canals between man-made water reservoirs. The hydraulic system in place in Sri Lanka provides an opportunity for water management practices to assist in reducing the malariogenic potential of an area. A study, undertaken in the north central dry zone of Sri Lanka from 1994 to 2004, focusing on settlements located along a natural water way, confirmed the significance of the local stream as the principal breeding site for *A. culicifacies*, established the seasonal importance of the vectors involved in malaria transmission, and documented the importance of *A. culicifacies* in initiating small outbreaks of malaria that may later be sustained by secondary vectors. Risk factor studies found that residents in houses located 750 meters or less from the stream had a 500 percent greater risk of infection than people living further away from the stream. Water balance and entomological studies established that the critical water levels in the stream (below 30 cm) were conducive for vector breeding and estimated the periods of the year when such conditions would favor vector breeding. In support of other malaria preventive and curative interventions, different options for water and stream management were discussed. These included: periodic releases of water from the upstream reservoir to maintain water levels above pooling levels, during the most critical periods of the year; attempts to dry out the stream bed through complete closure of the upstream gate during critical dry season periods; making use of routine water level/water release monitoring by irrigation authorities to alert malaria control agencies of breeding opportunities; selective removal, vegetation changes and manipulation of breeding habitats in streams; and permanent modification of the stream bed to reduce the potential for pooling. The latter option was implemented on 8 km of the 30-km stretch of stream connecting the two reservoirs, in close collaboration with the irrigation authorities. The environmental modification had an impact on drying out of the streambed, vegetation and water depth. This particular case in Sri Lanka, together with experiences documented from elsewhere, is used to discuss the opportunities and constraints related to land and water management modifications for malaria vector control in Asia. This discussion highlights, among other issues: the importance of identifying interventions with benefits in addition to malaria control; the importance of local land-water management practices and resource utilization; the site-specific entomological information required; the challenge for interdepartmental collaboration; the capital-intensive nature of most interventions aimed at long-term environmental modification; and the potential negative environmental impacts of relevance for such interventions.

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[20]With co-authors Felix Amerasinghe, Pryani Amerasinghe, Wim van der Hoek, Eline Boelee and A. K. Weerasinghe.

Treating malaria in the community

Guy Barnish, LSTM-MKP, UK

The Abuja Declaration (April 2000) states that (by 2005) at least 60 percent of those suffering from malaria should have prompt access to and are able to use correct, affordable and appropriate treatment (good quality antimalarials at appropriate dosages) within 24 hours of onset of symptoms. However, in Africa, more than 70 percent of malaria episodes in rural areas and more than 50 percent in urban areas are self-treated, and so generally do not receive the correct treatment.

There are a few reasons why the current system probably does not work, and why people do not receive proper treatment in time. These include: the inconvenience of travelling long distances from home to health facilities; often people cannot afford to buy the services and treatment offered by the public health providers; the perceived poor quality of service at public health facilities; frequent drug stockouts mean that people lose faith in the health services as they cannot always get the proper treatment; health workers' behavior sometimes discourages people from attending public health facilities, and although confirmatory tests might be negative for malaria parasites the health worker "knows" it is malaria and will prescribe antimalarials (i.e., poor diagnosis and inappropriate treatment).

In recognition of the fact that many people self-treat, a strategy within Roll Back Malaria (RBM) has been initiated to help overcome this problem. This strategy, known as Home Management of Malaria (HMM), is to provide access to affordable and appropriate treatment, taking into account isolated rural poor populations as well as urban populations, and which relies on the community and the services provided by the formal and informal private health sectors.

Thus, HMM is an integral part of the malaria case management strategy that aims to improve ineffective self-medication practices. Whilst HMM should be part of a national health delivery system (within the National Malaria Control Program, and NOT as a separate program), it should also operate within the RBM partnership and create an enabling environment for implementation. This, however, requires the highest level of political commitment. It is a decentralized health care system so that decisions can be made locally, rather than centrally. Community ownership is important, and caretakers should be trained to recognize malaria illness promptly, and take early and appropriate action—thus they should have adequate knowledge and capacity to respond to malaria illness.

Home-based management is a popular early treatment option, but home-based treatment is often inappropriate, and fewer than 15 percent of episodes are treated correctly. Thus, early diagnosis and treatment are critical to illness outcome. Ultimately, home-based management of malaria produces public health gains.

The challenges to implementation are:

- The increasing ineffectiveness of commonly available and relatively cheap drugs for treating malaria.
- Developing community ownership and sustainability of community volunteers.
- Ensuring that severely ill children are referred and appropriately treated.
- A reluctance to scale up to HMM.
- Fears that actively promoting HMM will encourage inappropriate treatment.

To successfully implement the strategy, every full course of antimalarials should be unit-dose packaged with pictorial labeling (for illiterates) and, within each community, there should be community-targeted IEC for behavior change—health seeking behavior; training of mothers and other community resource persons plus training of shopkeepers, drug vendors, chemical sellers, and drug shop owners.

However, before moving to the communities, there are some essential steps. These are:

1. Assess and develop political support
2. Conduct a situation analysis
3. Identify key stakeholders
4. Address regulatory issues
5. Establish procurement and supply management systems
6. Establish financing mechanisms at central and at district/community levels
7. Develop a country-specific communication strategy
8. Develop training materials and tools, and then
9. Implement at district and community levels

Session 3

Reaching the Vulnerable with Malaria Interventions

Session chairs: Imelda Bates and Umberto D'Alessandro

In this session, the targeting of the vulnerable and the consequences of misdiagnosis and health system performance were discussed.

Initial trials of a community-based environmental management program for malaria control in Uganda [21]

Eugene Brantly, EHP, Washington, USA

In the early 1990s in cities in sub-Saharan Africa, malaria was controlled using environmental management (EM) for vector control. What this approach lacked in effectiveness, compared with the residual insecticides that appeared on the scene in the 1950s, was largely made up by its sustainability. Yet today malaria control in Africa is focused almost entirely on the use of antimalarials and insecticide-treated bed nets, not on biophysical environmental modifications or on strengthened social systems to perform effective environmental manipulation. While drugs and insecticides are extremely effective weapons, their initial promise has been undermined by the development of resistance, and growing concerns for some about the long-term costs and environmental impact. This report describes the activities and findings of a two-year study designed to assess the strengths and weaknesses of a community-based EM program for malaria control in two Ugandan cities, Kampala and Jinja. The overall goal was to test the use of EM in urban areas and, if successful, generate useful lessons for expanding EM in these and other cities.

Kampala and Jinja are both situated close to the equator and experience a tropical climate with rain falling throughout much of the year. Kampala is the nation's capital and is built on rolling hills and valleys. Housing there is confined largely to the hills, while in the valley floors, where water collects, are areas of market gardening, swamps and brick pits. It is in these valley bottoms that anopheline breeding sites abound. In Jinja, the hills are less pronounced and the valleys broader, collecting water that drains into Lake Victoria. Both cities are essentially rural outside the main commercial centers. Four sites were selected for the study, two in Kampala

[21]Executive summary from: Lindsay, S. W.; Egwang, T. G.; Kabuye, F.; Mutambo, T.; Matwale, G. K. 2004. Community-based environmental management programme for malaria control in Kampala and Jinja, Uganda. EHP Activity Report 140. Full report is available at *www.ehproject.org*. This replaced Dr. Daniel Wacira's planned presentation, Contrasting Patterns of Access to ITNs in Rural and Urban Areas, as Dr Wacira was unable to attend.

(Kitebi and Kikulu) and two in Jinja (Police Barracks and Loco Estate). Both sites in Kampala were in small valleys with extensive areas of flooded brick pits, while in Jinja they were estates close to farmland or swamps. The first-year activities focused on collecting essential data and preparing action plans. Routine entomological and clinical surveys were performed to determine the sources of vectors and the level of malaria transmission at each study site, and the results revealed a complex picture. Generally malaria transmission was low in all sites, with anopheline mosquitoes being far less common than the abundant culicine mosquitoes. Anopheline mosquitoes occurred in a wide variety of different water bodies at each study site. In Kampala, brick pits, tire ruts and puddles were the predominant sites favored by the major malaria vector, Anopheles gambiae s.l. In Jinja, few anopheline larvae were found near the Police Barracks, while in Loco Estate most were on the edges of the extensive swamp bordering the settlement. The level of infection with malaria parasites was similar in children living in all study sites (14-29%), except for Loco where the prevalence was markedly higher (36-46%). The study team provided local communities and health departments with this evidence and technical support to help them develop action plans for the environmental management of malaria. A key element of the approach was to actively involve the communities and municipal authorities in the decision-making processes. This involved project staff facilitating discussions within the study communities and key people from relevant municipal and governmental departments. The action plans were specific to the ecology and social make-up of each site. In Kampala, the interventions included filling puddles, introducing larvivorous fish and improving drainage. In Jinja, the plans focused on building and repairing drainage channels and soak pits. The action plans were implemented in the second year in Kitebi (Kampala) and the Police Barracks (Jinja). The other two communities were followed as non-intervention controls. Community residents in Police Barracks were highly active and had the strong support of the local municipal and district health authorities. Community participation and support from local officials were noticeably less in Kitebi. Entomological and clinical surveys were continued in order to assess the impact of environmental management on the level of transmission and infection experienced in the intervention sites, as compared to controls. Results from both intervention sites provide evidence that the actions taken reduced the number of potential breeding sites for anopheline mosquitoes and the numbers of anopheline larvae and pupae. Collections of adult mosquitoes from sentinel houses suggest that there was also a reduction in malaria transmission, as indicated by a drop in the number of adult mosquitoes collected.

The interventions were associated with reductions in malaria prevalence of 11 percent in the Police Barracks and 36 percent in Kitebi, providing very important evidence of the potential benefits of EM for reducing malaria transmission in urban areas. In this study, the team was unable to use larvicides to further reduce the numbers of anopheline larvae in certain types of breeding sites (e.g., brick pits). The activity did not result in the reduction of the number of culicine mosquitoes found indoors, probably because mosquito abatement activities in pit latrines were not carried out. This was a serious oversight because, during the interventions, people in the local communities were still being bitten by large numbers of nuisance mosquitoes. Thus the communities may have perceived that the EM interventions were less successful than was actually the case.

The findings from this pilot study suggest that EM was successful in reducing malaria transmission in urban settings. EHP recommends that further work be undertaken to determine practical means of implementing environmental management at a larger scale in Uganda's cities, including addressing the operational problems of community participation, public sector capacity and support, and financial sustainability.

Prospects for increasing the role of urban farmers in malaria control

Henk van den Berg,[22] *UNEP/WUR/IWMI, Switzerland/The Netherlands/Sri Lanka*

Rural pockets of crop cultivation within the expanding boundaries of African cities often provide suitable aquatic habitats for malaria vectors, and potentially contribute to urban malaria. In this context, environmental management is often an appropriate intervention but will require active participation of farmers. To enhance the role of farmers in malaria control, an integrated educational approach was developed in Sri Lanka based on the Farmer Field School (FFS). The FFS, which uses field-based experiential learning methods to build farmers' expertise, has a proven record in empowering farmers to deal with agro-ecological problems, particularly in relation to integrated pest management. A combined farmer-training curriculum was developed on agriculture and health, incorporating methods on the ecology and management of disease vectors. Results imply that farmers can be motivated to play an active role in the ecological control of mosquitoes, and post-training experience confirms farmer-driven coordinated action on source reduction. The approach needs testing in appropriate African settings, to include studies on vectors and malaria risk. We argue that the approach is particularly relevant in an urban context with confined rural pockets and man-made habitats, where vector control can rely heavily on environmental management, but do not discount the epidemiological complexities of malaria transmission that may confound or modulate such an approach. The agricultural component will provide an incentive for people to participate, provided that improvements in crop husbandry or reductions in agro-chemical inputs can be achieved. It is anticipated that experiential learning about malaria will influence treatment-seeking behavior and personal protection.

[22]Co-authors: Felix Amerasinghe (IWMI) and Willem Takken (WUR).

Review of the role of parasitological diagnosis to support malaria disease management: Focus on the use of RDT in areas of high transmission deploying ACTs[23]

Guy Barnish, LSTM, UK

In areas with intense transmission, infants and young children suffer the highest rates of acute malarial illness and mortality. Clinical diagnosis of malaria results in over-diagnosis. Treating non-malaria cases with chloroquine was not a major issue, as the drug was safe and cheap. However, due to increased chloroquine resistance, ACTs are now being increasingly used as first line treatment in many countries. As they are 20 to 30 times more expensive than chloroquine there is an urgent need to improve parasitological diagnosis, to avoid misuse of these expensive medicines.

In addition to clinical diagnosis, WHO recommends parasitological confirmation of malaria with microscopy or, where not available, RDTs, in the following circumstances:

1. To guide malaria case management in areas with low to moderate transmission.
2. For confirmation of a malaria epidemic.
3. For monitoring changes of malaria prevalence over time.
4. For the assessment of patients with suspected severe malaria.
5. For investigating antimalarial treatment failures.

It is therefore recommended that:

- Parasitological confirmation of clinical diagnosis should be part of good clinical practice, to improve quality of care.
- Existing laboratory services providing malaria microscopy should be strengthened. Where it is not possible to have microscopy, RDTs should be introduced with appropriate Quality Assurance (QA) systems in place.
- QA of both microscopy and RDTs should be promoted at all levels in the public sector.
- Note that trained health workers, including community health workers, can effectively use RDTs.

[23]Based on a presentation of the WHO Technical Consultation, 25-26 October 2004, Geneva, Switzerland.

Parasitological diagnosis in areas of high transmission in different population groups.

1. **Malaria** diagnosis should be based on a parasitological confirmation of diagnosis in ***children over*** *5 years of age and adults.* In these age groups, infection rates are lower and clinical diagnosis alone leads to over-diagnosis of malaria, over-consumption of antimalarial drugs and high treatment costs.

2. There is insufficient evidence to recommend withholding antimalarial treatment in ***children less than*** *5 years of age* with a clinical presentation of malaria on the basis of negative parasitological results (microscopical examination or RDT). The risk of mortality in this age group due to missed malaria diagnosis (false negative results) may exceed the benefit of using parasitological diagnosis to reduce unnecessary consumption of antimalarial drugs.

3. Parasitological diagnosis should be promoted in pregnant women as part of good clinical practice, to improve the differential diagnosis of fever. *The potential clinical benefit of RDTs detecting antigens from parasites sequestered in the placenta requires more investigation.*

Performance requirements of RDTs

1. *Malaria RDTs should have high sensitivity (95%) in all situations.* To reduce the risk of missing true positive cases, RDTs should be able to reliably detect parasite densities close to 100 parasites per microliter.

2. *Performance of RDTs in the field must be compared to microscopy on a regular basis.* Diagnostic standards must be maintained at all levels by the introduction of a QA system.

3. *Where P. falciparum is the predominant species (> 90%), RDTs that can detect P. falciparum only would be appropriate.* In areas where non-falciparum malaria represents more than 10 percent of malaria infections, a test that detects falciparum plus pan-malaria antigens or falciparum plus non-falciparum species would be preferable.

Clinical benefits of parasitological diagnosis

1. The use of parasite-based diagnosis allows exclusion of malaria in the differential diagnosis of febrile patients.

2. By reducing malaria over-diagnosis and unnecessary antimalarial treatments, parasitological confirmation of diagnosis has the potential to improve adherence to treatment (as less drugs are taken) and to reduce the risk of adverse drug reactions.

Economic benefits of parasitological diagnosis

1. Modeled estimates based on current prices and anticipated use of both diagnostic tests and antimalarials show that cost savings can be achieved due to reduced drug consumption, on the assumption that patients with negative results will not be treated.

2. More evidence is required from large-scale operational settings to define the economic and health benefits of parasitological diagnosis.

Naturally, when initiating a new system new procedures are required. There are both risks and operational requirements to be taken into consideration.

Malaria misdiagnosis: Consequences for the most vulnerable[24]

Imelda Bates,[25] LSTM, UK

First question is: Who are "the vulnerable"? The Vulnerability and Health Alliance (VHA) has developed a framework for understanding the different types of vulnerability to infectious diseases (Bates et al. 2004). "Vulnerability" is not limited to poverty; it includes those who are vulnerable because of:

- Individual/biological factors (micro level)
- Household/community factors (meso-level)
- Political instability and environment factors (macro level)

Vulnerable people have the heaviest burden of malaria. Forty percent of the population in the poorest countries where malaria is transmitted is at risk of infection. Malaria causes 5,000 deaths a day. Ninety percent of these deaths are in young children, mostly in Africa. Because the majority of these children die at home there is an urgent need for malaria management to be optimized at community level. International guidelines promote effective and affordable treatment within 24 hours of fever. Because of the difficulties in obtaining an accurate diagnosis of malaria, especially in poorer communities, in practice all childhood fevers

[24]References: Amexo, M.; Tolhurst, R.; Barnish, G.; Bates, I. 2004. Malaria misdiagnosis: Effects on the poor and vulnerable. *Lancet*, 364, 1896-8. Bates, I.; Fenton, C.; Gruber, J.; Lalloo, D.; Lara, A. M.; Squire, S. B.; Theobald, S.; Thomson, R.; Tolhurst, R. 2004. Vulnerability to malaria, tuberculosis, and HIV/AIDS infection and disease. Part 1: Determinants operating at individual and household level. *Lancet Infect Dis.* 4, 267-77. Bates, I.; Fenton, C.; Gruber, J.; Lalloo, D.; Lara, A. M.; Squire, S. B.; Theobald, S.; Thomson, R.; Tolhurst, R. 2004. Vulnerability to malaria, tuberculosis, and HIV/AIDS infection and disease. Part II: Determinants operating at environmental and institutional level. *Lancet Infect Dis.* 4, 368-75. Reyburn, H.; Mbatia, R.; Drakeley, C.; Carneiro, I.; Mwakasungula, E.; Mwerinde, O.; Saganda, K.; Shao, J.; Kitua, A.; Olomi, R.; Greenwood, B. M.; Whitty, C. J. 2004. Overdiagnosis of malaria in patients with severe febrile illness in Tanzania: A prospective study. *BMJ* 329, 1212.

[25]Presented on behalf of The Vulnerability and Health Alliance (VHA).

in endemic areas are treated as malaria. Vulnerable households have the greatest gap between "ideal" (i.e., obtaining accurate diagnosis and only treating those with proven malaria) and "practical" (i.e., treating all fevers as malaria). So what are these gaps? And how can they be reduced?

To reduce malaria illness and deaths we need to understand the reasons for vulnerability and how to increase resilience. If we look at the pathway to malaria care for the most vulnerable, step 1 is: When a child develops a fever, a mother will first look for leftover tablets; this implies that the previous time the full course of treatment was not followed. If this does not work out, step 2 is often to buy herbal medicine, which is generally cheaper than conventional medicine and more easily available. Step 3 is to get permission to seek help outside the immediate community. Step 4 is to raise money, for example, by borrowing or selling assets (if available) and step 5 is to travel to a clinic where hopefully proper care and treatment is available. Even here there is evidence to suggest that the quality of service is often poor with long delays, poor staff attitudes, inaccurate diagnosis and ineffective drugs. The reality is that most children with malaria and other illnesses never get to stage 5 and often die at home without reaching the health facility.

How many children with fever really have malaria? Using fever as a marker for malaria results in significant over-diagnosis of malaria and missed diagnoses of other fever-causing illnesses. Malaria microscopy is the gold standard for malaria diagnosis but accuracy, in practice, is around 66 percent (Reyburn et al. 2004) due to faulty microscopes or supplies, and lack of supervision or quality checks. A solution could be rapid diagnostic tests (RDTs) but they are expensive and not quantitative or species specific. The difficulties associated with getting an accurate diagnosis of malaria means that presumptive diagnosis is still the norm, with an average 61 percent overestimation of malaria.[26] Overestimation increases as malaria prevalence decreases. So, in urban areas with lower prevalence than rural areas, misdiagnosis is likely to be a major problem. The growing problem of increased malaria resistance means that the vulnerable are increasingly disadvantaged, as for them presumptive diagnosis of malaria is still their only feasible option. The wrong diagnosis means exposure to drugs they don't need and wastage of critically needed money. The situation will worsen because the new first line antimalarial combinations are expensive and complex to take; many illnesses (e.g., pneumonia and urine infections) that are not malaria will be left untreated increasing the burden of ill health and risking long-term complications.

So what is the effect of malaria misdiagnosis on the vulnerable? More ill health due to delayed diagnosis and repeat visits, overburdened health services, more severe malaria, increase in real and perceived malaria resistance and chronic disease secondary to untreated infection (e.g., chronic renal failure from untreated urine infection). The resultant loss of faith in health services will encourage detrimental health-seeking behavior. This leads to increased poverty, as the vulnerable will prioritize health over food and education. Indirect costs increase overall costs by 80 percent. Loss of livelihood, income and schooling and increased mortality leads to reduced GNP/capita. Persistent illness promotes stigmatization and outcasting and inaccurate public health data results in misallocation of national and global resources.

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[26]Amexo, M.; Tolhurst, R.; Barnish, G.; Bates, I. 2004. Malaria misdiagnosis: Effects on the poor and vulnerable. *Lancet*, 364, 1896-8.

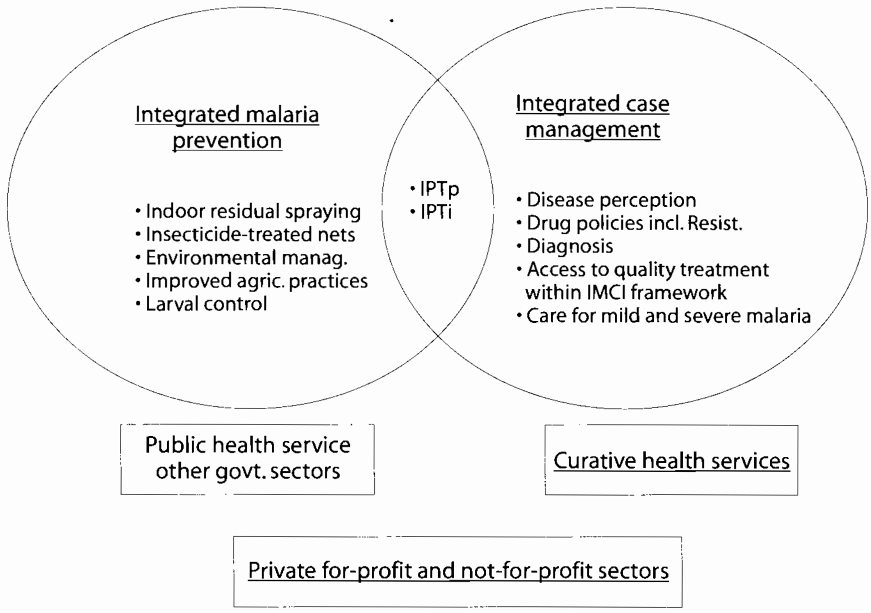
So how can we increase resilience to the effects of malaria? What are the challenges and solutions? The solution is that the effective malaria drugs available must be targeted at those who truly have the disease. The challenge is that the majority of those with disease do not come to health facilities and the tools to diagnose malaria are too complex (i.e., microscopy), inaccurate (i.e., clinical diagnosis) or non-specific (i.e., rapid tests) to be used at community level. The action that should be taken is that, for the most vulnerable, access to high quality health care and accurate malaria diagnosis linked to effective treatment should be improved.

Health systems development

Christian Lengeler, STI, Basle, Switzerland

The curative health system (from the primary to the tertiary level, including both public and private sectors) forms the backbone for malaria diagnosis and treatment—the most basic strategy to control malaria (RBM's first strategy). In Africa, malaria represents the bulk of attendance at health facilities and reducing this bulk through malaria prevention will help the health system a great deal. Among the many new initiatives for malaria control there is unfortunately very little talk about strengthening of the health services. This will be needed, as, for example, it will be very difficult to introduce new drugs like ACT without proper investment in the health system.

Integrated malaria control requires both the curative and the public health systems to work well and in a coordinated way (Antwerpen Declaration 2001, Mexico Forum 8). The framework for integrated control should be:



A well functioning health service can:

- Give prompt access to an effective malaria treatment to all, including the poorest.
- Be responsive to the local situation.
- Promote positive behaviors, including early recognition of malaria, micro-environmental management, use of ITNs, and acceptance of IRS and other interventions.
- Organize basic preventive and vector control activities.
- Interact with other government sectors.

But there are a few challenges:

- Increased decentralization requires more competent staff down to district level (e.g., vector control).
- Treatment of severe malaria remains a formidable practical challenge.
- Quality of treatment for mild malaria is often poor despite clear national IMCI and malaria treatment guidelines.
- Access to health care facilities remains poor in many African countries and the outlook is bleak.
- Most major international initiatives do not consider system strengthening (GFATM) and others have the potential for weakening it (HIV treatment initiatives).
- 50-80 percent of all fever episodes in children is treated outside the formal health care structure.

The Dar es Salaam Urban Health Project, 1990-2002 (run by the Swiss Tropical Institute on behalf of SDC), was a case study for health services development in urban areas. The project was fully integrated within the Dar Es Salaam City Medical Office of Health and was compliant with the health sector reform and local government reform process (decentralization). Three main steps were taken: (1) Rehabilitation of the physical infrastructure of public health facilities, cost-recovery and drug supply, (2) Development of health system and institutional capacity, and (3) Strengthening of community involvement and ownership.

In conclusion, developing the quality of, and access to, health services is crucial for any progress towards achieving international health goals (general and malaria). Such developments will need a long-term, well-funded, systemic approach. Integrated malaria control should aim at strengthening health services and not run in parallel to them, or even take resources away from them. Health services have the potential to promote malaria prevention (IPTp, IPTi and ITNs) as well as ensuring cure.

Session 4

Evaluation and Implementation Strategies for Urban Malaria

Session chair: Ian Hastings

In this session, aspects of study design and issues of standardization of definitions and suitability of different indicators for measuring the malaria burden were discussed.

Problems confounding standard study designs

Ian Hastings, LSTM, UK

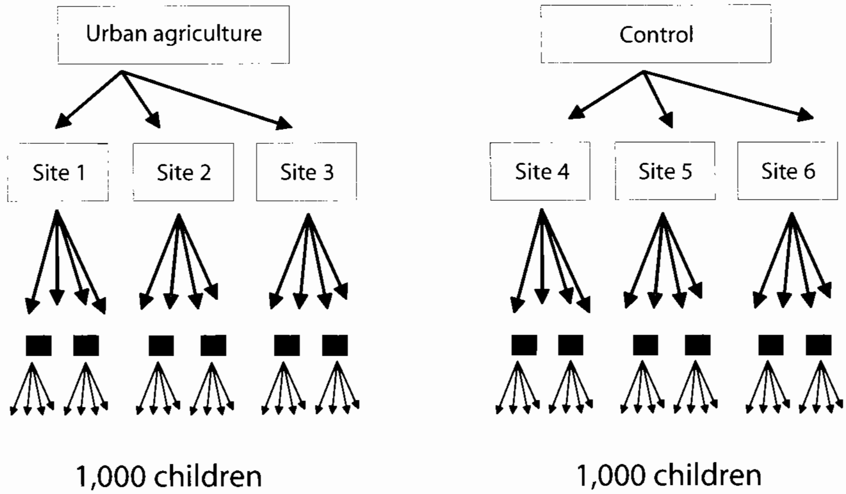
The main questions to answer on study design are: What to measure? and How to analyze it? In general the smaller the size of the effect being measured, the larger the sample size required to confirm a "significant" effect. This is illustrated in the following table where the prevalence of several features is assumed to double between intervention and non-intervention sites.

Proxy	Prevalence	Sample size
Death from malaria	1% to 2%	n = 2 x 2,300 = 4,600
All-cause mortality	2% to 4%	n = 2 x 1,140 = 2,280
Severe anemia	4% to 8%	n = 2 x 551 = 1,102
Mild anemia	8% to 16%	n = 2 x 257 = 514

Note: The above are calculated with power = 80%; sample size is doubled to account for data structuring.

If your measurement of primary interest is rare, then it is statistically difficult to detect it. Consequently, "proxy" measurements are often used. Proxies are related to the variable of interest, but have higher prevalence, allowing a difference in these proxies to be detected using more feasible sample sizes. In the above table, the proxy "mild anemia" is used as a proxy for malaria death, allowing a near 10-fold reduction in sample size. Which proxy to chose obviously depends on your research question and has to be clinically justified.

So, how best to analyze it? In general we make a comparison between "intervention" and "non-intervention" sites, but data are often "structured" as in the example illustrated below.



We could simply compare the prevalence of malaria in each group of 1,000 children BUT this would simply indicate *whether* UA and control site(s) are different. It does not indicate that they differ *because* of presence of UA. To test whether UA does have an impact, we need to compare the 3 UA sites with the 3 controls sites (so n = 6, rather than n = 2,000 in the simple comparison). It is statistically straightforward to do this using a technique called generalized linear mixed model (GLIMM). This recognizes that the data on children are "structured": children from the same house may be more similar than children from other houses, and children from the same site may be more similar than children from the other sites. Once this is specified in GLIMM, then the effect attributable to UA can be quantified, and the appropriate "p" value obtained for the hypothesis that UA is associated with a change in malaria prevalence. You can also analyze the effects of other factors that affect the chance of acquiring malaria, such as age, gender, etc., and include them in GLIMM.

Data structuring can be incorporated in statistical analysis only when it has been identified. You also need to be aware that unidentified sources of data structuring can undermine your analysis. One example could be the presence of small mosquito breeding sites away from the main UA sites you are testing. They can obscure the effect as shown below.

Defining rural, peri-urban and urban: A case study from Kisumu, Western Kenya

Jose Siri, University of Michigan, Ann Arbor, USA.[27]

Despite increasing urbanization in sub-Saharan Africa, the epidemiology of malaria in urban settings remains inadequately characterized. Research on urban malaria is complicated by heterogeneities of environment and population distribution, while the lack of a consistent definition of "urban" in the epidemiologic literature limits the potential for effective targeting of malaria control interventions in this environment. We developed a novel, map-based sampling strategy to ensure equal geographic and population representation of individuals residing in urban Kisumu, Kenya, selected for a cross-sectional study of knowledge, attitudes and practices (KAP) related to malaria. The survey instrument included questions on demographics, knowledge of the causes and prevention of malaria, health and travel history, indicators of socioeconomic status and local environmental characteristics. We interviewed a total of 4,343 caregivers of children under 10 years old from all areas of the city with sampling probabilities proportional to population density. Results were characterized for urban, peri-urban and semi-rural ecological strata across the study area as defined by *a priori* knowledge of administrative boundaries and ground observation of population density, poverty, community infrastructure and geographic location within census enumeration areas.

Urban residents were significantly wealthier and more educated, had better access to services and were more likely to own bed nets and practice appropriate preventive behaviors than inhabitants of peri-urban and semi-rural zones. No differences were observed in the proportion of respondents familiar with symptoms of malaria or the proportion seeking prompt appropriate treatment for a malaria episode. In general, peri-urban residents were more similar to semi-rural dwellers than to urban, an observation with important implications for malaria control. A second analysis attempted to characterize urban ecological strata based on objective statistical considerations; a principal components analysis (PCA) of ten variables representing important intra-urban differences yielded categories that were highly correlated with the original classification for urban zones and moderately so for peri-urban and semi-rural zones. Though further research is needed, the PCA approach is likely to produce results that are more generalizable and less subject to bias than currently used methods for defining intra-urban zones, and should therefore lead to improved malaria control efforts in cities of sub-Saharan Africa.

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[27]Co-authors: Mark L. Wilson, Laurence Slutsker, John M. Vulule, Daniel H. Rosen and Kim A. Lindblade.

Rapid Urban Malaria Appraisal (RUMA)

Christian Lengeler,[28] *STI, Basle, Switzerland*

The objective of RUMA is to formulate and validate a generic rapid assessment procedure for determining the burden and epidemiology of urban malaria in sub-Saharan Africa in order to:

- understand the malaria burden in urban health services,
- expand the knowledge basis of malaria epidemiology in urban sub-Saharan Africa,
- evaluate the attributable fraction of malaria among fever cases treated for malaria in health facilities, and
- provide key information as a starting point for effective interventions and/or further in-depth assessments.

The project was supported by the Roll Back Malaria Partnership.

The study was carried out in four capital cities in Africa: Abidjan, Cotonou, Ouagadougou and Dar es Salaam. The methodology consisted of two stages, a preparation stage and an implementation stage. In the preparation stage (duration, 2 weeks), a literature review was done, demographic data, health statistics and maps were collected, and a transect walk in town was performed. All health facilities were mapped by GPS and the survey sites (schools and health facilities) were selected for the implementation phase. A summary of the health statistics collected in the four cities is given below.

	Under 5s (% of total)	All (% of total)	Severe malaria (% of total)
Abidjan (Yopougon)	140,497 (38.1)	227,480 (38.3)	na
Cotonou	na	100,257 (34.6)	12,195 (4.2)
Dar es Salaam	na	na (ca 40%)	na
Ouagadougou	na	203,466 (34.1)	20,071 (3.4)

Note: na = Not available; results available by facility and by month.

In the implementation stage (duration, 3-4 weeks), health facility and school based surveys were done and a general assessment of the health care system was made. Initially it was planned to also map all breeding sites in this stage but that proved to be impossible in such a short time period. For health facility based surveys, 3-4 health facilities in central, intermediate and periphery areas were selected and a health facility fever (HFF) survey was done. In each health facility, 100 fever cases and 100 controls aged <5 years were selected from the pediatric clinic. Another 100 fever cases and 100 controls ≥5 years old were recruited from the outpatient department of the clinic. After giving informed consent, each patient, either fever case or control,

[28]Co-authors: S. J. Wang, M. Tanner, P. Vounatsou and T. Smith.

had an axillary temperature measurement, a thin and thick blood film was taken and all the fever cases received free treatment. The results showed that the fraction attributable to malaria among fever cases was very low, ranging from 0 to 27 percent according to age and setting. Clearly, there is an urgent need for laboratory diagnosis of malaria in all urban settings, especially in view of the introduction of the much more expensive combination therapies.

The parasitemia surveys were done in 3-4 schools nearest to the selected health facilities. For each child, a consent form and questionnaire were given to the head of household. Collection of blood samples was made from 200 students aged 6-10 from each zone. Questionnaire answers were checked with the assistance of schoolteachers and all fever cases received free treatment. The main results obtained from the school surveys are given below.

	Measured parasitemia (%)		
	Center	Intermediate	Periphery
Abidjan (Yopougon)	na	na	na
	14.2 contr.	16.4 contr.	20.0 contr.
Cotonou	2.6	9.0	2.5
Dar es Salaam	0.8	1.4	2.7
Ouagadougou	24.1	38.6	68.7

Note: na = Not available; contr. = Control.

Other collected data include data on parasite species, parasite density, fever prevalence, relative risk of parasitemia, if fever relative risk of fever for different levels of parasitemia, basic socioeconomic variables, illness awareness, mosquito net usage during last night, travel history outside city and malaria treatment during last 30 days. All results were collected by residence, age, sex, etc. A complete overview is given in the final report prepared for each city.[29]

The major constraints experienced during the RUMA were:

- Time: 6 weeks is very short, especially for mapping.
- Availability of information, especially on health statistics.
- Coup d'état in Abidjan, accident in Cotonou.
- Sample may not be representative.
- Few data on seasonality.
- Availability of base maps.
- No independent validation possible.

[29]Wang, S.; Lengeler, C.; Smith, T. A.; Tanner, M. 2004a. Rapid Urban Malaria Appraisal (RUMA), final report for Abidjan, 58 pp. ——. 2004b. Rapid Urban Malaria Appraisal (RUMA), final report for Benin, 68 pp. ——. 2004c. Rapid Urban Malaria Appraisal (RUMA), final report for Dar es Salaam, 67 pp. ——. 2004d. Rapid Urban Malaria Appraisal (RUMA), final report for Ouagadougou, 62 pp. All submitted to Roll Back Malaria Partnership/WHO by Swiss Tropical Institute, Basel.

Conclusions:

- It is possible to collect a useful basic set of data on urban malaria within 6 weeks.
- Prevalence rates and their heterogeneity were lower than expected.
- Only limited historical survey data.
- Health statistics are very important (if available and reliable).
- Basic mapping of health facilities feasible if base maps available.
- Basic mapping of breeding sites not possible during such a short period.
- Assessing the likelihood of malaria among treated fever cases is very important in an urban setting.

Anemia as an indicator of the burden of malaria[30]

Imelda Bates, LSTM, UK

Changes in anemia prevalence are one of the ways that the impact of a malaria intervention may be measured. The question discussed in this presentation is "Can anemia be used as an indicator to measure the burden of malaria?"

Before anemia can be used as an indicator of malaria burden we need to know:

- What is the background anemia prevalence?
- How is anemia prevalence measured?
- What are the causes of anemia?

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[30]References: Korenromp, E. L.; Armstrong-Schellenberg, J. R.; Williams, B. G.; Nahlen, B. L.; Snow, R. W. 2004. Impact of malaria control on childhood anemia in Africa—a quantitative review. *Trop Med Int Health* 9,1050-65. Snow, R. W.; Korenromp, E. L.; Gouws, E. 2004. Pediatric mortality in Africa: Plasmodium falciparum malaria as a cause or risk? *Am J Trop Med Hyg.* Aug; 71 (2 Suppl), 16-24. ter Kuile, F. O.; Terlouw, D. J.; Phillips-Howard, P. A.; Hawley, W. A.; Friedman J. F.; Kolczak, M. S.; Kariuki, S. K.; Shi, Y. P.; Kwena, A. M.; Vulule, J. M.; Nahlen, B. L. 2003. Impact of permethrin-treated bed nets on malaria, anemia, and growth in infants in an area of intense perennial malaria transmission in western Kenya. *Am J Trop Med Hyg* 68 (4 Suppl), 68-77. Shulman, C. E.; Dorman, E. K.; Cutts, F.; Kawuondo, K.; Bulmer, J. N.; Peshu, N.; Marsh, K. 1999. Intermittent sulphadoxine-pyrimethamine to prevent severe anemia secondary to malaria in pregnancy: A randomised placebo-controlled trial. *Lancet* 353, 632-6. Schellenberg, D.; Menendez, C.; Kahigwa, E.; Aponte, J.; Vidal, J.; Tanner, M.; Mshinda, H.; Alonso, P. 2001. Intermittent treatment for malaria and anemia control at time of routine vaccinations in Tanzanian infants: A randomised, placebo-controlled trial. *Lancet* 357, 1471-7. Massaga, J. J.; Kitua, A. Y.; Lemnge, M. M.; Akida, J. A.; Malle, L. N.; Ronn, A. M.; Theander, T. G.; Bygbjerg, I. C. 2003. Effect of intermittent treatment with amodiaquine on anemia and malarial fevers in infants in Tanzania: A randomised placebo-controlled trial. *Lancet* 361, 1853-60.

- How does malaria cause anemia?
- How closely do changes in anemia mimic alterations in malaria burden?

Anemia is the world's second leading cause of disability[31] and prevalence is increasing due to the HIV epidemic and high levels of malaria drug resistance. In high malaria transmission areas, about 70 percent of pregnant women are anemic resulting in stillbirths and small babies. Anemia is extremely common in children in malaria areas. The usual definition of anemia is Hb <11g/dl with Hb <8g/dl considered as severe anemia and Hb <5g/dl as very severe anemia. More than 20 percent of children under 1 year in high malaria transmission areas are severely anemic resulting in stunting and intellectual impairment.

How is anemia diagnosed in resource-poor malaria regions? Either by clinical diagnosis or by laboratory diagnosis.

1. *Clinical diagnosis* has poor sensitivity and specificity. For example:

    - 66% sensitive and 68% specific in children for Hb 5-8g/dl (Malawi).
    - 82% sensitive and 65% specific in pregnant women for Hb <7g/dl (Kenya).

2. *Laboratory diagnosis*: Here the problem is that there is no simple, cheap, accurate method available for resource-poor countries. The "Gold standard" is the colorimeter but this is too complex, the HemoCue is easy and accurate but too expensive and the hemoglobin color scale has not been properly evaluated for use as a screening tool.

Hemoglobin measurement for the detection of anemia is a major workload for African district hospitals. For example, the number of hemoglobin tests per year in 7 districts in Kenya[32] with a mean population 510,000 is 5,128 with a cost to the patient of US$0.4-0.65 per test. In Malawi's Ntcheu district with a population of 500,000, the number of Hb tests performed per year is 6,161. In Ntcheu, the majority of laboratory tests and costs are malaria-related; for example, 21 percent is spent on malaria diagnosis, 26 percent on blood transfusion (predominantly for treating severe malarial anemia) and 13 percent on hemoglobin tests.

The quality of hemoglobin measurement needs to be improved before it can be used as a routine malaria indicator. In Ghana, the accuracy of hemoglobin tests at district hospitals is around 70 percent and in Malawi (prior to recent improvements) it was only about 35 percent.

What also has to be taken into account while assessing the suitability of anemia as an indicator for malaria burden is that there are other causes of anemia like HIV-AIDS, iron deficiency, hookworm and hemoglobinopathies. Local causes of anemia other than malaria need to be understood before changes in anemia prevalence can be attributed to malaria. Malaria

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[31]Murray, C. J.; Lopez, A. D. 1996. Evidence-based health policy—lessons from the Global Burden of Disease Study. *Science*. Nov 1; 274(5288):740-3.

[32]Information from Dr. J. Carter, AMREF, Kenya.

causes anemia by several mechanisms; directly by the breakdown of infected red cells and indirectly by increased clearance of uninfected red cells by the spleen and reduced red cell production. Malaria is a major risk factor for anemia,[33] so it is reasonable to look at the suitability of using anemia as an indicator for the malaria burden.

What happens to anemia levels during malaria interventions? Does malaria prevention reduce anemia? Different studies (ter Kuile et al. 2003; Shulman et al. 1999; Schellenberg et al. 2001; Massaga et al. 2003) show that:

- Bed nets reduced severe anemia by 47 percent in pregnancy and 60 percent in children under five.
- Intermittent treatment reduced severe anemia by 39 percent in pregnancy and 50-67 percent in infancy.

So, anemia can be used to indicate the burden of malaria but we need to:

- Know the background prevalence and causes of anemia.
- Be sure of the method and accuracy of hemoglobin measurements.
- Improve understanding of relationship between anemia and malaria.

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[33]Snow, R.W.; Korenromp, E. L.; Gouws, E. 2004. Pediatric mortality in Africa: Plasmodium falciparum malaria as a cause or risk? *Am J Trop Med Hyg* Aug. 71 (2 Suppl), 16-24.

Outcomes for assessing intervention efficacy[34]

Umberto D'Alessandro, ITG, Antwerp, Belgium

Successful malaria control measures should be able to decrease childhood mortality, though this is not easily shown. However, such information is important for advocacy purposes and for convincing policy makers that controlling malaria is a worthwhile investment. It would be impossible to show any impact on mortality on small study populations; it needs large populations in the order of several tens of thousands people. Different approaches are possible. Malaria can be a direct (cerebral malaria and severe anemia) or indirect (other causes of death) cause of death. This is the reason why the mortality reduction observed in successful control/ eradication activities is higher than expected. Mortality can be measured by collecting information on all-cause mortality, malaria-specific mortality and malaria case fatality rate.

All-cause mortality

The rationale behind measuring all-cause mortality is the assumption that, in places where malaria is an important cause of death, controlling malaria will necessarily result in a decrease of general mortality. It can be measured directly and prospectively by combining a system of longitudinal surveillance (continuous registration of all births and deaths at village level by village reporters) with an initial census followed by an annual re-enumeration. The latter will allow checking the information collected by the village reporters. These are labor-intensive methods that collect a large amount of information needing an important investment in data entry and management. A possible alternative is a continuous census where each house is visited regularly (every 3-4 months) and throughout the surveillance, by a small team registering all events. Besides this direct method, mortality can be estimated by indirect methods, for example, by collecting information on the children ever born to women of reproductive age and those alive at the moment of the survey. Mortality trends (probability of dying by age of five) over the past 10-15 years can be estimated by using demographic models.

[34]References: Alonso, P. L.; Smith, T.; Schellenberg, J. R.; Masanja, H.; Mwankusye, S.; Urassa, H.; Bastos de Azevedo, I.; Chongela, J.; Kobero, S.; Menendez, C. et al. 1994. Randomised trial of efficacy of SPf66 vaccine against Plasmodium falciparum malaria in children in southern Tanzania. *Lancet* 344: 1175-81. D'Alessandro, U.; Leach, A.; Drakeley, C. J.; Bennett, S.; Olaleye, B. O.; Fegan, G. W.; Jawara, M.; Langerock, P.; George, M. O.; Targett, G. A. et al. 1995. An efficacy trial of the malaria vaccine SPf66 in Gambian infants. *Lancet* 346:462-467. Nosten, F.; Luxemburger, C.; Kyle, D. E.; Ballou, W. R.; Wittes, J.; Wah, E.; Chongsuphajaisiddhi, T.; Gordon, D. M.; White, N. J.; Sadoff, J. C.; Heppner, D. G. 1996. Randomised double-blind placebo-controlled trial of SPf66 malaria vaccine in children in northwestern Thailand. *Lancet* 348: 701-7. Snow, R. W.; Armstrong, J. R.; Forster, D.; Winstanley, M. T.; Marsh, V. M.; Newton, C. R.; Waruiru, C.; Mwangi, I.; Winstanley, P. A.; Marsh, K. 1992. Childhood deaths in Africa: Uses and limitations of verbal autopsies. *Lancet* 340: 351-5.

Malaria-specific mortality

Malaria-specific mortality can be estimated by collecting the necessary information using the following methods:

- Post-mortem questionnaire (PMQ) in a prospective surveillance system or administered retrospectively.
- Household questionnaire (cause of death registered if known).
- Death certificates.

None of these methods is satisfactory mainly because it is extremely difficult to identify, without laboratory support, malaria as a cause of death. PMQs have shown different degrees of sensitivity and specificity in identifying malaria as a cause of death, but none had a sensitivity over 75 percent (the lowest was at 46%) and a specificity over 89 percent (Snow et al. 1992).

Malaria case fatality rate

Malaria case fatality rate is the proportion of hospitalized malaria cases that died in a given period. It is more an indicator of the performance of the health services rather than an estimation of the impact of a preventive intervention. Most deaths occur at home and often hospital deaths are not representative of the situation in the community.

Morbidity

Another possibility to assess the impact of an intervention is to measure malaria morbidity. This is complicated by the fact that the definition of an uncomplicated "malaria case" might vary according to the intensity of transmission. As an example, we can consider the definition used in the clinical trials for the evaluation the efficacy of the SPf66 vaccine carried out in Tanzania (Alonso et al. 1994), Gambia (D'Alessandro et al. 1995) and Thailand (Nosten et al. 1996). Moreover, the method for detecting the cases (active, passive or both) can also differ so that their severity might not be comparable across methods. Information on severe malaria cases can also be collected. This is a proxy for clinical malaria that could lead to death. It can be collected only by passive case detection and needs a clear case definition. Other less direct indicators, according to the nature of the intervention, can be used: spleen rate, parasite rate (crude or specific), parasite density, anemia prevalence, low birth weight (proportion in primigravidae as compared to multigravidae), and IgM prevalence in infants. Such information can be collected by cross-sectional surveys on a random sample of the study population.

Case-control studies represent a different approach for the estimation of impact. Cases can be deaths or uncomplicated malaria cases. The risk of being a case can be estimated according to several factors, including those linked to the intervention (e.g., ITN). The major problem is the choice of the adequate controls.

Session 5

Setting the Agenda for Urban Malaria

Session chairs: Guy Barnish and Flemming Konradsen

In this session, different organizations highlighted their experience, programs and priorities in terms of urban malaria to set the agenda for future programs and collaborations.

The Ecohealth initiative

Renaud de Plaen, IDRC, Ottawa, Canada

There is a great potential for improving human health through better natural resource management, a concept that deserves wider recognition. This potential is based on the fact that in nature the well-being of people cannot be separated from their physical environment, which provides all species, including humans, with a home and both sustenance and hazards. So what are ecosystems? Broadly speaking, an ecosystem is a dynamic complex of plant and animal (including human) communities situated within a given environment. The boundaries of ecosystems often have more to do with the parameters that humans set arbitrarily according to the scientific, management or policy question they wish to examine rather than with physical dimensions. Because of its focus on human health, the Program Initiative will only consider projects whose focus is on ecosystems that include human communities as a significant component of the whole. It will emphasize projects that take a holistic approach to human health. All elements of an ecosystem are essential for the continued existence and well-being of humans. Some elements are nurturing, such as clean air, safe water, rich agricultural soils, and social behavior that demonstrates caring attitudes. Other elements, such as toxins, pathogens, and asocial behavior, endanger human health and happiness. It is important to recognize that not all health risks arising from the environment are the product of human activities. Many such hazards are an inherent part of the ecosystem, but can be minimized through judicious ecosystem management. The aim of the *Ecosystem Approaches to Human Health Program Initiative* is to support research that focuses on ecosystem management interventions leading to the improvement of human health and well-being while simultaneously maintaining or improving the health of the ecosystem as a whole. The research focus of ecohealth is by definition on research using ecosystem approaches to human health, promoting a holistic view of human health and environmental sustainability. This approach depends on *a trans-disciplinary framework, and participatory and social/gender sensitive methodologies.* A better understanding of the determinants of human health will enable us to identify, in the context of an entire ecosystem, sustainable, preventive interventions and more effective means to monitor ecosystem sustainability leading to better human health. In order to focus efforts while promoting the holistic approach, supported projects will concentrate on three stressor situations: *mining, agriculture and cities.* While different, these settings do have some commonalities; they present potential environmental risks as well as benefits to communities; at the same time, finding sustainable solutions will likely require true community involvement.

More information at www.idrc.ca/ecohealth.

Cross-sectoral challenges in malaria—the SIMA experience

Clifford Mutero, SIMA, Pretoria, South Africa

The purpose of the CGIAR-led Systemwide Initiative on Malaria and Agriculture (SIMA) is to promote research and capacity building on the links between malaria and agriculture, and to validate innovative interventions that would strengthen and complement existing malaria control strategies in clearly defined settings. SIMA conducted an exhaustive consultation with stakeholders between December 2000 and November 2002 in order to formulate an appropriate research and capacity building agenda. The consultation reinforced the widely held view that malaria represented a complex, multi-dimensional health problem with a host of interacting variables ranging from the parasite, mosquito vector, human host and local healthcare delivery systems, to land use and global climate change. It was generally agreed that a balance was needed in research and interventions in relation to physical, biomedical, socioeconomic and institutional determinants of malaria. SIMA has made some significant achievements but also encountered important challenges with regard to cross-sectoral collaboration. Thus, although a growing number of SIMA projects involving cross-sectoral collaboration are being initiated in Africa, bringing together researchers from different academic backgrounds is still a daunting task. An opportunity exists for post-graduate level formal training in approaches/methodologies that will later enhance cross-sectoral collaboration at the research and policy-making levels. Cooperation between universities and Centers of the Consultative Group on International Agricultural Research (CGIAR) could provide crucial synergy to the capacity building process.

More information at www.iwmi.org/sima.

Malaria in school children in a peri-urban area of Mbarara Town, Uganda [35]

Joseph Okello-Onen, LHRI, Tororo, Uganda

A survey was conducted in primary schools in four sub-counties of Nyabushozi county, Mbarara district, Uganda to obtain baseline data on malaria parasite prevalence so as to facilitate power calculations on the sample sizes for the house-to-house surveys. This survey was part of a larger study investigating the key determinants of malaria outbreaks at village level and assessing malarial transmission and its influences in these villages from an ecosystem health approach. The four sub-counties (Sanga, Nyakashashara, Kensunga and Kikatsi) were purposively selected for the study (out of seven), since they had the four categories of targeted households: nomadic, semi-settled, settled, and non-pastoral. The number of primary schools and their enrolment in these sub-counties were compiled, from which seven schools were randomly selected; at least two per sub-county close enough to the study villages. In each school, about 50 pupils in primary one and two, aged 5-9 years, were randomly selected for the study. For each child sampled, a history of fever, temperature measurement and blood slide were taken. In addition, splenomegaly was detected through palpation. Thin and thick Giemsa-stained blood smears were examined using a standard protocol, covering 200 white blood cells per slide. Pupils, who were positive for malaria both clinically and parasitologically, were treated using a combination of chloroquine and sulphadoxine-pyrimethamine, in accordance with the national treatment guidelines. The results revealed an overall malaria parasite prevalence of 33 percent However, marked variations in prevalence were recorded between schools ($P<0.01$), ranging between 10 and 76 percent. The prevalence was identical for boys and girls and the main parasite detected was *Plasmodium falciparum*. Considering the parasitaemia load of malaria parasites per 200 WBC, variations were also observed between schools ($P<0.01$), with the highest load (up to 487 per 200 WBC) recorded in Sanga sub-county. The parasitological results provide evidence of an increase in malaria transmission since the 1960s that is corroborated by the secondary data obtained from health facilities over 7 years, prior to the study. More precise explanations for the increase in malaria transmission, and its variations in different sub-counties, will be made after completing the collection and analysis of socioeconomic data in household surveys.

[35] This replaced the scheduled presentation of Charles Delacollette of the Roll Back Malaria Programme in Geneva, who was unable to attend.

USAID priorities and urban malaria

Matt Lynch, USAID, Washington, USA

USAID focuses on implementation issues and the support of:

- Meetings and conferences to define issues, set agendas, reach consensus.
- Operations research support on identified priority topics: "How?" questions.
- Scaling up: Technical assistance for scaling up proven interventions.
- Monitoring and Evaluation: Documentation and dissemination of results.

The relevant programs in USAID with regard to malaria are: the Bureau for Global Health (Infectious Diseases/ Malaria; Health Systems Strengthening); Bureaus for Economic Growth, Agriculture and Trade (Urban Programs office; Women in Development; Integrated Water Resource Management) and Mission programs, as a large part of the funding is at the country mission offices.

As mentioned earlier, there was an EHP/USAID urban malaria meeting in 1999. Main issues raised in this meeting were also raised in the 1999 meeting; e.g., high variation between urban areas, what works in one place might not work in another so it will be very difficult to come out with one approach, but control methods as such are quite standard. There was not much discussion on institutional issues. Key points from the EHP/USAID literature review[36] were: (a) Urban transmission is confounded by rural exposures; it is important to document, to understand the dynamics; it interacts with human behaviors and livelihoods); (b) Highly variable epidemiology over short distances requires intensive study; (c) Control measures are known, and feasible. Four areas of inquiry were identified: (1) Epidemiological/clinical (confirm transmission, document fever treatment practices); (2) Vector biology and control options; (3) Behavioral issues regarding exposure risk, transmission, treatment and use of services; (4) Institutional analysis: Cost-effectiveness and capacity.

1999 Programmatic Agenda Principles:

- Urban malaria should be included in overall malaria prevention and control.
- Urban malaria should be included in other urban health issues.
- Urban malaria has important economic consequences beyond health.
- Urban malaria not purview of health alone.

[36] Warren, McW.; Billig, P.; Bendahmane, D. B.; Wijeyaratne, P. Malaria in urban and peri-urban areas in sub-Saharan Africa. August 1999. EHP Activity Report 71 (online via www.ehpproject.org).

Current Activities:

1. Research in Larval Control
   - Urban settings identified in Kampala meeting in 2001 as likely settings for larval control.
   - Support for small efficacy/effectiveness studies in four east African sites: Uganda (urban); Tanzania (urban); Kenya (highlands and urban).

2. Implementation Support: Preventive interventions—ITNs and IRS

   ITNs:
   - Establishing sustained availability of ITNs in urban areas supports rural access.
   - Strengthening the commercial ITN sector.
   - Targeting subsidies for greater equity.
   - Testing Targeted Subsidy methods: voucher programs, e.g., via measles campaigns (1 urban district in Zambia).
   - Vouchers via health facilities for pregnant women (24,000 vouchers distributed in 5 Zambian towns as of August 2004).

   IRS: Training of trainers for 5 urban councils in Zambia on conducting effective IRS operations.

For the future there will be continued emphasis on partnership (RBM, public-private partnerships). USAID strategic focus is traditionally on reducing **mortality**, especially in children, although recently, there is increasing attention to economic impact of health interventions and implications for development.

In terms of **prevention**: Technical support for GFATM implementation:

- Technical support for ITN distribution.
- IRS included in several grants.
- Support for targeting use to appropriate settings, including urban areas.
- Technical support to improve IRS operations capacity.

Issues on **treatment**:

- Equitable, Effective and Efficient targeting.
- Limited treatment resources to prevent mortality have implications for urban populations.
- How to most efficiently manage ACTs? Public/private, home/facility? Urban/ rural fever?
- Role of pre-treatment diagnosis: more feasible in urban settings?
- Maintaining equity in face of urban political power—treatment issues with ACTs will inevitably need to address urban demand versus rural need.

Monitoring and Evaluation is important for donors:

- What is the burden of malaria in urban settings?
- Mortality distribution in urban areas?
- Economic impacts?
- Impacts on women?
- Cost-effectiveness of control options in urban settings?
- Opportunities for further analysis of DHS.

More information at www.usaid.gov

Summaries of Workshops

OUTPUT WORKING GROUP 1

Integrated Malaria Control

Key discussion points

- Urban malaria is a man-made problem; sustainable long-term solutions require incorporation of health issues into integrated urban planning.
- Urban development may generate novel donor interest to assist funding of antimalaria activities.
- Of the different control options, ITNs have proven benefit but do not always reach the most vulnerable. IRS is appropriate in a number of communities and could replace ITNs where appropriate. Larval control requires evaluation and trials are underway.
- Community participation is crucial.
- Heterogeneity of urban environment will pose challenges.
- Evaluation methods (e.g., estimating transmission indices) might need attention as the "classical" (i.e., developed for rural epidemiology) ones might not be appropriate for the urban setting.

Choosing and targeting interventions: Important prerequisites

- Is there a problem of malaria and is it locally transmitted?
- How much malaria exists and where is it located?
- How does malaria relate to other health and social issues?
- What is the local perception of importance of malaria (by the community, by the health system and by local government/municipality)?
- Assessment of impact at baseline and potential effect of intervention on many levels, including environmental, social and institutional (local government, health sector, public works, etc.).
- Planning interventions: community participation is essential and might be achieved via stakeholder workshops and technical consultations.
- Selection of intervention approach by building and improving on existing control where possible, encouraging local interventions of known efficacy and discouraging ineffectual practices.

- Resource implications (capacity, knowledge, financial, etc.) must be accurately estimated.
- Sustainability is essential.

OUTPUT WORKING GROUP 2

Integrated Case Management

1. Assess the Burden of Malaria
2. Implementation of Control Measures
3. Measuring/evaluation tools of new interventions

Burden of Malaria

- Insufficient knowledge (How much is there? Where is it?).
- Data collection for baseline for intervention (improved diagnosis; especially with low malaria prevalence and error rates, very difficult to assess impact at this level).
- 1st time—all age groups.
- Special attention to pregnant women.
- Take into account heterogeneity in space and time.
- Pilot survey—cross-sectional.
  - Schools
  - ANC
  - Random samples
- Quantify the burden with prevalence and incidence surveys; depends on prevalence rates, if very low prevalence, the only way is to measure incidence rates is to assess whether transmission is taking place.
- Passive case detection with improved diagnosis.

Recommendations for Control

- IPT in low risk situations.
- Emphasize research needs for using RDTs for diagnosis in pregnant women.
- Drug policy:
  - Increased need for gametocidal drugs.
  - Easy access to wide range of antimalarials.
  - Need for documentation.

Case Management, including Diagnostics

- Strong rationale for improved diagnosis (urban malaria—low prevalence).
- Need for good supervision and secure supplies.
- Retraining, including alternative testing of test-negative patients.
- Research on alternative causes of fever (improve differential diagnosis).

Strengthening Health Care

- Secure supplies.
- Ensure proper supervision.
- Quality Assurance.
- Strengthening documentation of cases—feedback for both curative and preventive systems.

Evaluation—Direct Measures on Health

- Regular monitoring of pregnant women at ANCs using RDTs.
- Passive case detection with improved diagnosis.
- Active case detection:
  - Prevalence measured by cross-sectional surveys.
  - Incidence measured by cohort studies.
- Standardized measurements.
- Shift in epidemiology—change monitoring systems over time.

Evaluation—Intermediate steps: Monitoring

- Regular larval and adult monitoring: Species identification, infection status.
- Standardized quantification.
- Monitor insecticide resistance.

Additional tools

- Measure the micro and macro economic impacts.
- Measure mortality—nice to have if affordable.
- What percentage of resources is devoted to M&E? Will be higher in urban areas because of low frequency of indicators.

Summary

- For malaria disease and transmission—ongoing: Active and passive case detection.
- Interventions for which controlled implementation is impossible: Diagnosis, case management, IPT, ITNs—but CC studies possible.
- Interventions for which controlled implementation is possible: IRS, larviciding, and environmental management: targeted vs comprehensive (take into account ITN level—background).

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Abbreviations

ACD	Active Case Detection
ACT	Artesunate Combination Therapy
AMREF	African Medical and Research Foundation
ANC	Antenatal clinic
CBHC	Community-Based Health Care
C C	Case Control
C I	Confidence Interval
CORPS	Community Owned Resource Persons
DHS	Demographic and Health Surveys
EA	Enumeration Area
EHP	Environmental Health Project
EIR	Entomological Inoculation Rate
EM	Environmental Management
GFATM	Global Fund for AIDS, TB and Malaria
GLIMM	Generalized Linear Mixed Model
Hb	Hemoglobin
HBC	Human Bait Catch
HMM	Home Management of Malaria
ICMR	Indian Council of Medical Research
IDRC	International Development Research Centre
IEC	Information, Education and Communication
IgM	Immunoglobulin M
IHRDC	Ifakara Health Research and Development Centre
IMCI	Integrated Management of Childhood Illnesses
IPT (p, i)	Intermittent Preventive Treatment (pregnant women, infants)
IRD	l'Institute de Recherche pour le Développement
IRS	Indoor Residual Spraying
ITG	Instituut voor Tropische Geneeskunde

ITM	Insecticide Treated Material
ITN	Insecticide Treated Net
IWMI	International Water Management Institute
KAP	Knowledge, Attitude, Practice
KEMRI	Kenya Medical Research Institute
LHRI	Livestock Health Research Institute
LSTM	Liverpool School of Tropical Medicine
MCP	Malaria Control Program
M&E	Monitoring & Evaluation
MKP	Malaria Knowledge Programme
NMCP	National Malaria Control Program
PCD	Passive Case Detection
PMQ	Post-Mortem Questionnaire
PPV	Positive Predictive Value
PSC	Pyrethrum Spray Catch
QA	Quality Assurance
RBM	Roll Back Malaria
RDT	Rapid Diagnostic Test
RUMA	Rapid Urban Malaria Appraisal
SES	Socio-Economic Status
SDC	Swiss Agency for Development and Cooperation
SP	Sulfadoxine-Pyrimethamine
SIMA	Systemwide Initiative on Malaria and Agriculture
STI	Swiss Tropical Institute
UA	Urban agriculture
UMCP	Urban Malaria Control Program
UNEP	United Nations Environment Program
USAID	United States Agency for International Development
WHO	World Health Organization
WUR	Wageningen University and Research centre