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The feasibility assessment described in this report was made possible with the advice and contributions of many people both within and outside the Zanzibar Malaria Control Program. Special thanks to the Honorable Minister of Health and Social Welfare Sultan M Mugheiry, the Principal Secretary Mohamed S Jiddawi and Director General Malick A Juma, not only for their brave decision to assess the feasibility of malaria elimination on Zanzibar, but also for their continued support during assessment. The ZMCP acknowledges the technical advice from many local and international experts and is grateful to the Clinton Foundation and all those who contributed to the conduct of the assessment and preparation of this report. This work benefited from the intellectual leadership provided by the Malaria Elimination Group (malariaeliminationgroup.org), an entity established and managed by the Global Health Group at the University of California, San Francisco. The ZMCP would like to acknowledge the UCSF Global Health Group for providing copyediting and design support to this report. We are also very grateful to the UCSF Global Health Group and ExxonMobil for providing the funding that made this assessment possible.

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### ABBREVIATIONS

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<tr>
<th>Abbreviation</th>
<th>Full Form</th>
<th>Description</th>
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<tr>
<td>ACD</td>
<td>Active Case Detection</td>
<td>Monitoring and evaluation</td>
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<td>ACT</td>
<td>Artemisinin-Based Combination Treatment</td>
<td>Malaria Endemic Countries</td>
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<td>AS-AQ</td>
<td>Artesunate – Amodiaquine</td>
<td>Malaria Early Epidemic Detection System</td>
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<td>BCC</td>
<td>Behavior Change Communication</td>
<td>Malaria Indicator Survey</td>
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<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
<td>Ministry of Health and Social Welfare</td>
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<tr>
<td>CQ</td>
<td>Chloroquine</td>
<td>Over-the-Counter</td>
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<td>DALY</td>
<td>Disability-Adjusted Life Year</td>
<td>Pro-Active Case Detection</td>
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<td>DDT</td>
<td>Dichlorodiphenyltrichloroethane</td>
<td>Passive Case Detection</td>
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<tr>
<td>DHS</td>
<td>Demographic and Health Survey</td>
<td>Polymerase Chain Reaction</td>
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<tr>
<td>DHMT</td>
<td>District Health Management Team</td>
<td>Public Expenditure Review</td>
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<tr>
<td>DNA</td>
<td>Deoxyribonucleic Acid</td>
<td>Plasmodium falciparum Parasite Rate</td>
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<tr>
<td>EIR</td>
<td>Entomological Inoculation Rate</td>
<td>Primary Health Care</td>
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<tr>
<td>GFATM</td>
<td>Global Fund to Fight AIDS, Tuberculosis and Malaria</td>
<td>Primary Health Care Unit</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
<td>Primary Health Care Center</td>
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<tr>
<td>GMEP</td>
<td>Global Malaria Eradication Program</td>
<td>President’s Malaria Initiative</td>
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<td>G6PD</td>
<td>Glucose-6-Phosphate Dehydrogenase Deficiency</td>
<td>Quality Assurance/Quality Control</td>
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<tr>
<td>HFBSS</td>
<td>Health Facility-Based Sentinel Surveillance Site</td>
<td>Reactive Case Detection</td>
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<td>HMIS</td>
<td>Health Management Information System</td>
<td>Roll Back Malaria</td>
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<tr>
<td>ICR</td>
<td>Imported Case Risk</td>
<td>Controlled Reproductive Number</td>
</tr>
<tr>
<td>IDSP</td>
<td>Integrated Diseases Surveillance and Response</td>
<td>Rapid Diagnostic Test</td>
</tr>
<tr>
<td>IEC</td>
<td>Information, Education, and Communication</td>
<td>Basic Reproductive Number</td>
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<td>IFH</td>
<td>Innovative Financing for Health</td>
<td>Sustained Control</td>
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<td>IHR</td>
<td>International Health Regulations</td>
<td>Shehia Health Custodian Committee</td>
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<tr>
<td>IMCI</td>
<td>Integrated Management of Childhood Illness</td>
<td>Standard Operating Procedure/Protocol</td>
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<tr>
<td>IPTp</td>
<td>Intermittent Preventative Treatment for Pregnant Women</td>
<td>Sulphadoxine - Pyrimethamine</td>
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<td>IRS</td>
<td>Indoor Residual Spraying</td>
<td>United States Agency for International Development</td>
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<td>ITN</td>
<td>Insecticide-Treated Bed Net</td>
<td>Vectorial Capacity</td>
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<tr>
<td>LLIN</td>
<td>Long-Lasting Insecticide-Treated Bed Net</td>
<td>World Health Organization</td>
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<td>ZFDRB</td>
<td>Zanzibar Food and Drug Regulatory Body</td>
<td>Zanzibar Malaria Control Program</td>
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<td>ZMCP</td>
<td>Zanzibar Malaria Elimination Program</td>
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EXECUTIVE SUMMARY

Over the past several years, the islands of Zanzibar have made dramatic progress in reducing the burden of malaria, driving the parasite prevalence down from historic levels of more than 70% to less than 1.5% currently. As a result of this success, the Zanzibar Malaria Control Program (ZMCP) finds itself at a crossroads: it can seek to maintain and marginally improve its current control operations in order to indefinitely keep malaria suppressed but still present (so-called “sustained control”), or it can attempt to eliminate malaria from the islands altogether. This decision has significant programmatic, financial, and technical implications. As such, the Ministry of Health and Social Welfare (MOHSW) is determined to engage in careful analysis and deliberation before determining the way forward. To reach an appropriately informed decision, the MOHSW has sought answers to a range of critical questions, including: Can elimination be feasibly achieved in Zanzibar? If elimination is achieved, can malaria-free status be maintained in perpetuity? What will the ongoing costs of an elimination program be and how will these compare to sustaining current control measures?

Due to the lack of focus on malaria elimination over the past three decades and the innate complexity of the issue, answers to these questions are not readily available from current sources. As a result, the MOHSW asked the ZMCP to conduct a comprehensive assessment of the feasibility of elimination on Zanzibar, drawing on international best practice and in-depth analysis of conditions on the islands. The ZMCP accordingly brought together a group of local and international experts from a range of institutions to assist it in producing a high-quality assessment and commenced the exercise in July 2008. As current international guidance on how to assess elimination feasibility is unspecific, the working group drew on frameworks from the Global Malaria Eradication Program in the 1950’s-60’s to develop an appropriate contemporary methodology for the assessment. This methodology examines the question of elimination feasibility along three key dimensions:

• **Technical Feasibility:** Can complete interruption of malaria transmission on Zanzibar be achieved and sustained using the currently available control tools?

• **Operational Feasibility:** What measures must be in place to achieve the level of interventions required to reach and sustain elimination?

• **Financial Feasibility:** What is the cost of a malaria elimination program compared to a sustained control program? How can Zanzibar sustainably finance its malaria interventions?

The working group pursued these questions sequentially through a range of methods, including literature reviews, consultation with local officials and key informants, and mathematical modeling. The technical feasibility analysis, which forms the core of the overall assessment, relies on a series of new or adapted mathematical models that estimate critical epidemiological determinants and predict the impact of various interventions on malaria transmission. The operational implications of the interventions recommended by the technical feasibility exercise were then estimated by determining the gaps in the relevant systems and the capacity that would be required to enable the intervention coverage needed to achieve elimination. Lastly, both the interventions and supporting systems and capacity needed to achieve and sustain elimination were costed using standard techniques and compared to updated cost estimates of sustained control.

It is important to use caution when interpreting the results of this assessment. There are major gaps in global understanding of malaria elimination that required the working group to limit the scope of analysis and/or make assumptions in some areas. Mathematical modeling is always incapable of fully replicating real-world conditions and was further limited in this exercise by the lack of data for some analyses. And the estimation of costs and impact over a period as long as 25 years into the future is inherently limited by the inability to predict change in conditions that could fundamentally influence key outputs (e.g., overall wealth, health system strength, or climate).

Given these limitations and the scope and objectives of the work, it is recommended that the information provided in this report be used primarily for strategic planning purposes and not detailed operational activities (e.g., commodity quantification). Nevertheless, the working group is confident that this assessment provides the MOHSW with a robust analysis of this issue and therefore a strong foundation from which to make its strategic decisions.

RECOMMENDATIONS

Based on its analysis, the feasibility working group reached a series of conclusions on the core questions that prompted the assessment and recommended steps that the MOHSW should take if it decides to pursue malaria elimination. They include:

**Technical Feasibility**

• Mathematical models indicate that local malaria transmission on Zanzibar can be reduced to zero through universal coverage with vector control measures. This interruption of transmission can be achieved by maintaining high coverage of indoor residual spraying or long-lasting insecticide-treated bed nets.

  ➔ Given Zanzibar’s high innate transmission potential and outbreak risk, current IRS activities should not be scaled back until surveys indicate that effective coverage (usage) of LLINs is 75% or above.
To maintain malaria free status, the surveillance system will need to rapidly detect a high proportion of all new malaria infections.

The passive case detection system (i.e., health facilities including the private sector) will need to detect and treat a high proportion of imported infections to minimize risk of onwards transmission. By 2020, facilities should ideally be capable of detecting at least 75% of all new malaria infections arising in the population.

Every new case detected at health facilities—public and private—will need to be immediately investigated through visits to patients’ homes and screening of approximately 100 neighboring households to identify additional cases (i.e., those missed by passive case detection).

Estimates of Zanzibar’s importation risk (the number of infected people entering the island) are imprecise but suggest that maintaining malaria free status will be extremely difficult unless this risk is substantially diminished either by reduction of malaria in mainland Tanzania or through screening of travelers and/or high risk groups.

It will not be possible for Zanzibar to reduce LLIN effective coverage (usage) below 75% unless importation risk is dramatically decreased.

More precise estimates of Zanzibar’s importation risk are urgently needed to better determine the need for and potential impact of additional screening measures (e.g., border screening and/or screening of high-risk groups).

Operational Feasibility

To achieve the intervention coverage and surveillance detections rates required to achieve and maintain elimination, Zanzibar will need to improve key systems and services. It is not necessary for the health system to be “perfect” for Zanzibar to achieve and sustain elimination. However, specific improvements will need to be made in targeted areas. These improvements have been identified in past evaluations and strategic plans; to achieve elimination, the MOHSW will need to move beyond this planning to the concrete financing and implementation of the relevant improvements. In addition, specific operational recommendations include:

- Increase the proportion of people that receive prompt and effective fever treatment. This can be achieved by:
  - Improving health-seeking behavior through aggressive education and communication campaigns so that everyone with a fever promptly visits a high quality facility. Measures to ensure community ownership of the elimination program will be important to ensure continuation of desired behavior even when malaria is absent—“elimination fatigue.”
  - Ensuring universal financial access by providing malaria diagnosis and treatment for free in both the public and private sectors.
  - Ensuring adequate human resources and supplies at all public health facilities.
  - Testing all individuals with a fever or a history of fever cases presenting at health facilities. We recommend that a new diagnostic algorithm be adopted using RDTs as the main tool for fever screening at all levels, microscopy only at secondary facilities, and DNA PCR testing for all quality control.

- Improve the core facility-based surveillance system and establish a highly efficient complementary system to proactively detect and clear additional cases not presenting at health facilities. These improvements can be achieved by:
  - Expanding the current mobile phone-based case reporting system (Malaria Epidemic Early Detection System) to cover all health facilities, both public and private.
  - Establishing outbreak response teams in all districts with continued transmission risk (i.e., not in urban areas) once elimination is achieved, with sufficient staff and logistic support to rapidly investigate every new case and screen surrounding households.

- Increase the capacity and skill mix of the ZMCP to manage and implement the changed interventions required for elimination.

- Form an Elimination Technical Advisory Committee composed of 8-10 relevant independent experts to guide planning and implementation and a National Malaria Elimination Steering Committee, with representation from all relevant ministerial departments and key partners, to ensure continued leadership and financing of the program.

- Apply measures that restrict individual liberties (e.g., mandatory house spraying or blood screening) only once all other possible measures have been exhausted in compliance with international legal frameworks.
Financial Feasibility

The optimal method of determining the economic attractiveness of an elimination program would be a cost-benefit analysis—i.e., do the direct (e.g., lower morbidity and higher productivity) and indirect (e.g., potential higher tourism) benefits of achieving and sustaining elimination outweigh the costs of the program? This type of analysis is highly complex and was not possible in this assessment. Instead, the analysis presented here is purely indirect (e.g., potential higher tourism) benefits of achieving possible benefits, including the national pride of being malaria free, justify an elimination program even if it is not cost-saving.

The core results of the financial analysis include:

- Elimination will not be cost-saving in the medium-term (25 years) under any of the scenarios analyzed.
- If vector control is entirely withdrawn, which is only possible following a dramatic reduction of importation risk, annual elimination spending will eventually fall below sustained control. However, it is unlikely that the necessary reductions in importation risk will be achieved through improved control on the mainland alone; screening of travelers may also be required. Depending on the extent and cost of that border screening, maintaining elimination will cost between 4% more and 18% less than sustained control annually.
- Even if the least expensive elimination scenario is reached (i.e., no vector control or border screening) elimination will not generate cost savings on a cumulative basis until after 2050.
- Increased spending on surveillance and diagnosis is the primary driver of the higher cost of elimination, with these categories combined comprising between 35-65% of average annual costs of the elimination scenarios compared to just 15% of sustained control costs.
- The period of achieving elimination will be 60-89% more expensive than sustained control. Compared to that elimination phase, the ongoing cost of preventing reintroduction will then range from 5% higher (the most feasible and likely scenario) to 30% lower (the best possible scenario).
- The average annual per capita cost of elimination over the 25-year period will be $2.97 under the most likely elimination scenario. The equivalent per capita cost for sustained control over that period is estimated to be $1.88.
- Regardless of whether or not the Zanzibar MOHSW decides to pursue malaria elimination or sustained control, consistent financing for the malaria program will need to be secured to avoid resurgence of malaria. This will require a significant change in the approach to malaria funding for Zanzibar to enable long-term financial commitments not tied to the burden of disease.

To address the challenge of unpredictable funding flows, we recommend that the Government of Zanzibar develop appropriate solutions through:

- Engaging in active discussions with its principal health and malaria donors to agree on the financial needs to achieve its malaria goals in the medium-term and explore approaches to ensure predictable financing.
- Commissioning a detailed assessment of the potential use of innovative financing mechanisms, including an earmarked tax and/or endowment fund, to increase the predictability of malaria financing.
- Developing and securing broad governmental buy-in for a plan to reduce reliance on donors resources for malaria control, including through gradual increases in domestic budget allocations.

Exploring potential contributions from countries such as Oman that have a self-interest in continued low malaria transmission on Zanzibar.
CONCLUSION

Overall, this assessment presents a mixed picture of the prospects of malaria elimination on Zanzibar. On the one hand, it shows that it is possible to completely eliminate malaria from the islands with currently available interventions. At the same time, it concludes that it will be operationally and financially challenging to prevent the reintroduction of malaria following elimination if importation risk remains high. In that way, Zanzibar’s elimination ambitions are tied to the fate of malaria control on the mainland: as malaria rises and falls in coastal Kenya and Tanzania, the difficulty and cost of sustaining elimination on Zanzibar will similarly increase and decline. This suggests that the MOHSW should engage in active dialogue with the relevant mainland Ministries of Health as it pursues further exploration and/or planning of malaria elimination. Yet even if importation is reduced through such collaboration, Zanzibar should expect to be able to only modestly reduce its annual expenditure on malaria.

This core conclusion—that elimination is feasible but very challenging—also indicates that the success of a potential elimination program will, in many respects, ultimately be determined by will: will to mobilize and sustain additional resources, will to overcome enduring systemic challenges, and will to pursue elimination of malaria above other health priorities, among others. Whether this will can and should be generated and therefore whether malaria elimination should be pursued is a decision that can only be taken by the MOHSW. It is hoped that this assessment will be a resource in that process.

As the MOHSW deliberates this decision, it is important to bear in mind the long time horizon associated with both elimination and sustained control. The technical feasibility analysis revealed that the earliest elimination that could reasonably be achieved would be 2020 and interventions will need to be sustained for several decades from now regardless of the strategy that the MOHSW pursues.

This longer time horizon presents challenges that are generally different from or more acute than short-term scale-up efforts. An essential conclusion of this assessment is that one of the most critical of those challenges is financing. Regardless of whether Zanzibar pursues elimination or sustained control, ensuring adequate funding to maintain interventions will remain essential but will become increasingly difficult. The great majority (>90%) of funding for Zanzibar’s malaria effort currently comes from international donors whose priorities and systems are aligned towards short-term reductions in disease rather than long-term maintenance of disease absence (as is the case with elimination and sustained control).

As shown in the figure above, even a modest decline in financing and therefore intervention coverage could lead to a devastating resurgence of malaria. Such resurgence is not speculation on Zanzibar: it has happened twice before on the islands when elimination campaigns were halted, taking a terrible toll on the people of the region. As such, although it may take several years for this challenge to become pronounced, we urge the MOHSW and its donors and partners to immediately begin work on potential solutions, including increases in domestic financing of malaria and mechanisms such as endowment funds and earmarked taxes, to provide a more secure financing base for the ZMCP. Perhaps more than any other factor, continued progress in freeing the Zanzibari people from malaria will depend on success in this area.
INTRODUCTION

BACKGROUND
In October 2007, Bill and Melinda Gates put malaria elimination and eradication back on the global agenda (Roberts and Enserink, 2007). Their bold statements, together with the impact recently seen from traditional malaria control interventions (WHO, 2008) have meant that several countries in sub-Saharan Africa are considering malaria elimination once again. Apart from the recently published World Health Organization (WHO) guidelines on malaria elimination (WHO, 2007; WHO EMRO, 2007a) and prevention of reintroduction (WHO EMRO, 2007b), few up-to-date reference documents are available to guide countries in the comprehensive planning for a malaria elimination program. In most countries, the institutional memory from the Global Malaria Eradication Program (GMEP) era has been lost. While one can read old accounts, many critical factors, from the control environment to the governance structures and health systems in place, have changed. Moreover, the current (WHO) guidelines set out a number of contextual prerequisites that effectively exclude developing countries in sub-Saharan Africa.

Zanzibar is one of the countries in sub-Saharan Africa that recently expressed its willingness to move from control towards elimination. Although elimination efforts have twice before failed in Zanzibar (in the 1960’s under the GMEP and in the 1980’s in a project funded by the United States Agency for International Development (USAID), the epidemiological context and the geographically limited island setting has always been considered as a model site for elimination (Schwartz et al., 1997; Minjas et al., 1988). As in most of sub-Saharan Africa, elimination efforts in Zanzibar failed both as a result of administrative issues and mosquito resistance to DDT used in indoor residual spraying (IRS), the main strategy of the GMEP. However, the recent increase in funding, mainly through the Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM) and the U.S. President’s Malaria Initiative (PMI), coupled with the introduction of highly effective treatment, long-lasting insecticide-treated bed nets for prevention, and new insecticides for IRS has again raised the government’s interests in the possibility of malaria elimination.

RATIONALE AND OBJECTIVES
In Zanzibar, the introduction of Artemisinin-based Combination Therapy (ACT) for malaria treatment in 2003 has been associated with a two-fold decrease in malaria prevalence in under-fives by 2005. Another ten-fold decrease was seen between 2005 and 2006 after the introduction of LLINs (Bhattarai et al., 2007). More recent data further justify Zanzibar’s move toward elimination. In 2008, more than 70% of under-fives and pregnant women slept under an insecticide-treated bed net; 96% of houses were covered with IRS during the last spraying cycle; the slide positivity rate is below the 5% WHO threshold to move towards pre-elimination; and the most recent survey revealed only 0.8% malaria prevalence (ZMCP, 2008).

The Zanzibar Ministry of Health and Social Welfare (MOHSW) and the ZMCP are now faced with a number of important strategic questions. Should they seek to completely eliminate malaria transmission from the islands or maintain it at roughly current low levels? How should they change the current intervention approach based on that goal? When can they begin scaling back interventions without causing a resurgence of malaria? These are technically complex questions, the answers to which are further complicated by the dearth of attention to and research on elimination in recent decades. Given this lack of information, the MOHSW and ZMCP decided to conduct a thorough assessment of the feasibility of malaria elimination on the islands to answer these and other critical strategic questions.

The primary objective of the feasibility assessment exercise was to provide the MOHSW with as robust as possible evidence to enable it to make informed decisions about the future of its malaria program and associated investment in the health system. A secondary objective was to develop tools and lessons learned to facilitate similar exercises by other countries considering malaria elimination.

METHODOLOGY
CONCEPT AND GENERAL FRAMEWORK
To our knowledge, there are no recent examples of country level feasibility assessments for malaria elimination. In order to develop a framework for this exercise, historical WHO reports and guidelines, including the only textbook on malaria eradication by Emilio Pampana (1969), from the GMEP era were reviewed. The review revealed that although the WHO encourages countries to assess the feasibility of malaria elimination, apart from a list of questions, they don’t provide a framework or methodology for this exercise (WHO, 2007). Historically, technical, administrative, and practical feasibility were clearly defined, but recommendations on assessing feasibility were ambiguous (Pampana, 1969). Technical feasibility was more or less assumed and formed, together with the fear for emerging resistance of the Anopheles mosquito to DDT, the basis for the GMEP (WHO, 1955). Administrative and practical feasibility, which included financial feasibility, on the other hand were not taken for granted, especially in developing countries and were encouraged to be evaluated by doing a pre-eradication survey and dealt with during a pre-eradication program (WHO, 1961). However, pre-eradication surveys were only recommended
when eradication was deemed technically feasible. Based on this literature review a general framework for this exercise was proposed in a concept note that was circulated to a wide group of international malaria experts for feedback. The concept note, which was generally well received by the experts, suggested using a framework along 3 broad dimensions: Technical, operational and financial feasibility, which was also recently recommended by the Malaria Elimination Group (Moonen et al., 2009).

PLANNING AND PROCESS

A panel of experts, both local and international, was constituted for each of these components. The international experts were selected because of their mandate (WHO), experience in Zanzibar (Karolinska Institute, Ifakara Centre) and/or their specific fields of expertise (Malaria Atlas Project, Harvard University, Brooking Institute, Clearly Gottlieb Steen & Hamilton LLP). All of the experts contacted agreed to contribute pro bono (for list of experts, see Acknowledgements). In July 2008, a meeting, opened by His Excellency the Minister of Health, was held in Zanzibar to bring together the international experts with their local counterparts to define key questions for each of the proposed components. A work plan and working groups, each with a focal person, were established. Each of the working groups was asked to draft an outline for their (sub) chapters. Based on these outlines, lead authors prepared initial drafts, and stakeholders were given the opportunity to comment and provide feedback in a meeting in February 2009. Final drafts were presented to the MOHSW in May for approval. Details on the methodologies used by each of the working groups can be found in their respective chapter. The entire exercise was led by the ZMCP under the leadership of the MOHSW.

CONTEXT

GEOGRAPHIC AND SOCIO-DEMOGRAPHIC CONTEXT

Zanzibar consists of two main densely populated islands, Unguja (1,666 km²) and Pemba (988 km²), as well as several smaller islands, some of which are uninhabited. The entire population is just over one million. The islands are located in the Indian Ocean, about 30 kilometers off the coast of mainland Tanzania between latitudes 5 and 7 degrees south of the Equator. The climate of Zanzibar is equatorial and humid. The maximum temperature is around 30°C during the hot season, lasting from December to March. The minimum temperature is around 20°C during the cool season, which lasts from June to November. Zanzibar has two main rainy seasons, a long rainy period (Masika) from March to June and a short rainy period (Vuli) that starts in October and ends in December. Precipitation is high, ranging from 900 to 1000mm during the heavy rains in April and May and 400 to 500mm during the short rains in November and December. On average, precipitation is slightly higher in Pemba in comparison to Unguja.
In 2002, Zanzibar was estimated to have 981,754 inhabitants and a population density of 370 inhabitants per square kilometer (National Bureau of Statistics, 2002). Forty percent were estimated to be living in urban areas. The population growth rate was high, 3.1%, and this was mostly attributed to a high fertility rate of 5.3 children/women. The projected population for 2008 was 1,193,127. The average household size in 2004 was 5.5 members. About a quarter of adults in Zanzibar are reported to have no education but almost 76% of adults can read and write in at least one language. The basic education enrollment rate remains high at 110/100,000 live births (National Bureau of Statistics and ORC Macro, 2005). HIV prevalence is estimated to be below 1%. The Household Budget Survey performed in 1999, to 61 per 1,000 live births in 2005 (National Bureau of Statistics and ORC Macro, 2005). Although 97% of women receive ante-natal care (ZMCP, 2008), only 50% of deliveries are assisted by a medical professional and the maternal mortality rate remains high at 110/100,000 live births (National Bureau of Statistics and ORC Macro, 2005). HIV prevalence is estimated to be below 1%. The Household Budget Survey performed in 2004 showed that about one-fifth of people suffered at least one kind of illness in the four week period preceding the survey; with variations of 23% in the rural population as compared to 13% in urban populations. More than four-fifths of individuals who were ill consulted with a health care provider, mainly through primary health care (PHC) units. Only 16% consulted with a provider through private health facilities. Seventy percent of all households (50% in rural areas, and more than 90% in urban areas) were located within 2 kilometers from their health centre (Office of the Chief Government Statistician, 2006).

A quarter of the labor force is in agriculture, mainly farming and livestock keeping, and only one in ten is an “employee”, employed either by the government, public enterprise, non-governmental organizations or faith-based organizations. Although work in agriculture is the largest single economic activity, wage labor is the most important source of cash income and one-third of the households reported running a business (Office of the Chief Government Statistician, 2006).

**Zanzibar Malaria Epidemiology**

Until recently, malaria in Zanzibar has been characterized by perennial stable transmission. The introduction of ACT as first-line treatment, the use of long-lasting insecticide-treated nets by a large proportion of pregnant women and under fives and the high coverage of indoor residual spraying is thought to have changed the endemcity pattern from hyper- to hypo-endemic (Bhattarai et al., 2007) with malaria prevalence estimates of below 1%; 0% in the Stonetown area and around 3% in Northern Pemba (see Figure 3) (ZMCP, 2008). Nevertheless, the entire population remains at risk of malaria and it is assumed that due to past transmission patterns older age groups still have some immunity and children below the age of five and pregnant women remain more vulnerable to infection.

**Plasmodium falciparum** is the predominant species and accounts for 97% of all malaria infections. The only other species found is *P. malariae*. (ZMCP, 2008). *Anopheles gambiae sensu lato*, *An. funestus* and *An. coustani* are the only malaria vectors on Zanzibar (Ilumba et al., 2007). Members of the *An. gambiae s.l.* include *An. gambiae s.s.; An. arabiensis*; and *An. quadriannulatus*. Because of the slightly different rainfall patterns between Pemba (uni-modal) and Unguja (bi-modal) the transmission patterns also differ. Pemba has a single transmission season while the evaluation of entomological inoculation rates on Unguja showed two peaks in malaria transmission with high biting rates during the long rainy season and lower ones during the short rains.

In 2000, the overall treatment failure to chloroquine was found to be 60% in a 14-day efficacy trial and consequently the Zanzibar MOHSW decided in November 2001 to change both first- and second-line treatment guidelines for uncomplicated malaria from chloroquine (CQ) and sulfadoxine-pyrimethamine (SP) to ACT (ZMCP, 2002). A combination of Artesunate and Amodiaquine (AS-AQ) was chosen as the first-line treatment while for second-line treatment Artemeter and Lumefantrine (Coartem™) was recommended. Quinine is still used to treat severe malaria and malaria in the first trimester of pregnancy. SP is only used for intermittent preventative treatment for pregnant women (IPTp). The ACT policy was implemented in September 2003 making Zanzibar one of the first regions in sub-Saharan Africa to recommend routine use of ACT. In the same year a study...
undertaken with support of the Karolinska Institute showed no significant parasite resistance to AS-AQ and Coartem® with clinical and parasitological response over 98.5% (Prof Anders Björkman, personal communication).

THE ZANZIBAR MALARIA STRATEGIC PLAN

The overall objective of the Malaria Strategic Plan for Zanzibar (2007-2012) (ZMCP, 2007) is to reduce the malaria incidence by 70% from the 2006 baseline by 2012. Because of the low prevalence already achieved, the plan also aims at early detection to avoid epidemics or resurgence of malaria. To achieve this ultimate goal, five specific objectives have been put forward:

1. To prevent infection with malaria by reaching and maintaining coverage of ITNs/LLINs at above 80% for pregnant women and children under 5 years, complemented by other vector control methods

2. To ensure effective case management by providing prompt access for all to parasitological diagnosis (by microscopy or rapid diagnostic test) and ACT

3. To prevent and control malaria in pregnancy, by increasing and maintaining coverage of IPTp to 80% in both private and public health sectors (at least two doses of SP) by promoting the regular and correct use of LLINs

4. To provide effective epidemic preparedness and response, by ensuring that for > 90% of health facilities, reports are on time, investigation of reported epidemics is initiated within 24 hours and supplies are at hand to mount a response if necessary

5. To assess the potential for sustainable elimination of malaria from Zanzibar, using newly available data from surveillance and operational research, as well as experience from implementation

These specific objectives are to be supported by complementary strategies on communication, management and coordination, monitoring and evaluation, operational research and surveillance. Although the current strategic plan does not aim for malaria elimination, one of the specific objectives is to assess the potential for sustainable elimination. As such, the preparation of an assessment on the feasibility of malaria elimination is in line with the national strategic plan.

HISTORY OF MALARIA CONTROL IN ZANZIBAR

Historically, malaria has been a major public health, social and economic problem in Zanzibar, with the exception of a short period during the malaria eradication program from 1958 to 1968. In the mid-1920’s, an early document on the epidemiology of malaria in Unguja reported a parasite prevalence of 68% among children 1-6 years of age (Manfield-Aders, 1927). In the 1930’s and 1950’s similar parasite prevalences were found in both Unguja and Pemba, but after that parasite rates have shown fluctuations mainly related to different malaria control efforts.

Before World War II environmental management, chemical larviciding and quinine distributions to schoolchildren were the main malaria control intervention tools in Zanzibar. Larvivorous fish and mosquito nets were also used but with limited success. After World War II spraying activities with DDT and dieldrin were started. In 1961 the malaria control program was upgraded to an eradication program. The eradication program continued the bi-annual cycles of IRS with dieldrin and started mass distribution of amodiaquine and primaquine resulting in community parasite prevalences below 5%. However, the eradication program failed to interrupt transmission, which was blamed on technical, administrative and operational shortcomings (Delfini, 1969). The eradication program was terminated in 1968, though malaria control activities continued, largely through the support of community volunteers. By the late 1970s, parasite prevalence had again increased to around 40% on Unguja (Matola, 1984).

In 1984, Zanzibar assisted by USAID, launched a five-year project to control malaria to a level where it no longer would be a major public health problem (Minjas et al., 1989). The main strategies included DDT spraying and chloroquine administration through dispensaries. Results, however, were poor due to inadequate coverage and operational problems similar to the eradication period. In the 1990’s funding for malaria control was limited. Nevertheless, in 1993 the new global strategy for malaria control was adopted emphasizing prompt and effective malaria treatment rather than IRS. This strategy was, however, highly hampered by increasing resistance to chloroquine. The start of the Global Fund to Fight Aids, Tuberculosis and Malaria (GFATM) and the President’s Malaria Initiative (PMI) marked a new era in malaria control for Zanzibar with a consistently well-funded program since 2002 resulting in the above described reduction in the malaria burden to date.
CHAPTER 1: TECHNICAL FEASIBILITY

INTRODUCTION

The belief that insecticides and effective treatment made eradicating malaria parasites technically feasible was the basis of the Global Malaria Eradication Program (WHO, 1956). The initial design of the GMEP was based largely on a successful indoor residual spraying program using DDT in Greece, where transmission had been interrupted by the end of 1949. In 1951, spraying was stopped on the island of Crete because of DDT shortages, but malaria did not return (WHO, 1967). In Greece that same year, DDT resistance was detected in the Anopheles sacharovi (Livadas and Georgopoulos, 1953). These experiences led the technical advisory committee on eradication to conclude that a time-limited program of indoor residual spraying was possible (because it had worked in Crete) and necessary (because DDT resistance had evolved), and it led the GMEP to adopt a 3-4 year attack phase (WHO, 1956).

The GMEP experienced some spectacular successes with this strategy in the early going, especially in many European countries which may be considered the “lowest-hanging fruit” (Gramiccia and Beales, 1988). Unfortunately, other programs did not experience the same level of success, especially in sub-Saharan Africa. The most notable early failure occurred in the Pare-Taveta Malaria Scheme, on the Kenyan-Tanzanian border, where transmission was not interrupted after three and a half years of spraying. The influence of these failures on awareness of the importance of rigorously assessing the technical feasibility of malaria elimination was reflected in the insistence of Emilio Pampana, one of the fathers of malaria eradication, that technical feasibility be determined before embarking on an elimination program. He defined technical feasibility as “evidence that conditions in a country are such that a particular technique [...] will succeed in an acceptable period of time and that, once obtained, absence of transmission could be maintained” (Pampana, 1963).

Since that time, there has been relatively little further work done to define conditions where it is technically feasible to eliminate malaria and maintain its absence. Currently, WHO guidance states that a prerequisite for an elimination attempt is “demonstrated technical feasibility of malaria elimination in similar eco-epidemiological settings in the recent past” (WHO, 2007). Mauritius, another island with conditions and populations that are similar to Zanzibar, reported its last malaria case in 1997. Based on this criterion, elimination in Zanzibar may be possible. However, the substantial differences between Zanzibar and Mauritius, including proximity to the mainland, clearly require a much more nuanced approach to technical feasibility to better define the potential for achieving and maintaining zero transmission.

This chapter seeks to define a new framework for assessing the technical feasibility of sustainable elimination of malaria in Zanzibar through application of mathematical transmission modeling and detailed analysis of human migration patterns. Using mathematical modeling techniques, the potential for currently available interventions and tools to interrupt transmission in the particular context of Zanzibar are evaluated to decide whether elimination can be achieved and what level of intervention would be required to do so. Just as importantly, this chapter assesses the level of effort that would be required to prevent the reintroduction of malaria transmission once elimination has been achieved.

ESTIMATING ZANZIBAR’S MALARIgenic POTENTIAL

An assessment of the feasibility of malaria elimination from the islands of Zanzibar must consider two principle dimensions of risk: risk of importation (often termed “vulnerability”) and risk of transmission (termed “receptivity”) (Moonen et al., 2009). Together, these two dimensions interact to comprise the malariogenic potential, or overall malaria risk, for the islands of Zanzibar. An assessment of malariogenic potential considering both risks simultaneously is central to determining the feasibility of elimination. For example, if Zanzibar’s importation risk can be reduced to very low levels, meaning that almost no infected individuals travel to Zanzibar from the mainland, control measures that suppress the transmission risk might be relaxed without creating an unacceptable risk of malaria resurgence. Conversely, if a high degree of control is maintained to reduce malaria transmission risk, such as a large majority of individuals sleeping under insecticide-treated bed nets, malariogenic potential may be kept at acceptable levels even if a large number of infected individuals are traveling to the islands from the mainland. If both importation and transmission risk are very high, however, elimination is likely impossible. Figure 4 provides an overview of this concept.
In the following sections, the two dimensions of malaria risk are considered in turn. First, available historical data for Zanzibar are analyzed in order to quantitatively assess the “innate” risk of malaria that exists there—that is, the level of transmission that would be expected in Zanzibar if no control measures existed. Second, information on current control measures in Zanzibar is additional and is considered here in order to estimate present-day risk of transmission. Third, importation risk is assessed using GIS, mathematical models, and spatial analysis. Understanding the feasibility of sustainable malaria elimination requires not only computing the risk of importation and transmission, but also determining whether those levels of risk are sufficiently low to permit elimination and maintain it. As such, the chapter concludes with applications of mathematical models to evaluate the prospects for elimination under present circumstances as well as the requirements for maintaining malaria-free status.

### Innate Transmission Risk

Assessing the feasibility of malaria elimination in Zanzibar requires understanding how current or potential interventions will affect transmission. To do so, we must consider not just the present-day amount of malaria—which is a product of all of the successful interventions implemented by the ZMCP—but also the “innate” amount of malaria that would occur eventually if all interventions were removed. Zanzibar’s current parasite prevalence of <1% on average would have very different implications for elimination if the innate prevalence was 5% than if it was 50%; the higher ceiling indicates both that control efforts have had an extreme impact on transmission, but also that removal or relaxing of those efforts would have severe consequences.

Although malaria transmission in Zanzibar has decreased to low levels in recent years, it would have been described as hyperendemic or holo-endemic in the past, or in other words, the prevalence of malaria in children aged 2-10 was greater than 50% (Metselaar and van Thiel, 1959). The British and Foreign State Papers from 1895-1896 describe Pemba as “a hot-bed of malaria” and indicate that “all classes of the inhabitants suffer severely from the various manifestations of that protean disease” (Oakes and Maycock, 1900). The most detailed early study of malaria in Unguja, published in 1927, found that approximately 68% of the children were infected (Mansfield-Aders, 1927).

Even before recent control measures like effective treatment, bed nets, and IRS were implemented, surveys indicate that some decrease in the innate malaria level had occurred. During the mid 1990s, reports indicated whole population parasite prevalence levels of around 35-40%. These levels are consistent with hyperendemic malaria; the population average prevalence is typically lower than in children aged 2-10 because of blood stage immunity to malaria; the population average prevalence is typically lower than in children aged 2-10 because of blood stage immunity to malaria (Smith et al., 2007). A 1994 study in Pemba found malaria parasites in 60% of children (Albonico et al., 1994). That same year, malaria prevalence in outpatients at the Mnazi Mmoja Hospital ranged from 18-49% throughout the year, but the ages of the outpatient population were not reported (Schwartz et al., 1997).

In 2003, before Zanzibar changed its drug policy, malaria prevalence in two sentinel districts was 8.2% and 14.4% (Bhattarai et al., 2007), lower than the 1957 surveys conducted before initiation of the malaria eradication program, even though no major control activities are known to have been occurring at that time. This substantial decrease, which likely facilitated the recent success of malaria control, may be the result of other changes that have been occurring in Zanzibar over the past decades, including socioeconomic development, changes in land use, drought, or urbanization. Evidence of demographic change is provided by Zanzibar’s national census, which indicates that the percent of the total population living in the dense Urban West region has increased from 27% in 1967 to 40% in 2002. Malaria incidence declined by 95% following the switch to ACTS in 2003, and the prevalence of malaria has been reduced.

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1 Hyperendemic malaria is commonly defined as $PrPR 50-75\%$ in children between 2–9 years old (Hay et al., 2008).
to below 1% with IRS (Bhattarai et al., 2007). These low levels of malaria prevalence in Zanzibar today suggest that elimination is feasible, although it may be challenging to go the last mile.

History has demonstrated numerous times that regions with high innate risk of malaria will see rapid resurgence of transmission if control measures are weakened or removed. For example, after Madagascar instituted a control program of DDT spraying and case detection and treatment in the 1940s and 50s, malaria was nearly absent from the highlands for many years. But when control activities were halted in the late 1970s, an explosive epidemic caused an estimated 40,000 deaths over five years (Mouchet et al., 1998). There are numerous similar examples from diverse environments and areas of the world. In contrast, countries that have effectively sustained interventions have successfully maintained a high level of control or elimination. In sub-Saharan Africa, examples of such success include South Africa (control) and Mauritius (elimination), both of which had successfully maintained a high level of control or elimination. In sub-Saharan Africa, examples of such success include South Africa (control) and Mauritius (elimination), both of which had to adapt their programs when changing conditions led to modest resurgence (Julvez et al., 1990; Mabaso et al., 2004).

Zanzibar itself has already experienced such resurgence. Malaria in Zanzibar reached a previous low forty years ago at the end of the GMEP. In June 1968, with prevalence reduced over 10-fold in Unguja and 40-fold in Pemba, malaria had been reduced to a “minor health problem” (Tavrow et al., 1988). The program was then halted for “political and economic reasons,” a trend that was occurring around the world due to disappointment that full elimination had not been achieved. Without control measures, the resurgence of malaria was rapid (Schwartz et al., 1997). A survey conducted five years after the end of the program found that prevalence had rebounded six-fold to 54% prevalence in Unguja and 10% in Pemba (Minjas et al., 1988). Should history repeat itself and the current control measures be relaxed, it is certain that malaria in Zanzibar will once again return to hyperendemic levels within a few years.

**CURRENT TRANSMISSION RISK**

Actual levels of malaria transmission in Zanzibar at a given time depend upon not only the historic, or innate levels of malaria, but also the levels of control activities that will decrease transmission from that baseline. Malaria transmission can be measured in several ways, but an extremely useful measure is the number of human malaria cases resulting from each human malaria case, called the basic reproductive number $R_0$ (Box 1), pronounced “R naught.” $R_0$ measures transmission under the conditions that maximize transmission—no control and no immunity. To define transmission risk under different levels of control, we use the controlled reproductive number, $R_C$, which is the number of new infections that will result from each infection at a certain level of control activities. Understanding both $R_0$ and $R_C$ is critically important for elimination and post-elimination planning, telling us what interventions are needed to get to zero transmission and how fast new imported cases might develop into outbreaks.

**Box 1**

**The basic reproductive number $R_0$**

Zanzibar’s high innate level of malaria—that is, the level of the disease that would naturally occur if all control measures were removed—is determined by the presence of efficient vectors, including *Anopheles gambiae*, appropriate climate, geography, and socioeconomic environment for malaria parasites to spread efficiently. Together, these factors produce a high basic reproductive rate of malaria ($R_0$)—the number of new infections an infected person would generate if there were no control measures in place.

**The controlled reproductive number $R_C$**

The value of $R_C$ indicates the number of new infections that each infected person will generate under a given level of control activities. If that value is greater than one, malaria levels are increasing, while if it is less than one, they are decreasing. The current $R_C$ level in Zanzibar depends on the effective coverage of control activities. For example, if around 60% of the population is fully protected by LLINs or IRS, $R_C$ will be approximately equal to one, while if 75% of the population is protected, it will drop to about 0.5.

To put the historical trends in malaria endemicity into a context that is useful for assessing the technical feasibility of elimination, it is necessary to estimate $R_0$ and $R_C$. Estimates of $R_0$ for malaria are based on the prevalence of malaria in children aged 2-10 and a mathematical model of malaria transmission (Smith et al., 2007). Zanzibar’s past hyperendemic malaria, with prevalence of around 60%, corresponds to estimates of $R_0$ around 100, but with wide confidence limits that suggest it was greater than 30 but could have been as high as a thousand. More recent data suggest that prevalence remained around 35-40% even in the absence of a formal control program. This lower (though still high) level of innate malaria suggests that $R_0$ had fallen to around 10 or 15.

$R_C$ is likely to depend upon a diversity of spatially varying factors including coverage of interventions like bednets or IRS, socioeconomic conditions, and urban development. As such, current levels of malaria transmission are not homogeneous across Zanzibar (Figure 5). Survey data indicate that Central and North B on Unguja and Micheweni in north Pemba appear to have higher malaria risk than elsewhere. These three districts also were three of the four districts with the lowest percentages of individuals reporting sleeping under treated nets in a 2007 ZMCP survey; all reported figures lower than 50%. Determining the relative importance of other factors will require regular and detailed data on interventions, socioeconomic status, development, and parasite prevalence across Zanzibar. Nevertheless, recent years of transmission data indicate that $R_C$ is likely around one on average, and it is probably lower than one across much of Zanzibar, particularly in the high population context of Stone Town and in surrounding urban areas.
FIGURE 5: MALARIA TEST POSITIVITY RATES BY DISTRICT FOR (A) 2008 AND (B) 2009

Malaria Epidemic Early Detection System, Positivity Rates (%) in 52 Health Facilities

(A) 2008

B) 2009
DEFINING IMPORTATION RISK

As illustrated in Figure 5, the control measures that are required to keep overall malariogenic potential in check and thus ensure sustainable elimination will differ depending upon the level of importation risk that exists. For this reason, understanding the amount of malaria being transported to the islands is as essential as understanding the risk of onward transmission.

Importation risk involves the probability of infectious individuals or mosquitoes carrying malaria parasites into Zanzibar. Because Zanzibar is comprised of islands, the risk of importing malaria is far higher in human hosts than mosquitoes, and we ignore the latter risk here. Calculating importation risk quantitatively involves considering each of the following factors:

- The entry routes through which people travel to Zanzibar, such as ferry, airplane, or informal boats;
- The number of people who travel into Zanzibar through each of these entries by traveler type, such as tourists, migrant laborers, or Zanzibar citizens;
- The probability of travelers being infected with malaria parasites, which will vary with the traveler type and where they stayed prior to arrival in Zanzibar; returning Zanzibar residents will have different probabilities of bringing parasites back with them depending on where on the mainland they stayed; and
- The probability of infected individuals within those groups infecting a mosquito in Zanzibar, which depends upon how long and where they stay.

In this section, we consider approaches to quantifying each of these factors, though limited data availability increases the uncertainty surrounding the estimates derived from information obtained on air and ferry passenger numbers, and evaluations on tourism to Zanzibar. A novel approach using mobile phone use data obtained from the Zantel mobile phone company allowed for more precise estimates, especially for Zanzibari residents traveling to the mainland. Careful assessment of each component must occur during the next several years as Zanzibar plans its strategy for eliminating malaria and ensuring that it does not return.

IMPORTATION RISK ANALYSIS BASED ON ROUTINE TRAVEL/TOURISM DATA

Routes of Importation

Because Zanzibar is comprised of islands, the majority of incoming people and consequently, parasites, arrive through specific gateways, including ferry ports and airports. A country sharing many land borders with neighbors would have far more points of entry, greatly complicating these calculations. Records exist of some passenger traffic via ferries and airplanes; however, no statistics exist at present on the specific numbers of passengers involved in informal boat traffic between the islands and the mainland (although landing points are known), so future surveys and surveillance on informal movements will be necessary to refine migration estimates.

Air Transport

As tourism to Zanzibar continues to increase, so do the number and capacity of incoming flights (Tanzania Ministry of Natural Resources and Tourism, 2007). Figure 6 shows that December-January and July-August represent the peak incoming passenger seasons, and that numbers increased significantly over the course of 2006 and 2007. This increase does not necessarily indicate an accompanying growth in infection importation risk because many, if not most, of the flights may be carrying tourists (often taking prophylactic drugs) traveling from non-endemic countries who have had to change flights in Malaria Endemic Countries (MEC) to get to Zanzibar (see tourism section below). As such, while data on passenger origins and purpose of visit are required for precise estimates, it can be safely assumed that air travel represents a minority of the risk of parasite importation.

Ferry Transport

Through collation and analysis of available ferry timetable data, Figure 7 shows the major ferry routes and daily capacities. These figures give a useful indication of maximum expected numbers of visitors and movements between islands, but do not indicate where passengers have typically traveled from. Nevertheless, the data shown in Figure 7 provide useful figures for estimating the volume and location of entry of passengers entering Zanzibar through the ferry system. Figure 8 provides additional information on actual numbers of ferry passengers and how these have varied through 2006 and 2007. The data shows some seasonal fluctuations and also some significant inter-annual variations. However, this data does not distinguish between numbers arriving or leaving the islands, which islands are involved and where passengers have come from—these are all features that should be included in future surveys.
Types of Travelers

Although data on ferry and airport traffic permits estimation of the number of people migrating from the mainland to Zanzibar, importation risk is only affected by the subset of those migrants who are infected with malaria parasites. Different subgroups of migrants will likely be at very different risks for importing malaria.

Tourism represents the principal income source for Zanzibar and brings in visitors from all over the world. Typically, three categories of tourist exist on Zanzibar (Heita-Mwampamba, 2003):

a. Those arriving as part of a journey that includes mainland Tanzania or Kenya—typically, but not exclusively (see below) backpackers staying at low budget accommodation (making up around 70% of Unguja tourist accommodation)

b. Those exclusively visiting the islands through package deals

c. Expatriate families and upper-class citizens from the mainland

Data from the Zanzibar Commission for Tourism indicate that tourists in groups (a) and (b) have almost doubled in the last five years, from 87,511 in 2002 to 143,265 in 2007. The vast majority of tourists visiting Zanzibar are from non-malaria endemic countries (Guerra et al., 2008). Just 15.5% of tourists in 2007 came from potentially malaria endemic regions in 2007, with the majority of countries and regions of origin of low or zero transmission (Hay et al., 2009).

Our analysis suggests that tourists represent a low risk group for malaria importation to Zanzibar. Many tourists will be taking prophylactic medication, and most will spend little time in high-risk areas. However, it should be noted that holiday packages involving mainland safaris in malaria-endemic regions, followed by a visit to Zanzibar, are popular. Numbers do not exist on those taking this type of vacation. Recent survey data have shown that 69% of tourists to Zanzibar come as part of a package deal (Tanzania Ministry of Natural Resources and Tourism, 2007) involving flights direct to Zanzibar (or changing briefly at Dar Es Salaam), and remaining on the islands (often within resorts) for the entire stay. These package holiday tourists (~100,000 visitors a year) represent an extremely low risk group for imported infections.

At this time, little information is available on the number of non-tourist travelers to Zanzibar arriving by air, ferry, or informal boat, though mobile phone data analyses (see below) have provided valuable data. Some of these travelers may be businesspeople who will stay in Zanzibar only briefly, migrant workers who will remain for weeks or months, or Zanzibar residents returning home from abroad. Much more information is needed on identifying the types of people traveling to Zanzibar especially by ferry or informal boat, since these individuals are much less likely to be taking malaria prophylaxis than those arriving by air.

Migrants

Given that different subgroups of migrants may have different average risks of being infected, the probability a specific traveler is carrying malaria is greatly dependent upon where he or she originated. Detailed maps of malaria prevalence are now available (Hay et al., 2009); unfortunately, data on the origin of migrants to Zanzibar are sparse, incomplete and outdated, making confident recommendations difficult for this key group in quantifying importation risk. Nevertheless, limited survey data on the origin of migrants regularly coming to Zanzibar to work in the tourist industry do exist (Gossling and Schulz, 2005), and are shown in Figure 9(a). Comparison of these locations with a map of P. falciparum malaria transmission intensity for 2007, measured in terms of parasite prevalence (Figure 9(b)), suggests that the majority of migrants to Zanzibar come from the relatively lower transmission areas of the mainland.

A measure of P. falciparum parasite prevalence per person can be calculated by weighting the parasite prevalence maps in Figure 9(b) by the population distribution in Figure 9(c). When this per person prevalence is combined with the percentage of all Zanzibar migrants originating in each region, a simple index of relative Imported Case Risk (ICR) can be calculated. The ICR identifies...
those regions from where the greatest numbers of imported cases in migrants are likely to originate, as depicted in Figure 9(d).

Patterns of malaria in origin regions can be highly seasonal, although great geographic variation exists in the intensity of transmission and the amount of the year during which it occurs. By accounting for the main transmission season months (Tanser et al., 2003) of each origin region, temporal changes in relative ICR can be examined to estimate when numbers of imported cases in migrants are likely to be highest. Estimates of the fraction of infected persons in each origin region at a given time were combined with migration rates from each region to estimate the proportion of migrants travelling to Zanzibar with *P. falciparum* (*Pf*). Moreover, the proportion of these ferry passengers traveling to Unguja and Pemba were assumed to match the ferry capacity proportions shown in Figure 8, summed over a month.

Estimates

These relative ICR estimates are depicted in Figure 10. They demonstrate a great range in imported infections risk from migrants through the year and between islands, reflecting traffic numbers, passenger origins and transmission seasons in the regions where passengers originate. Further data on ferry passenger travel histories is required to confirm ferry passenger composition, but analyses of mobile phone data (below) indicate that an overwhelming majority of ferry passengers simply travel between Zanzibar and Dar es Salaam.

Control efforts on the mainland will have a significant effect on imported infection numbers. In the analysis described here, we have not attempted to adjust for such effects. In reality, however, the current coverage of interventions like bednets, IRS, and prompt treatment with ACTs will likely greatly reduce the true number of imported cases. A careful analysis of the coverage of these interventions in mainland districts where migrants to Zanzibar originate will be necessary to assess the magnitude of the potential reduction; such reductions are likely to be significant and should increase over time as scale-up campaigns continue in Tanzania (Figure 11).

2 Scale shows percentage of total migrants (Gosling and Schulz, 2005)
3 Hay et al., 2009
4 Tatem et al., 2008
USING MOBILE PHONE DATA TO ASSESS IMPORTATION BY ZANZIBARI RESIDENTS

Recent approaches to quantifying human mobility patterns point the way to novel insights from new data (Brockmann et al., 2006; Brockmann and Theis, 2008), especially through the analysis of mobile phone records (Candia et al., 2008; Gonzalez et al., 2008). Anonymised phone call record data that has both the time each call was made and the location of the nearest mast that each call was routed through can be used to construct trajectories of the movements of individuals over time (Gonzalez and Hidalgo et al., 2008). The low market share on the mainland for the network provider restricts our focus here to those infections brought in by residents returning from mainland travel.

Data

The Zanzibar Telecom (Zantel) mobile phone operator has approximately a 10% share of the Tanzanian market (Tanzania Communications Regulatory Authority, 2009). While nine out of ten Tanzanians are reported to have ‘access’ to a mobile phone, what these figures mean in terms of ownership and usage are subject to debate and uncertainty (Vodafone, 2005; James and Versteeg, 2007). However, while the 10% share Zantel has likely represents an unrepresentative sample of Tanzania as a whole, Zantel does have a 99% market share on Zanzibar. With over 330,000 individual users apparently resident on Zanzibar (see later analyses) out of a total population of just over a million, this suggests that a substantial sample of Zanzibar phone users is covered by the dataset. Analyses here were therefore focused on Zanzibar residents only, though information derived from mainland resident users is presented in supplemental information.

Records encompassing 3 months of complete mobile phone usage for the period October–December 2008 were obtained from Zantel. This represents the limit of available Zantel data, since the company only keeps the preceding three months of records. Nevertheless, this covers the busiest period in terms of travel to and from Zanzibar, and therefore enables a conservative upper limit on infection importation risk to be estimated. The data included the dates of all phone usage by 770,369 individual users, making a total of 21,053,198 calls and text messages. Prior to receiving the data, Zantel assigned each individual user a unique code to ensure that the anonymity of users was maintained and that the data could only be used for studying general patterns of mobility. Each individual call and message was spatially referenced to one of six areas: Arusha, Dar Es Salaam, Dodoma, Mbeya, Mwanza and Zanzibar (Figure 12(a)). Any individual that made just four or less calls in any one month (an average of 1 per week) was removed from further analyses to ensure that sufficient temporal resolution existed in the remainder of the dataset for trajectory analysis.

For each of the three months in the study period, and for each Zantel region, the areas within their principal or secondary transmission seasons were identified and overlaid onto a map of daily Entomological Inoculation Rate (dEIR) (Figure 12(b)), a measure calculated from the parasite rate (Figure 9(b)) using mathematical models (Smith and Hay, 2009), the probability of each individual becoming infected was then calculated based upon the length of time they spent in these regions before returning to Zanzibar. With dEIR varying within regions, the full range of possible transmission levels that a traveler could be exposed to were tested. However, with travelers more likely to visit heavily populated regions than empty rural areas, it was assumed that population distribution-weighted measures of dEIR likely represented the more realistic average levels of traveler exposure. Realistically, while a significant majority of visitors to each region will visit the principal cities, others will travel to alternative population centres, thus the regional population weighted mean dEIR (upper) and principal city population weighted mean dEIR (lower) scenarios are presented here as credible limits for estimating the likely number of imported infections per month arising from returning residents. Full analyses are presented in Tatem et al. (2009).

Results

Over the three month period studied, 88% of users made calls that were routed only through masts on Zanzibar, suggesting that no long distance travel was undertaken by this group. Of those who made calls routed through mainland masts the vast majority of trips were estimated to be of less than five days in length, and to the Dar Es Salaam Zantel-defined region. To provide estimates of imported case numbers from returning Zanzibar residents and likely origins of infections, the data on dEIR scenarios for each Zantel region were combined with the trip length estimates. Estimates suggest that imported malaria risk from Zanzibar residents is heterogeneously distributed; a few people account for most of the risk for imported malaria.

Figure 13 shows the distribution of trips by probability of infection acquisition under the scenarios of exposure to regional population weighted mean dEIR and principal city population weighted mean dEIR. Each scenario highlights that the majority of trips made entailed a very low probability of infection acquisition.
FIGURE 13: ALL TRIPS MADE BY ZANZIBAR RESIDENTS PLOTTED BY PROBABILITY OF INFECTION ACQUISITION, BASED ON REGION POPULATION WEIGHTED MEAN $\text{dEI}_R$ (RED LINE) AND POPULATION WEIGHTED PRINCIPAL CITY MEAN $\text{dEI}_R$ (BLUE LINE)

The above calculations provide estimates of the number of infected inhabitants per year. However, improved information on all these factors will be essential to designing an effective program to prevent reintroduction of malaria following elimination. In particular, data must be collected on:

- How many individuals travel to Zanzibar by ferry or informal boats (including visitors and returning residents)?
- Where do these travelers originate?
- Where is their destination in Zanzibar?
- How long are they likely to stay there?
- What is their socioeconomic status and lodging while on the islands?

As such, the importation risk is a priori very different for different groups of people. Zanzibar residents, immigrants, and migrant workers are likely to stay on the islands the longest after acquiring an infection. They are also most likely to travel to areas of the islands with high transmission risk and to engage in activities that are conducive to transmission (sleeping in open areas rather than air conditioned rooms). If an infected individual is treated promptly, their infection will be cleared and they will be less likely to spread the infection. However, treatment seeking behavior with all of these groups will be an added challenge; in many cases, these people will have acquired malaria immunity, so they have mild or no symptoms and will be less likely to seek treatment. Treatment-seeking practices are known to vary by socioeconomic status (McCombie, 1996), so it is likely that migrant individuals with lower incomes will be less likely to be treated with effective ACTs than other migrant groups.

**DISCUSSION**

The calculations performed for migrant ICR in this section have relied upon data on travelers entering Zanzibar by ferry. While it is reasonable to assume that air passengers contribute little to importation risk, it is possible that informal traffic, including traders moving between the mainland and islands on small boats, could present a significant risk. Little information is available on this informal traffic but assuming that these informal travelers have a similar mobile phone use profile compared to the general population, the mobile phone analyses likely incorporate informal travel.

Assuming that returning Zanzibar residents represent half of all travelers to the island, and that visitors from the mainland have similar travel patterns (evidence from the mobile phone data suggests that this may be true), estimates from the mobile phone data analyses provide a likely range of 2-24 infections per 1000 inhabitants per year. However, actual importation risk will likely be towards the lower end of this range due to many individuals not spending sustained time on the islands, not traveling to areas of high transmission risk (urban areas), or not coming into contact with vectors. Moreover, residents traveling to the mainland may sleep under a net. For the modeling components below, we thus estimate importation to range from 2-8 infections per 1000 inhabitants per year. However, improved information on all these factors will be essential to designing an effective program to prevent reintroduction of malaria following elimination. In particular, data must be collected on:

- How many individuals travel to Zanzibar by ferry or informal boats (including visitors and returning residents)?
- Where do these travelers originate?
- Where is their destination in Zanzibar?
- How long are they likely to stay there?
- What is their socioeconomic status and lodging while on the islands?
A series of standardized surveys at different times of the year could easily be used to collect this information. Surveys might be conducted on board the ferries during the trip from the mainland, although sampling strategies will need to be evaluated to ensure a representative cross-section of passengers are interviewed. Informal boat traffic passes through a few known hubs in Zanzibar, and similar surveys could be conducted in these areas. It would also be very useful to ascertain the prevalence of infection in individuals traveling by ferry or informal boat using RDTs. However, in the absence of this information, infection prevalence can be estimated as long as travelers’ origins are known. Data over all months of a year from all mobile phone providers on the mainland and Zanzibar (and surrounding countries) would also provide a much more representative sample of movement patterns to and from Zanzibar, enabling more sophisticated analyses and robust conclusions to be drawn.

This analysis also emphasizes how Zanzibar’s prospects of malaria elimination will be highly related to progress with malaria control on the mainland. Importation risk will change in concert with malaria transmission intensity on the mainland. If strong control measures are put into place, prevalence of infection will decrease and will lead to fewer infected travelers to Zanzibar. Figure 7 displays an estimate of migrant-based ICR by mainland district. Improving coverage by control measures in those districts with high ICR will have a very large effect on decreasing the number of infected individuals entering Zanzibar, improving the long-term outlook for Zanzibar’s ability to reach and maintain malaria-free status.

CAN ELIMINATION BE ACHIEVED?

The previous sections have detailed the calculation of transmission and importation risk in Zanzibar. Together, these two measures indicate the amount of malaria parasites being transported to the islands and the amount they will spread among them given a particular level of interventions. In this section and the one that follows, we use these estimates of the malarialigenic potential as inputs into mathematical transmission models to predict the potential for reaching and staying at elimination. These models are simplified representations of the world, but they provide the best understanding of the potential and risks of malaria elimination on Zanzibar under different scenarios.

MODELING MALARIA IN ZANZIBAR

The potential for Zanzibar to eliminate malaria was evaluated using a published malaria transmission model (Smith and Hay, 2009). The model incorporates a number of complexities that make it more realistic than the models that were used for planning during the GMEP. For example, classical mathematical models assume that mosquitoes bite all individuals equally, but in this model it is more realistically assumed that some individuals are bitten more often than others. The model also incorporates important concepts like immunity and superinfection, the ability of individuals to harbor multiple infections at the same time. For more specifics of the model, see the appendix in this report or details in the publications in the literature.

An additional model was used in conjunction with the transmission model to estimate the effect of different levels of ITNs or IRS (Smith et al., 2009). This secondary model is based on the mosquito feeding cycle; it describes changes in the vectorial capacity, or the mosquito-related aspects of $R_0$ and $R_C$ (Garrett-Jones, 1964) that are related to ITN use. The effect of ITNs depends on the proportion of the whole community that owns and uses a net, called the effective coverage (Le Menach et al., 2007). Increased ITN use lowers the vectorial capacity and therefore reduces $R_C$. This lower transmission risk then feeds back into the malaria transmission model. In this way, the impact of ITN coverage on overall malaria incidence and the potential to get to and remain at zero can be examined.

For Zanzibar, current control measures include both ITNs and IRS. There is currently insufficient evidence to effectively distinguish between the effects of the two interventions or to determine their interaction when employed simultaneously. As such, we make an assumption that the model can treat the protection offered by having a house sprayed with IRS in the same way as the protection offered by sleeping under an ITN. For example, the model assumes that there is no difference between having 60% of the population protected by IRS and 60% sleeping under ITNs. The model should be updated once more evidence is available on this issue.

MODEL RESULTS

The results of these models indicate that elimination is possible with current control tools, but that it is dependent on maintaining high levels of effective coverage with ITNs and/or IRS. The rate at which malaria is decreasing (or increasing) in Zanzibar varies with $R_C$, and thus with the amount of control. If control measures are sufficient to keep $R_C$ less than one (meaning that each case of malaria generates fewer than one additional cases), malaria will eventually go to zero. If control measures are not high enough to keep $R_C$ at or below one (meaning that each case of malaria generates more than one additional cases), malaria will increase.

Using the model, it is possible to estimate the coverage of LLINs or IRS that equates to different values of $R_C$ in Zanzibar. We estimate that achieving the “tipping point” $R_C$ value of one should require, conservatively, coverage of about 60% of the population. It should be noted that considerable uncertainty surrounds this estimate because of the lack of detailed data on parasite prevalence over time, the heterogeneity in current transmission levels across Zanzibar, and the need to parameterize the model with values from studies conducted elsewhere. There is, however, an easy test. Surveillance of net usage, IRS coverage, and PfPR over time will provide the evidence to evaluate whether these levels are high enough to sustain elimination. This threshold means that achieving effective coverage of bednets and/or IRS for more than 60% of the population will likely result in decreases in transmission and, eventually, elimination, while lower effective coverage will mean that malaria will increase. The further the actual coverage level (and therefore $R_C$) is above or below this threshold will determine the speed with which elimination is
achieved or malaria resurges. Once effective coverage of greater than 60% of the population is reached, further increases in coverage will reduce the time required to reach elimination.

Using the model, we can estimate the time required to reach zero malaria and the predicted paths in Zanzibar under three different levels of effective coverage (Figure 15, see also Smith and Hay, 2009). The blue line illustrates a scenario in which every single individual in Zanzibar is completely protected from mosquito bites—a “best case” that is extremely unlikely. If such universal protection could hypothetically be achieved, $R_C$ would equal 0, which means that each case of malaria would produce zero additional cases.

In other words, there would be no ongoing transmission in the islands. This perfect coverage would produce the fastest path to achieve elimination. In such a scenario, the expected number of infected people would decline by approximately 84% each year; optimistically, fewer than 10 endemic cases would remain in Unguja after three years, and fewer than 10 endemic cases would remain in Pemba after four years. As such, even the “best case” scenario indicates that Zanzibar will not succeed in eliminating malaria immediately.

**FIGURE 15: EXPECTED TIME TO ACHIEVE ELIMINATION UNDER THREE CONTROL SCENARIOS**

![Diagram showing expected time to achieve elimination under three control scenarios]

In reality, effective coverage is not at 100% and is unlikely ever to reach it (100% effective coverage would mean that every single individual was protected by interventions like nets or IRS, and that the protection conferred by those interventions was absolute). Figure 15 also depicts two scenarios in which partial effective coverage is attained. The red line depicts the rate at which Zanzibar would eliminate malaria if $R_C=0.5$, a transmission level achievable if effective coverage of approximately 75% is achieved. Under this situation, elimination could be attained by around 2020. Finally, the green line depicts a scenario in which effective coverage is only around 65%; such coverage leads to $R_C$ of about 0.75 and elimination only after two decades. Effective coverage levels lower than 65% will be insufficient if Zanzibar chooses to attempt elimination.

These same models can also be used to evaluate the number of malaria cases that would occur in Zanzibar due to onward transmission from inevitable imported cases. To illustrate how these additional infections would affect the above estimates of elimination feasibility, it is worth considering the following example. Suppose 30,000 Zanzibar citizens return to Zanzibar each month from trips to the mainland and that 1% of them acquire malaria abroad. At this rate, approximately 300 cases from onward transmission, for a total of 5,400 new malaria cases each year. Thus, according to the most recent ZMCP survey, Zanzibar has achieved high levels of net use by children under five and pregnant women (74% and 73% in 2007, respectively). In comparison, roughly 60% of the general population reported sleeping under a treated net. In addition, IRS campaigns are reaching even higher proportions of the population. Of houses visited for the survey, 95.4% had been sprayed with insecticide during the previous six months. Although data on the overlap between the population using nets and receiving IRS is not presently available, the combination of these two control activities may result in higher overall effective coverage.

If such high IRS coverage levels can be maintained, and if they can remain effective, these exceptional levels of coverage could put Zanzibar on a course to follow a trajectory more similar to the red or blue curves in Figure 10 than the slow green one, and elimination could be achieved within the next decade. However, without the coverage by IRS, effective coverage would revert to the approximately 60% general coverage by ITNs. As discussed above, 60% coverage probably equates to an $R_C$ value of close to one; as such, elimination will not be achieved at these levels.

Because the model does not discriminate at present between nets and spraying, the outputs described here indicate that the higher IRS coverage renders the lower net coverage irrelevant. It would be a mistake to conclude from this apparent redundancy that bed nets could be scaled back as long as IRS is maintained. For one thing, development of resistance or behavioral change in mosquitoes could greatly reduce the effective coverage by IRS. Without the additional protection of nets, loss of effective coverage due to resistance to IRS would result in a high $R_C$ and subsequent risk of a rapid resurgence in transmission.

Additionally, there is considerable heterogeneity in both malaria risk and intervention coverage on Zanzibar that must be considered when examining the potential for elimination.
(Figure 15). The previously reported statistics for IRS and LLIN coverage mask the variability in these measures across the islands. Looking at individual districts, ITN coverage ranges from a high of 82% in Mkoani down to only 44% in North B. Two of the three districts with prevalence greater than 1% in the last ZMCP survey also reported less than 60% of the population sleeping under treated nets (Wete with 54% and Micheweni with 49%). These districts are at high risk of reversing the gains made against malaria if high IRS coverage is not maintained to compensate for the low net coverage. More specific modeling using shehia-specific prevalence information will result in more precise estimates.

**Box 2: Primaquine**

ACTs and other first line malaria drugs kill the asexual blood-stage parasites that cause fever and chronic infections but they leave the mature gametocytes, the sexual stages of the parasite that are infectious to mosquitoes. Patients treated with ACTs can therefore still transmit malaria (Reeder et al., 2009). In some situations, first-line treatment alone, even if high fractions of new infections are detected and treated, might not be sufficient to achieve elimination necessitating additional treatment with primaquine to cure gametocyte infections.

Primaquine has been used safely and effectively in thousands of patients, but it should be used with great caution because there is a risk of hemolysis in persons with the genetic defect glucose-6-phosphate dehydrogenase (G6PD) deficiency (Capellini and Fiorelli, 2008). Symptoms are rare in those with modest G6PD deficiency but in those with severe deficiencies there is a risk of major hemolytic episodes that can on occasion lead to severe anemia and acute renal failure (Reeve et al., 1992). All individuals who are treated with primaquine should therefore be tested for G6PD deficiency first, and since it is not possible to test a fetus, pregnant women should not be treated at all.

Primaquine’s main benefit is that it kills mature gametocytes but the drug has a very short half-life and is cleared from the bloodstream after a few days. Gametocytes on the other hand take about 8 days to mature, and effect of primaquine on maturing gametocytes is not known. Primaquine given at the time of treatment might therefore not kill mature gametocytes unless it is given about 7 days after the clinical episode of malaria. To be effective, primaquine might require a follow-up treatment 7 days after the primary episode.

We recommend that Zanzibar considers adding G6PD testing + primaquine on a 7-day follow-up visit to their outbreak response regimen and to reduce malaria transmission in residual transmission foci in the end phases of malaria elimination.

It should be noted that the picture of malaria in Zanzibar is more complicated than illustrated in these relatively simple models. The model outputs described here assume a closed system—that is, they do not yet take into account the number of imported cases occurring each year. The initial estimates described above suggest that there are a considerable, although still unknown, number of parasitaemic individuals traveling to the islands. Inclusion of these cases could substantially increase the time required to reach elimination. As such, it is clear that a robust surveillance system will be essential to promptly identifying imported cases, treating them, and sustaining elimination in the current environment. If imported cases are identified and treated promptly, before they can lead to infected mosquitoes, they will not affect the overall malaria risk in Zanzibar. In the absence of such a system or a dramatic natural decline in imported infections (e.g., due to control measures on the mainland), it will not be possible to achieve elimination.

In summary, mathematical modeling indicates that malaria elimination in Zanzibar is feasible given the currently existing tools. However, achieving it will require maintaining high effective coverage of the vector control interventions across the island. At present, coverage by bed nets alone is too low to achieve elimination. Coverage by IRS is quite high at present, and the redundancy of coverage by both interventions provides a safety net. However, the expense of maintaining both interventions over the next decade may be prohibitive, and IRS can be discontinued if ITNs are scaled-up to a high proportion of the population, ideally universal coverage with > 80% usage. Finally, given the constant risk of importation, a strong surveillance system must be developed.

**CAN ELIMINATION BE SUSTAINED?**

Elimination will not mean the end of malaria in Zanzibar. As detailed in the section on importation risk above, infected individuals will continue traveling into the country, although it is hoped that these numbers will decrease over time as control measures on the mainland succeed in decreasing prevalence there. Mosquitoes will bite some of these individuals, and some measure of transmission will likely result. The WHO defines an “introduced” case as the product of “first-generation local transmission; epidemiologically linked to a proven imported case,” (WHO, 2007) and indicates that both they and second-generation transmission (an imported case leads to infection of an introduced case, which in turn leads to the infection of a second-generation case) may occur even in countries certified as having eliminated malaria:

“Because certification is the recognition of a considerable operational achievement, countries will remain listed as having achieved malaria elimination even if they subsequently suffer a temporary occurrence of local transmission. An indication of the re-establishment of transmission would be the occurrence of three or more introduced and/or indigenous malaria infections linked in space and time to local mosquito-borne transmission in the same geographical focus, for two consecutive years for *P. falciparum*, and for three consecutive years for *P. vivax.*” (WHO, 2007).

The goal of preventing reemergence of malaria following elimination is thus not to prevent every single case of malaria,

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6 A case is defined as a person infected with the malaria parasite whether symptomatic or not.
but rather to create an environment in which any sporadic transmission that does occur is immediately halted.

Uncertainty about the cause of the decline in malaria endemicity in the years leading up to 2003 remains the biggest cause for concern in considering the potential for Zanzibar to have a resurgence of malaria following elimination. If these declines were caused by a drought, a change in weather could bring malaria transmission back to much higher levels. If the declines were caused by development, absent significant socioeconomic shifts, the innate risk of malaria will not change following elimination. In any case, vectors will remain prevalent and able to rapidly restart transmission. At the same time, importation risk will continue as well, with a significant number of infected individuals traveling to the islands. Thus, if control measures are inappropriately relaxed, malaria will resurge. The same model used to predict the time required to reach zero transmission can be used to estimate what will happen in the absence of sufficient levels of IRS/ITN coverage and surveillance.

**FIGURE 16: ESTIMATED RESURGENCE OF MALARIA FOLLOWING RELAXATION OF VECTOR CONTROL MEASURES**

As Figure 16 shows, even modest reductions in IRS or ITN coverage can lead to dramatic resurgence of malaria. As a result, it is imperative that Zanzibar use caution in withdrawing or altering interventions even once transmission has been interrupted. This is further reinforced by the uncertainty associated with these models: changes due to the current $R_0$ and the importation risk, among others, could mean that the risk of resurgence is greater than currently shown.

There are two primary means through which Zanzibar could prevent the re-emergence of malaria following elimination:

- Permanently maintain effective coverage of interventions at a level sufficient to keep $R_c$ below one across all of Zanzibar;
- Improve surveillance and response capacity to the point that all imported cases will be identified and treated before local transmission can occur.

These options are not mutually exclusive, and it may be necessary for Zanzibar to do both in order to prevent reintroduction. The safest course would be both to develop strong surveillance and response capacity to identify cases and treat them rapidly before an opportunity to transmit occurs, as well as maintaining high levels of interventions to make such onwards transmission unlikely. However, the realities of maintaining political will, financial resources, and community engagement present challenges to such a comprehensive malaria control program after malaria is no longer perceived to be a public health threat. As such, a new simulation model was constructed to examine the potential for preventing resurgence of malaria in Zanzibar under different conditions and using different long-term control strategies.

**SIMULATING RESURGENCE RISK POST-ELIMINATION**

Determining the feasibility of preventing resurgence of malaria following elimination required using mathematical models that could test out different control strategies. To do so, we simulated outbreak control in a stochastic, spatial, individual-based simulator in a representative population of around 6,000 individuals living in over 1,000 houses. The time course of each individual infection was determined by simulating infections to determine when a person first displayed symptoms, when the infection became patent, and when mature gametocytes first reached densities high enough to be infectious. The location of new infections was determined by an individual-based description of mosquito movement, and active case detection occurred in the houses that were nearest to the index case. The models were developed in R\(^3\) and are available on request. The simulator allows specification of key parameters of interest, including the importation rate, the fraction of infected individuals who seek treatment at health facilities, and the fraction of individuals protected by protective measures like nets or IRS. Different antimalarial strategies can then be implemented in the simulated community to evaluate their effect on transmission.

The simulator was used to examine the potential for different control strategies to prevent malaria reemergence under different scenarios. A wide range of strategies and scenarios were examined to understand approaches that might be feasible. Here, we describe a few key scenarios that best illustrate requirements for maintaining elimination over many years.

**Simulating Post-elimination with High ITN Coverage**

Reaching zero will require high coverage by nets and/or IRS. In this first scenario, we assume an effective ITN coverage of 75% is maintained following elimination, giving an $R_c$ of about 0.5. We must further define the fraction of infections that are identified and treated at health facilities. This fraction will be affected by:

- The fraction of infected individuals with clinical disease
- The fraction of individuals with clinical disease who seek treatment at health facilities
- The fraction of those seeking treatment who are tested
- The sensitivity of the diagnostic test
- The fraction of those with a positive test that are treated and adhere to treatment

Although detailed information on all of these parameters is not available, it is conservatively estimated that 50% of all infections will be routinely identified in health facilities by the time that elimination is achieved (it is calculated that slightly less than 40% of infections are identified today). Finally, the importation rate is taken from the importation risk calculations presented earlier in this chapter. Because considerable uncertainty surrounds those estimates, two possible importation rates are used here—rates of 2 imported infections per 1000 people/yr and 8 imported infections per 1000 people/yr.

Under these conditions, repeated simulations indicate that sporadic introduced transmission will occur, as will occasional secondary transmission.

**FIGURE 17: LOCAL TRANSMISSION OCCURRING OVER A 40-YEAR SIMULATION RUN WITH IMPORTATION = 2/1000 (TOP) AND 8/1000 (BOTTOM)**

![Graph showing local transmission over a 40-year simulation](image)

If importation is 2/1000, over 80% of transmission is predicted to be composed of introduced (first-generation) cases; about 5% more of local cases would be second generation or higher if importation were 8/1000. Although this rate of local transmission is unlikely to result in large-scale reemergence of malaria, it is more than allowed under the WHO’s definition of no more than three epidemiologically-linked local cases in two successive years.

Maintaining elimination according to this definition would thus require additional intervention. Two potential options are considered here. First, the fraction of cases identified and promptly treated could be increased through better passive case detection or through proactive screening. Second, active case detection teams could be used to follow up identified cases, test family members and neighbors, and actively find other cases before more transmission occurs.

**Passive Case Detection**

Strengthening Zanzibar’s passive surveillance system will need to occur during the years before elimination is achieved, with a system that combines testing of all fever cases in health facilities, prompt, appropriate treatment, and reporting of all malaria cases to a central body. This system, potentially coupled with active case detection in which surveillance officers proactively identify infected individuals, is the first line of defense against reintroduction of malaria following elimination. If nearly all malaria cases can be identified before entering Zanzibar—through border screening, for example—importation risk is effectively cut to zero. More likely, some number of cases will continue to be imported into the country, and surveillance and response capacity must be sufficiently strong to respond to them in a timely fashion. The minimum strength of this system required to maintain an acceptably low level of risk will vary inversely with the population coverage of interventions like IRS and ITNs.

The simulation was run repeatedly at different levels of passive case detection to determine the level at which local transmission could be reliably kept below the threshold defined by the WHO. Results indicate that the percent of cases that must be identified to ensure second generation transmission does not occur in two consecutive years is 70-80%, depending upon importation assumptions.

**FIGURE 18: SIMULATED SECOND GENERATION TRANSMISSION OCCURRING WITH DIFFERENT FRACTIONS OF INFECTIONS IDENTIFIED THROUGH PASSIVE CASE DETECTION**

![Graph showing simulated second generation transmission](image)

The green line indicates predictions for importation = 2/1000 while the blue line is for 8/1000; the dotted line indicates the approximate threshold below which WHO criteria for prevention of reintroduction are met.

Such levels of passive case detection are technically feasible in the timeframe being considered here for elimination. The fraction of individuals promptly taking their febrile children to public health facilities has increased from 8% in 2002 to 22% in 2005 to 32% in 2007. If this rate of increase continues, over 90% of febrile cases might be observed in health facilities by 2020. At
the same time, it is expected that the fraction of infections that are clinically symptomatic will increase as immunity to malaria decreases with transmission. These two trends combined may make it possible to reach the 70-80% requirement estimated here and maintain elimination as long as net coverage is kept in place. Increases of this magnitude will require active strengthening of the health system as discussed in Chapter 2.

**Active Case Detection**

It will take many years before passive surveillance alone can reach the high levels described above. Complementing the passive surveillance system with targeted active surveillance activities will help prevent imported cases from leading to reintroduction of transmission. Active surveillance would likely be most effective if focused on key high-risk areas. At present, it appears that the northern ends of Pemba and central Unguja comprise areas of particularly high risk. However, there may be very specific, identifiable clusters, such as areas around vector breeding sites that will be identified as residual foci during the elimination campaign. Active case detection teams that visit the homes and neighbors of identified cases who have not traveled outside of Zanzibar and who thus, likely represent local transmission may prove to be an efficient means of halting onwards transmission.

As malaria is eliminated, Zanzibar should maintain a GIS database of case locations in order to identify spatial clusters—these locations will indicate where interventions should be particularly focused on the way to elimination, as well as where active case detection might usefully continue following elimination. Such clustering may also suggest key vector habitats that would benefit from environmental management or larviciding, as well as indicate high-risk groups where screening could potentially occur (e.g., “hot-spots” around agricultural areas may signal the need for migrant worker screening). The relative importance of active surveillance is likely to increase over time as overall malaria prevalence continues to approach zero.

In the simulation, we modeled an active case detection (ACD) program in lieu of the previously modeled increases in passive case detection. Simulated ACD teams visited the houses of cases identified through passive surveillance that did not have a history of traveling outside of Zanzibar, testing family members and all neighbors in a defined number of closest houses. The simulation was run repeatedly while varying the number of neighbors visited by the ACD teams but keeping the fraction of infections identified by passive case detection at 50%, to determine the level at which local transmission could be reliably kept below the threshold defined by the WHO (Figure 19). Results indicate that performing ACD on approximately 100 neighboring houses around each identified case appears to be sufficient to prevent reemergence of malaria if no increases in passive case detection are assumed. The required amount of ACD will decrease as passive case detection increases.

![Figure 19: Relationship Between Simulated Onward Transmission and ACD Given 75% Effective ITN Coverage](image-url)

*The green line indicates predictions for importation = 2/1000 while the blue line is for 8/1000; the dotted line indicates the approximate threshold below which WHO criteria for prevention of reintroduction are met.*

**Simulating Post-elimination with No ITN Coverage**

If the $R_C$ for Zanzibar can be maintained permanently below one through sustained use of nets or IRS, malaria will not spread effectively in the islands if it is introduced. However, as described previously, $R_0$ in Zanzibar—the rate that transmission would occur if control measures were stopped—remains quite high. As such, maintaining such a low $R_C$ would require permanently high coverage by interventions like effective ACT treatment, and protection by measures like LLINs or IRS. Over the long term, it will be desirable for both operational and financial reasons for interventions like IRS and LLINs to be scaled back. After malaria is no longer an apparent threat, it may be difficult to convince individuals to continue to use their nets or to allow their homes to be sprayed. Additionally, the ongoing costs of sustaining net distribution or widespread IRS will place considerable financial pressure on the program (see Chapter 3). Finally, long-term use of insecticides will eventually lead to the development of resistance by mosquitoes and parasites.

As long as the innate risk of malaria remains high, however, scaling back safely can only occur if importation risk is minimized and effective surveillance and response capabilities can identify imported cases and prevent them from resulting in local transmission. Other countries that have scaled back these protective measures without adequately considering the risk of importation or ensuring the existence of sufficient surveillance and response capacity have seen severe epidemics cause high mortality and morbidity.

With no nets, it is expected that $R_C$ will increase until it reaches $R_0$. As estimated previously, $R_0$ in Zanzibar is estimated to be...
around 10-15. In this scenario, the lower value of 10 is used. As in the scenario predicting transmission with nets, it is assumed that passive case detection can promptly identify and treat 50% of all infections, and that importation is either 2 or 8 per 1000 people/yr.

Under these conditions, repeated simulations indicate that malaria would rapidly reemerge in Zanzibar unless other interventions or health system strengthening take the place of the nets. In this scenario, we assume that reemergence has occurred when 50 new infections are identified within two weeks. At this threshold, it is assumed that drastic action would be required involving focal IRS, larval control, and other measures. This “failure” point was reached within 9-13 months, depending upon assumptions about importation. Such timing is in line with rapid resurgence observed historically in places with a high $R_0$, including twice previously in Zanzibar. Clearly, additional interventions are required if nets are to be scaled back. As with the nets scenario, simulations were used to estimate the minimum fraction of cases identified and promptly treated through passive case detection or the amount of active case detection that would sustain elimination.

**Passive Case Detection**

The simulation was run repeatedly at different levels of passive case detection to determine the level at which local transmission could be reliably kept below the threshold defined by the WHO. Results indicate that, without nets, the percent of cases that must be identified to ensure second generation transmission does not occur in two consecutive years is 97-98%, depending upon importation assumptions.

Achieving near perfect infection detection and treatment is not technically feasible. Even if 100% of individuals with clinical disease sought treatment at a public health facility, some infections would remain asymptomatic and thus not seek treatment. Additionally, diagnostics in the health facility will always have some error, meaning that some infections will be misdiagnosed.

**Active Case Detection**

Alternatively, active case detection (ACD) could be implemented in lieu of increases in passive case detection (or in addition to smaller increases). The simulation was run repeatedly at different levels of active case detection, keeping the fraction of infections identified by passive case detection at 50%, to determine the level at which local transmission could be reliably kept below the threshold defined by the WHO (Figure 20).

Results indicate that ACD alone is insufficient to prevent reemergence of malaria if no increases in passive case detection are assumed. The required amount of ACD will decrease as passive case detection increases, but at 50% detection, nearly every house in the region must be investigated following each case to maintain elimination.

**Combined Interventions**

Increasing both passive and active case detection may result in making it technically feasible to withdraw net coverage while still maintaining elimination. Additionally, it may be possible to decrease importation through border screening. Mainland Tanzania is currently engaging in a massive effort to scale-up ITN and ACT coverage around the country, which may also decrease importation rates.

The fraction of cases that can be identified by passive case detection is a function of the percent of infections that cause clinical disease, the percent of febrile individuals that seek treatment in the public sector, and the fraction of those at public facilities that are tested and treated for malaria. It may be possible for Zanzibar to increase the fraction of febrile individuals seeking treatment in public health facilities greatly over the course of the decade; as discussed above, the current rate of increase in the fraction of parents taking febrile children to public health facilities could reach 90% by 2020. The fraction of infections that have clinical disease will increase as malaria become rarer; we assume that 90% of infections will be clinically apparent in 10 years time. Finally, it is assumed that all fevers are tested and treated accordingly, but that achieving greater than 95% sensitivity in diagnosis is not possible. As such, under these assumptions, passive case detection would identify 90% x 90% x 95% = 77% of infections in Zanzibar.

The estimates of importation used here of 2 or 8 per 1000 people/yr may also be reduced over time using border screening or due to reductions in transmission on the mainland. If border screening can test 90% of individuals entering Zanzibar with a 90% accurate
Using these estimates of technically feasible increases in passive detection and decreases in importation, the simulator was run multiple times to identify the amount of active case detection required to maintain elimination.

**FIGURE 21: RELATIONSHIP BETWEEN SIMULATED ONWARD TRANSMISSION AND ACD GIVEN 0% EFFECTIVE ITN COVERAGE AND REDUCED IMPORTATION**

![Graph showing the relationship between onward transmission and active case detection](image)

The green line indicates predictions for importation = 0.4/1000 while the blue line is for 1.6/1000; the dotted line indicates the approximate threshold below which WHO criteria for prevention of reintroduction are met.

Figure 21 demonstrates that at the low range of importation, 0.4/1000, active case detection of about 100 neighboring houses surrounding each case will be necessary to maintain elimination. However, at 1.6/1000, active case detection does not appear to be a viable means of preventing second generation transmission. While ACD appears to have very large effects on decreasing transmission in such a scenario, sporadic transmission remains. As in previous scenarios, even small changes in importation appear to have large ramifications for Zanzibar’s ability to maintain elimination.

These results indicate that it is very likely that local transmission of malaria will occasionally occur on Zanzibar following elimination. Even countries such as the United States (Filler et al., 2006) and Belgium (Peleman et al., 2000) continue to face occasional local transmission due to importation of cases or infected mosquitoes. Zanzibar therefore must be prepared to rapidly respond to and contain any malaria outbreaks before they spread into generalized epidemics. Response teams will need to be created and trained to be deployable whenever a new malaria case and/or renewed local transmission is identified.

Focusing on improving surveillance and response capacity has at least two potential advantages over infinitely maintaining high levels of personal protection. First, it has the potential to be less expensive compared to sustained control (see Chapter 3) since it obviates the need to continually distribute/replace nets or spray houses. Second, these efforts will contribute towards the strength of the overall public health system, not just malaria control; for example the surveillance infrastructure that will be required for malaria reporting will also allow the monitoring of other diseases as well, while the trained response teams will be able to focus on other types of outbreaks during periods in which no malaria is present. For the foreseeable future, however, Zanzibar should be prepared to emphasize both surveillance/response and coverage by interventions including ACTs and ITNs/IRS.

**RECOMMENDATIONS**

Mathematical models predict that Zanzibar can achieve elimination if it maintains high levels of its current control activities. Given current scale-up plans, it may be possible to eliminate malaria within the decade, but it is essential that scale-up occurs in all districts and that other preventative measures—notably IRS—protect the population until high effective levels of net use are ensured. Once surveys confirm that net usage is greater than 80% in the general population, it is likely that measures like IRS can safely be scaled back without jeopardizing the chance for continued progress against malaria.

We estimate that, given the lead times for grant signing and procurement, universal coverage with ITNs will not be achieved in all districts before the end of 2010. We therefore recommend continuing blanket IRS at least for the next 2 years. Given the heterogeneity in net coverage today and initial indications that certain areas have a higher transmission potential, it is highly likely that IRS will need to continue in targeted areas after this for an additional 2 years. Survey data on ITN use and the Malaria Early Epidemic Detection System (MEEDS) data can direct the decision to scale back spraying in these high risk areas.

**Surveillance activities must be strengthened.** It is not necessary for Zanzibar to wait until its surveillance system is “perfect” before engaging in elimination activities, but strengthening of surveillance should be emphasized at the same time that nets are being scaled up if Zanzibar is to achieve elimination in a sustainable way. Mathematical models indicate the importance of both passive and active surveillance in identifying cases promptly. Given Zanzibar’s high innate level of risk of malaria, withdrawing control measures like IRS and ITNs after elimination will only be possible if capacity to rapidly identify cases, swiftly treat them, and prevent local transmission has been developed.

Zanzibar should plan to maintain universal ITN coverage until it can confirm reductions in malaria importation and improvements in surveillance. Once malaria elimination is achieved, the high innate level of malaria means that control activities such as nets and IRS can only be relaxed if passive detection rates are greatly increased and importation risk greatly reduced. Extensive active case detection will also have a substantial effect, but preventing reintroduction will prove extremely challenging without some ongoing prevention activities. Creation of a very strong response capacity in the form of deployable teams will act as a final safety net necessary before reductions in control activities can safely occur. The strengthening of surveillance activities and enhancement of
response capabilities will permit better control of malaria even if Zanzibar decides not to attempt elimination.

The rate at which malaria is imported into Zanzibar is a crucial factor about which too little is known. Given the high uncertainty surrounding the level of importation risk and the importance of this measure for confident prediction of the operational requirements to ensure sustainable elimination, we strongly recommend that Zanzibar begin a series of rigorous surveys to identify the rate with which parasites are traveling to the islands. Additionally, Zanzibar should develop a careful plan for how it will prevent the reintroduction of malaria transmission before embarking on an elimination program.

Continue to collect data and conduct surveys to improve the precision of models and their predictions and to monitor progress. The recommendations made here are based upon relatively simple mathematical models that are generalized representations of the real world. They are also dependent upon the available data, which is at times limited and/or outdated. As such, an important next step in considering and planning a potential elimination program will be for Zanzibar to collect additional data in a number of key areas.

These include:

- Immigration and migration patterns
  - Importance of informal traffic and ferries for bringing travelers to Zanzibar and returning potentially infected Zanzibar residents to the islands;
  - Prevalence of infection in travelers arriving in each case;
  - Travel patterns—where travelers go in Zanzibar and how long they stay; where and for how long residents of Zanzibar go on the mainland.

- More detailed prevalence data
  - Surveys conducted at the shehia level will permit identification of particularly high risk areas and will inform more specific modeling;
  - Within high risk areas, spatial analyses should be used to identify focal areas of transmission.

- Incidence data from all health facilities
  - Expanding MEEDS collection to all facilities will permit creation of a complete database of incidence in Zanzibar;
  - Using this information, algorithms can be developed to identify unusual spatiotemporal clustering of malaria and trigger outbreak response.
CHAPTER 2: OPERATIONAL FEASIBILITY

INTRODUCTION

Historically, operational feasibility has been described in terms of administrative and practical feasibility. Administrative feasibility was defined as “the possibility to create a national organization that can carry out a malaria elimination program with a strong long-term governmental commitment, a conducive legal environment for malaria elimination control activities especially spraying and surveillance, and the availability of sufficient funds.” Practical feasibility meant “country wide access for personnel and materials, sufficient human resources for the malaria control program and the health facilities, and cooperation of the general public” (Pampagna, 1969). Financial feasibility is discussed in Chapter 3, and here we focus on requirements related to the implementation of the activities recommended in the previous chapter to achieve and maintain elimination.

The operational feasibility component of this assessment mainly focuses on whether the interventions needed to achieve and sustain elimination can be implemented given the capacity of the national malaria program and the health system. The main recommendations from the technical feasibility chapter—continued high levels of prevention coverage, building up a robust surveillance system, creating an efficient rapid response team, and the testing of (ideally) all fever cases—are the backbone of this chapter. This chapter describes these aspects in detail and provides recommendations for strengthening of the surveillance system, strengthening of the health system, moving of the Zanzibar Malaria Control Program (ZMCP) to a Zanzibar Malaria Elimination Program (ZMEP), fostering community involvement, and evaluating the potential legal implications of an elimination program.

One cross-cutting theme is the need for continuous and aggressive communication to the population. People will need to be convinced and reminded that all fever cases must be tested, and everybody needs to comply with the preventive measures necessary to achieve and maintain elimination. In addition, certain activities such as re-active case detection and IRS will require full collaboration from the population. Strong IEC/BCC campaigns are therefore a recurring recommendation throughout the different sections of this chapter. In general, we believe that any future IEC/BCC activity should be based on a strong communication strategy adapted to the prevalent malaria situation and thus regularly reviewed throughout the elimination process.

The operational feasibility of malaria elimination in Zanzibar will ultimately depend on whether the government can or is willing to meet the necessary programmatic requirements and create an enabling environment to facilitate the elimination process (Moonen et al., 2009). The Government of Zanzibar has already shown strong political commitment to move towards elimination. This commitment will need to be translated into solid political support for the Zanzibar Malaria Elimination Program, not only within the Ministry of Health, but also from other ministries and departments such as immigration, education, agriculture, and even the judiciary. The speed required for the execution of the elimination activities will not allow for a protocol heavy decisional process. Strong political leadership from the highest level and an efficient coordination mechanism will empower the ZMEP and facilitate inter-departmental collaboration respectively. We therefore strongly recommend the set-up of a technical advisory committee, ideally appointed and given a mandate by either the Minister of Health or even the President and a National Malaria Elimination Steering Committee, with representation from all relevant ministerial departments and key partners, chaired by the Director General or the Permanent Secretary (see From ZMCP to ZMEP). We propose a technical advisory committee composed of between eight and ten independent international experts, to be invited by the Minister of Health. The committee should meet at least once a year to review the progress of the elimination program and to provide independent technical advice to the ZMCP. The purpose, composition/structure, authority, frequency of meetings/reporting, and budget should be specified in a charter much like the charter for the Advisory council for the elimination of Tuberculosis in the USA (Department of Health and Human Services, 2007).

The success of elimination and the feasibility of its maintenance will also depend on further reduction of the malaria burden in mainland Tanzania (see Chapter 1). The ZMCP should therefore ensure strong links with Tanzania’s National Malaria Control Program (NMCP) with regular information sharing from both sides. Although the technical feasibility working group did not identify specific high-risk countries that are potential import sources of infection, cross-border collaboration might become necessary if further research indicates this might be the case. Imported cases of P. falciparum in Oman, for example, were mainly coming from Zanzibar. A drop in malaria prevalence on the islands means that today almost no cases originate from Zanzibar.

1 The committee could be chaired by the Zanzibar WHO representative and should consist of experts from research institutes from the mainland and other countries. To safeguard its independence, the committee should not have any members related to any of the main donors of the ZMCP.
SURVEILLANCE AND RESPONSE FOR MALARIA ELIMINATION

OVERVIEW AND OBJECTIVES

As discussed in Chapter 1, elimination is fragile, and malaria will definitely surge on Zanzibar if necessary interventions are not put in place and maintained. The most important of those interventions, both for achieving elimination and preventing reintroduction, is a robust surveillance system. If new imported malaria cases and emerging outbreaks are rapidly detected and reported, the program will be able to mount an appropriate response and prevent large-scale resurgence. Without these “eyes and ears,” the program will be largely powerless to stop imported malaria cases from leading to the reestablishment of local transmission and potentially devastating epidemics. Table 1 gives an overview of how surveillance should evolve if Zanzibar pursues an elimination program.

TABLE 1: SURVEILLANCE IN THE DIFFERENT STAGES OF MALARIA CONTROL AND ELIMINATION

<table>
<thead>
<tr>
<th>Goal</th>
<th>Control</th>
<th>Pre-elimination</th>
<th>Elimination</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce morbidity and mortality</td>
<td>Reduce local transmission</td>
<td>Halt local transmission</td>
<td>Halt local transmission</td>
<td>Prevent re-introduction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective</th>
<th>Control</th>
<th>Pre-elimination</th>
<th>Elimination</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce transmission intensity</td>
<td>Reduce onward transmission from existing cases</td>
<td>Reduce onward transmission from imported cases</td>
<td>Reduce onward transmission from imported cases</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>Country</th>
<th>Foci</th>
<th>Foci/case (local and imported)</th>
<th>Case (imported)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveys/Health facility data (monthly)</td>
<td>Sero-prevalence surveys/Case notifications/Active and passive case detection</td>
<td>Sero-prevalence surveys/Active and passive case detection</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Adapted from WHO, 2007)

The surveillance system must be able to rapidly detect, investigate and respond to any (abnormal) increase in the number of malaria cases. The main differences when moving towards elimination are that the surveillance system will not only have to detect symptomatic cases but asymptomatic ones as well and that one single case—not an increase in cases—will require an immediate response. Mapping all identified cases using GIS technology will enable the program to identify and appropriately address potential or new pockets of malaria transmission, also called “foci”. A transmission focus is defined as “a circumscribed locality situated in a currently or formerly malarious area and containing continuous or intermittent epidemiological factors necessary for malaria transmission” (WHO EMRO, 2007). In Zanzibar, a focus could be a village, shehia, town, or district.

A strong surveillance system is also needed to eventually confirm and receive certification for the achievement of elimination (Yekutiel, 1980). However, the WHO only certifies countries, and it is unlikely that Zanzibar, which is part of the United Republic of Tanzania, will be eligible for certification when they have achieved elimination (WHO, 2007).

During control, programs are focused on population-wide interventions and are therefore interested in broad measures of morbidity that can be captured monthly or sometimes even less frequently in a limited geographical area (sentinel sites). An elimination program, however, must eventually be interested in every individual case and needs a system sensitive and efficient enough to detect and report those cases within hours or days throughout the country.

As a program moves to elimination, it must invest heavily in its surveillance system to ensure that it meets the necessary standard of speed and sensitivity. A surveillance system is comprised of three core components:

- **Collection** of case data through active and passive detection methods;
- **Analysis and interpretation** of data including case investigation; and
- **Appropriate response**, including radical treatment and targeting of foci.

When moving towards elimination, it is not only important to detect symptomatic cases to ensure prompt and effective treatment but also to detect cases that do not necessarily present with symptoms, as these can also be a source of onward transmission. The malaria case definition during an elimination program should therefore shift to: “a person in whom, regardless of any symptoms, malaria parasites have been confirmed by quality-controlled laboratory diagnosis” (WHO, 2007). In addition, when the malaria endemicity becomes very low, malaria transmission becomes more heterogeneously distributed with foci erupting in apparently random places. The implication of this new case definition and the heterogeneous behavior of malaria transmission are discussed below.

If Zanzibar wants to eliminate malaria, they will need to progressively strengthen and adapt their current surveillance systems to meet the targets outlined in the table above. With the support of the President’s Malaria Initiative, Zanzibar has recently taken important steps in that direction by improving its passive surveillance system. Much greater effort will be required in this area if the country does pursue elimination. Not only will the current passive surveillance system need to be further improved, but also a complementary active case detection system will have to be created. The specific surveillance methods needed are further described below.
DATA COLLECTION METHODS

A robust surveillance system on Zanzibar will need to incorporate both passive and active approaches to detecting and reporting malaria cases. Passive and active case detection have been defined as follows (Teutsch and Churchill, 2000):

- **Passive case detection**—system where data are routinely received by a central health authority based on a set of rules/laws that require a healthcare provider or health facility to report certain diseases or conditions on an ongoing basis and at specific intervals (weekly, monthly, annually).

- **Active case detection**—system where data are regularly pursued by a central health authority at periodic intervals, often with the intent to validate the representativeness of a passive surveillance system. An active surveillance system will likely provide more complete reporting, and can identify asymptomatic individuals, but it is more labor-intensive and thus more costly to operate as compared to passive case detection.

There is relatively little central guidance on both of these approaches for malaria elimination. This lack exists because they are highly context-dependent and must be adapted to each country and area.

**Passive Case Detection (PCD)**

A strong passive case detection system is the cornerstone of any approach to surveillance—if new malaria cases identified at health facilities are not being adequately reported and followed up, elimination will not be achieved. In Zanzibar, the passive case detection system will have to be substantially improved to ensure that a high proportion of infections are detected (both symptomatic and asymptomatic) and reported to the central level with the required speed (e.g., initially within 24 hours but once at or near zero local transmission as soon as possible). From the results of the simulations described in the Technical Feasibility Chapter we know that as long as preventive measures have an effective coverage of 75%:

- Between 70-80% of infections have to be promptly identified and treated for passive case detection alone to be sufficient to avoid second-generation infections.

- Passive case detection that identifies around 50% of all infections—a detection rate only slightly higher than the present day—will need to be complemented with active case detection that screens about 100 households neighboring each newly identified case.

Achieving the required detection levels is influenced by a range of factors: the fraction of infections that will become symptomatic, the people’s health seeking behavior for fever, testing rates at the facility, and the sensitivity of the test used. The operational requirements for the surveillance system to achieve the above-mentioned detection levels are described below.

In addition, the Zanzibar MOHSW will need to strengthen the central units that record and analyze cases that are reported by increasing human resources, improving skills, and obtaining appropriate technology.

**Current System**

There are currently two systems for passive detection of malaria cases on Zanzibar: the Health Management Information System (HMIS) and a vertical Malaria Early Epidemic Detection System (MEEDS) through sentinel sites (52 sites operational in 2009).

The HMIS is managed by a specific unit in the MOHSW that was established in 2001 and strengthened through funding from DANIDA. The HMIS serves as the primary clinical services monitoring system for the MOHSW and fits within the larger context of health sector M&E efforts in Zanzibar. Data from peripheral facilities are collected by the HMIS focal point at the district level. Aggregated data are compiled at the district level and sent to the HMIS unit in the MOHSW.

Malaria information collected as part of the HMIS is supposed to be reported quarterly through District Health Management Teams (DHMT) and provincial offices. The cases reported are both (parasitological) confirmed and non-confirmed based on clinical diagnosis and therefore include non-malarious fever cases. Although most facilities have diagnostic capacity (RDT and/or microscopy) and the results are supposed to be captured in the laboratory reports, the HMIS is currently not providing this information to the ZMCP. The following indicators are theoretically available through routine HMIS:

- Out Patient Department monthly malaria cases (both confirmed and non-confirmed)

- Laboratory data (total slides, positive films for malaria parasites, hemoglobin tests)

- Malaria and severe anemia admissions and deaths

Unfortunately, the information collected through the HMIS system is not routinely passed on to the different control programs within the MOHSW. The ZMCP therefore decided to collect malaria data for their strategic planning using 6 health facility-based sentinel surveillance sites (HFBS). These sites are part of the normal HMIS and do not report different information as such. The main difference is that the HFBS provide regular, timely, high-quality malaria-related laboratory, morbidity, and mortality data, an important pillar for the ZMCP strategic decision. The MEEDS (see below) now provides these data regularly, and the HFBS will most probably be scaled down and even stopped in the near future.

The second existing malaria surveillance system, malaria early epidemic detection system (MEEDS), is connected to a broader effort by the MOHSW to strengthen infectious disease surveillance. It is funded by PMI and uses mobile phone technology to provide weekly malaria data to a central server where they are automatically analyzed. It provides aggregate data (for under fives and over fives) on total number of patients seen at the facility, total numbers tested and numbers testing positive. The MEEDS is so far the only operational component of the planned Integrated Diseases Surveillance and Response (IDS) system that aims at providing health workers with additional epidemiological information on key diseases to assist in decision-making on and implementation of interventions. As the MEEDS
progresses, it is envisaged that the IDS will adopt a similar system and technology to collect data on other diseases.

**Strengthening for Elimination**

While the MEEDS provides a strong foundation for elimination surveillance, we recommend a number of additional important actions to strengthen HMIS to the necessary level.

Over time, the HMIS will need to be improved to contribute to the surveillance targets described above. This improvement will be closely connected with overall strengthening of the health system described below, but there are also specific steps related to the capturing and recording of malaria data that must be taken. These include:

- **Health facilities, including private clinics, should over time only report (parasitological) confirmed cases.**
- **Laboratory data should not only capture the number of tests done and their result but should also record the number of fever cases to enable calculation of the testing rate (number of slides/RDTs divided by the number of fever cases), an important indicator for the evaluation of health care workers efforts in terms of case detection.**
- **Malaria and severe anemia admissions will be less important to record as such, especially in the long run. Initially, the proportion (not the number) of severe cases might go up and the age profile might shift towards more adults, but eventually all cases should be detected before severe cases occur.**

In addition, the necessary efforts will need to be made to ensure that the data collected reach the HMIS in a timely manner. Monthly health facility and laboratory data from the HMIS can be used to cross check data received through the MEEDS. Our assessment did not include a thorough review of the HMIS system and more practical recommendation to strengthen the HMIS are therefore not within the scope of this report. With the MEEDS system soon covering most public health facilities, the weakness of the HMIS should not stand in the way of moving towards malaria elimination.

Ideally, the MEEDS would be incorporated into the HMIS to minimize parallel systems. However, given the critical role of the MEEDS in malaria elimination and the ongoing evolution of the HMIS, we recommend keeping the MEEDS as a separate system until the HMIS is deemed strong enough and/or elimination has been achieved. When such integration does occur, it will be critical to ensure that it is done carefully so that there is no disruption and that the important attributes of the MEEDS are not lost in the process.

If Zanzibar does pursue an elimination target, we recommend gradually expanding the MEEDS system to include all health facilities, including private facilities that will be allowed to provide malaria treatment. This will ensure that all cases observed at facilities are rapidly reported as well as incorporated into the slower HMIS reports. As the elimination program progresses, health workers should be encouraged to use the MEEDS cell phone system to immediately notify a case once it is detected rather than waiting for weekly reporting. In a setting with little or no transmission, one case can spark an epidemic or represent an outbreak already underway and must be followed up as rapidly as possible. Lastly, we recommend exploring the possibility of geo-locating detected malaria cases/carriers. There is currently a proposal to develop a composite database including all the structures already geo-located by the Ministry of Land as well as the household database collected by ZMCP for IRS. Once this occurs, it may be possible to geo-locate all malaria positive cases reported by health facilities, which will facilitate identification of transmission foci and appropriate response by the program.

The operational requirements to scale up the MEEDS in terms of staffing, diagnostic capacity and, more in general, guaranteed access to care are discussed in the health systems strengthening section of this chapter. Before the end of 2009, all public health facilities will be part of the MEEDS (Fabrizio Molteni, personal communication), and the necessary training and equipment are covered with PMI funding. Future operating costs are discussed in Chapter 3.

**Active Case Detection (ACD)**

Given the relatively high importation risk (estimated at 2-8/1000 inhabitants/year), even with a strong passive detection system, secondary infections will be common and it is likely that many malaria cases may go unnoticed. Patients may choose not to seek treatment at a formal facility and some parasite carriers will not present with symptoms. In an elimination program, these cases represent a significant threat of resurgence (especially when prevention will be scaled down) and must be addressed. The principle means of doing so is active case detection (ACD). Many different ACD approaches have been used, but there is little evidence on the comparative benefits and disadvantages of each (Macaulay, 2005). As such, it is important for Zanzibar to carefully develop the ACD approach that seems to best fit its conditions and then consistently evaluate and revisit that approach. ACD methods can be described in 2 broad categories: re-active case detection and pro-active case detection. The reaction triggered by the detection of a case through these systems is discussed under the analysis and response section of this chapter.

**Re-Active Case Detection (RACD)**

This approach is triggered by the detection of a confirmed case through the passive system (e.g., MEEDS), with surveillance officers following up the case and screening family members and/or surrounding households to determine if it represents broader transmission. Our simulations indicate that once elimination is achieved, under a scenario where preventive measures are maintained and PCD detects > 70% of infections, RACD might not be necessary. However, if PCD only detects around 50% of all infections, approximately 100 households will need to be screened for each case detected (both passively and through the screening) even when nets and/or IRS coverage is > 75%. The operational feasibility of RACD thus depends on the number of cases detected and the level of passive case detection achieved. However, screening 100 households is the threshold needed to meet the WHO definition of elimination and is as such the upper limit required. Screening 50 houses would already avoid...
most secondary cases but would occasionally lead to a small outbreak. We calculated the operational requirements for 100 households to be screened as any number lower than 100 can then be considered to be within an operationally feasible range. The operational requirements can be calculated as illustrated in Table 2.

**TABLE 2: OPERATIONAL REQUIREMENTS FOR RACD FOR DIFFERENT LEVELS OF IMPORTATION RISK ONCE ELIMINATION IS ACHIEVED (ESTIMATES BASED ON 2020 POPULATION EXTRAPOLATIONS)**

<table>
<thead>
<tr>
<th># Cases detected (PCD + ACD)</th>
<th>2/1000/year (prevention at &gt;75% effective coverage)</th>
<th>8/1000/year (prevention at &gt;75% effective coverage)</th>
</tr>
</thead>
<tbody>
<tr>
<td># Households to be screened (100/detected case)</td>
<td>1.6 per 1000 people per year 2,781 cases</td>
<td>7.35 per 1000 people 12,759 cases</td>
</tr>
<tr>
<td># HH/district/month (if to be screened / 01 district/ 12 months)</td>
<td>278,089</td>
<td>1,275,879</td>
</tr>
<tr>
<td>Estimated number of teams per district</td>
<td>2.317</td>
<td>10,632</td>
</tr>
</tbody>
</table>

The estimates from Table 2 assume that only 50% of infections are detected by the PCD system and the rest through RACD. It is safe to assume that by 2020 PCD should be able to pick up a higher proportion of infections thus reducing the proportion RACD needs to pick up, making the estimates in the table very conservative. Nevertheless, at lower ends of importation risk, RACD will be challenging but seems operationally feasible even if PCD only detects 50% of all infections.

If preventive measures would be scaled back completely, PCD complemented by RACD alone cannot avoid outbreaks unless the importation risk is significantly reduced. This can only be achieved through pro-active case detection methods such as border screening or screening of high-risk groups (see below).

Given the encouraging results from the simulations, we recommend that Zanzibar begin developing and implementing RACD early in their elimination program. As discussed below and in the section “From ZMCP to ZMEP,” this will require additional human resources both at the central and the district level, the necessary diagnostics tests for screening (RDTs), and standardized reporting tools and systems. As discussed in detail below, the area to be screening will depend on whether the initial investigation suggests that the identified case is most likely a locally acquired infection (no travel history) or an imported case (recent travel to a malaria endemic country/region).

**Pro-Active Case Detection (PACD)**

Pro-active case detection is the screening of an area or group of people considered to be at high risk for malaria transmission, even if no cases have been identified recently. This screening can be done either continuously or during certain high-risk seasons (defined by the malaria transmission and/or human migration patterns). Potential groups/areas targeted by this approach might include:

- Areas with a high entomological inoculation rate (EIR) and a high population density;
- Seasonal migrant workers;
- Travelers from (high) endemic areas (border screening).

The surveillance simulation indicates that prevention can be scaled back if PCD detects 77% of all infections, RACD screens around 100 households around every case detected, and a combination of malaria control on the mainland and PACD lowers the importation risk dramatically (see Table 3).

**TABLE 3: REQUIREMENTS FOR PCD, RACD AND PACD TO AVOID RESURGENCE WHEN PREVENTION (IRS/LLIN) IS SCALED-BACK**

<table>
<thead>
<tr>
<th>Passive Case Detection</th>
<th>Pro-Active Case Detection</th>
<th>Re-Active Case Detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>90% of infections become symptomatic</td>
<td>90% of all febrile cases seek medical care</td>
<td>Importation risk reduced from 2/1000/year to 1/1000 per year through control measures on the mainland</td>
</tr>
<tr>
<td>The diagnostic test used has sensitivity of 95%</td>
<td>Testing and treatment rates at 100%</td>
<td>Border screening and screening of high risk groups detects and treats 60% of imported cases</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>77% of all infections detected and treated</th>
<th>Importation risk at 0.4/1000/year</th>
<th>With a maximum capacity of 20 HH/day for 24 days/month; 2 teams per district are sufficient</th>
</tr>
</thead>
</table>

Although the estimates for RACD might seem operationally feasible, achieving 77% passive case detection rates and importation risk of 0.4/1000/year will be extremely challenging and will depend on what will can be achieved on the mainland. We are therefore not in a position to make concrete recommendation on PACD. Operational research needed to define high-risk areas/groups is discussed in the Technical Feasibility Chapter. In the short-term, PACD is therefore not yet recommended.

**ANALYSIS AND RESPONSE**

The surveillance system is only as useful as the response it elicits. As described above, strong surveillance enables the program to identify and target its interventions at residual and potential foci. To do so, the program must first understand and interpret the often complex data gathered by the system. This is done through:

- Epidemiological analysis of the data gathered by the MEEDS, from case investigations and re-active case detection (screening) around the index case;
- Analysis of entomological data collected from targeted areas (see below); and
- Geo-statistical analysis using geo-referenced data on malaria cases, vector breeding sites, remotely sensed data and climate/meteorological data.

The results of the analysis not only define the required response, but also allow for the identification of high-risk areas. Such identification can permit preemptive action directed at potential
transmission foci, allow targeting of screening to high-risk populations, and direct the scaling up or relaxation of surveillance measures under the algorithm proposed below.

**Existing Protocol**

The recently drafted M&E plan and Early Epidemic Detection and Response Plan (ZMCP, 2008) describe in detail the response triggered by an (abnormal) increase in cases. The protocol focuses on epidemic response rather than epidemic prevention. It has 3 main components:

- Confirmation of the existence of the suspected epidemic
- Provision of relief to the affected population
- Defining the extent of transmission and containment (prevention of onward transmission to other areas)

Although the ZMCP (in collaboration with partners) recently reacted to an outbreak in the Bambwini area, the necessary resources (human, transport, consumables) are not in place to ensure a rapid response by the ZMCP without having to count on emergency contributions from partners. In the short-term, the ZMCP will need to ensure financing for their outbreak response team and set-up the necessary structures to enable a quick and effective reaction following the protocol outlined in the M&E and Early Epidemic Detection and Response Plan.

This protocol, adapted to the current malaria epidemiological context, will need to be fine-tuned when the program moves from control to (pre)elimination and maintenance.

**Rapid Response Protocol for Elimination**

We propose a protocol with different levels of vigilance in a limited geographical area depending on suspected or demonstrated ongoing transmission (see Figure 15). The different activities described in the proposed algorithm are still based on the same rationale—confirmation, treatment, prevention—but with a more sensitive trigger mechanism and a more cautious approach in terms of further investigation and response.

In the MEEDS health facilities, weekly malaria cases are currently plotted into a chart with individual scale and threshold. A situation of epidemiological alert is reported when the plotted cases are over the threshold for two consecutive weeks. This time delay (and number of cases) is unacceptable when elimination has been achieved. The threshold will therefore need to change over time when cases become extremely rare. As elimination is approached, one case will constitute an outbreak and every time a case is identified the response described below will need to take place as rapidly as possible.

**Level 0**

Level 0 is the baseline with normal levels of vigilance. All fever cases that present at the health facility (public or private) have to be tested with an RDT (and where possible, with microscopy). This passive case detection system has to detect a minimum of 50% of all infections but ideally > 75%. This will require additional activities to influence health-seeking behavior (IEC/BCC) as described below. One positive RDT/Slide should trigger an immediate reaction that consists of the following actions:

If the case is confirmed, investigate (using a standardized case investigation form; SOP to be established) to determine if most probably locally acquired (no travel history) or imported (history of recent travel to malaria endemic country/region). Depending on the results of the initial investigation, move to level 1 or 2.

**Level 1**

When an imported case has been detected by the passive case detection and no other cases have been seen in the catchment area of the health facility nearest to the home of the index case, no further re-active case detection is required. However, the case investigation team will need to follow up the case to ensure that:

- The patient adheres to the given treatment;
- Family members of the same household receive an LLIN for personal protection; and
- The traveler is briefed on how to protect him/herself against malaria when traveling to a malaria endemic country.

**Level 2**

When the initial investigation suggests that the case might be locally acquired, the response, both in terms of further investigation and prevention of onward transmission, will need to be more robust than when a case is likely to have been imported. Table 5 gives an overview of the actions to be taken when a case is likely to be the result of local transmission (level 2).

---

**TABLE 4: REACTIONS FOR LEVEL 0 UPON DETECTION OF A PARASITOLOGICALLY CONFIRMED CASE**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Assumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Facility</td>
<td>Fill in the case reporting form (including residence for mapping).</td>
</tr>
<tr>
<td></td>
<td>Collect and store samples (RDT, thin/thick smear, blood spot on filter paper)</td>
</tr>
<tr>
<td></td>
<td>Treat the patient with an ACT</td>
</tr>
<tr>
<td>District</td>
<td>Check contingency stocks</td>
</tr>
<tr>
<td></td>
<td>Notify the local authorities/village health committees</td>
</tr>
<tr>
<td>ZMEP (Pemba/Unguja)</td>
<td>Immediately dispatch an investigation team to the health facility where the case was identified (this might be possible at the district level)</td>
</tr>
<tr>
<td></td>
<td>Confirm if the index case is a malaria case.</td>
</tr>
</tbody>
</table>

---

footnote: Increase in cases for 2 consecutive weeks.
TABLE 5: RAPID RESPONSE ACTION FOR LEVEL 2

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 2 (locally acquired case)</td>
<td></td>
</tr>
<tr>
<td>Re-active Case Detection</td>
<td>Mass screening with RDTs regardless of the presence of fever in 100 households around the index case and any subsequent case detected through ACD.</td>
</tr>
<tr>
<td>Case Management</td>
<td>Treatment of RDT positive cases from screening and follow up visit to ensure 100% adherence.</td>
</tr>
<tr>
<td>Entomological Investigation</td>
<td>Mapping of potential important breeding sites in the Shehia. Investigate the vectorial capacity in the village of the index case and 2-3 control villages in the Shehia. Review LLIN/IRS coverage levels in the Shehia using GIS database.</td>
</tr>
<tr>
<td>Integrated Vector Control</td>
<td>LLIN “top-up” in all houses screened. Focal IRS in the Shehia depending on the results of the entomological investigation.</td>
</tr>
<tr>
<td>IEC/BCC</td>
<td>Immediate start of IEC/BCC campaign in the whole district.</td>
</tr>
</tbody>
</table>

FIGURE 22: SURVEILLANCE AND RESPONSE ALGORITHM FOR ELIMINATION

- **Level 0 (baseline)**
  - Passive Case Detection
  - Test all fever cases
  - Health facility level

- **Case Detected**

- **Case Investigation** (Protocol to be developed)

- **Case Confirmed**

- **Case NOT confirmed**

- **Probably Locally Acquired** (no travel history)

- **Level 2**
  - Active Case Detection
  - (100 households around the index case)
  - Screening with RDT regardless of fever

- **Secondary Case(s) Identified**

- **Level 2**
  - Continuous ACD
  - LLINs for all screened houses

- **Level 3**
  - > 3 secondary cases
  - IRS in whole district
  - Continuous ACD

- **Probably Externally Acquired** (Travel to endemic area)

- **Level 1**
  - Ensure adherence to treatment
  - Provide LLIN to all members of the household
  - Information on personal protection when travelling to MEC

- **Level 0**
  - Back to level 0
The first objective of the responses triggered at level 1 is to avoid onward transmission. The second objective is to determine and/or confirm whether transmission is still ongoing. The mass screening proposed aims at identifying secondary cases, which will determine if moving to level 3 is warranted.

When no secondary cases can be identified it is still recommended to remain cautious (especially when the index case was likely locally acquired). The active case detection should therefore be repeated twice with an interval of 4 weeks (more or less the time of the parasite cycle). When two consecutive mass screenings cannot identify any secondary cases, the outbreak can be declared over and the area can return to vigilance level 0. In a scenario where effective coverage of preventive vector control measures is kept at around 75%, our simulations indicate that secondary cases will almost never occur and the risk of epidemics is low. However, when prevention is called back, epidemics become a real risk, and the thresholds for moving towards level 3 should therefore be far more conservative. We propose three secondary cases; far less than what is used in the simulator (outbreak defined as 50 cases in 2 weeks).

At level 3, the ZMCP (in collaboration with all its partners) should initiate a massive response that aims at interrupting transmission. We suggest considering mass treatment of fever cases if the parasite cycle). When two consecutive mass screenings cannot identify any secondary cases, the outbreak can be declared over and the area can return to vigilance level 0. In a scenario where effective coverage of preventive vector control measures is kept at around 75%, our simulations indicate that secondary cases will almost never occur and the risk of epidemics is low. However, when prevention is called back, epidemics become a real risk, and the thresholds for moving towards level 3 should therefore be far more conservative. We propose three secondary cases; far less than what is used in the simulator (outbreak defined as 50 cases in 2 weeks).

As such, entomological surveillance plays a key role in:

- Monitoring the effectiveness of vector control interventions
- Identifying active transmission foci
- Monitoring potential transmission foci
- Helping to establish the receptivity of an area to malaria transmission

At a basic level, routine vector collection and processing will define vector populations in terms of species, biting and resting behavior, immature and adult stage density, and infection rates. However, additional investigation can be used to define the levels of resistance to insecticides. Levels of resistance are especially important when evaluating the effectiveness of vector control interventions such as IRS and LLINs. Insecticide resistance genes can develop rapidly when mosquitoes are exposed to similar chemical families (e.g., pyrethroids). These factors are important to monitor, especially when evaluating how the vector population reacts when intensive vector control measures, such as IRS, are scaled back.

These population effects are extremely important when assessing the potential receptivity of an area to re-infection from outside. WHO states that the degree of receptivity of an area is, amongst others, defined by its malaria history (WHO, 2007), specifically:

- **Original degree of endemicity**: This can be obtained from case records and any entomological data from the specific area (see technical feasibility chapter).
- **Vectorial capacity before the implementation of intensive control measures**: This will define the nature of the vector population and give a baseline for comparison after control measures are scaled.
The majority of the entomological monitoring efforts can
be based around field collections that will be augmented by
routine measurement of parity rates via ovarian
dissections from female mosquitoes gleaned from routine
collections. The length of the sporogonic cycle can be
obtained from standard formulae based on temperature
measurements.

- **Response of vector to withdrawal of insecticide spraying**
  after the application of intensive control measures
  Monitoring of the response to the withdrawal of insecticides
  will form part of the overall entomological monitoring
efforts and collections will need to measure vector density,
species composition, biting rates, infection rates and
insecticide resistance assays. The bulk of this work will be
obtained from standard entomological collections outlined
above. Standard WHO cone assays can be used to simply
measure insecticide resistance.

- **Environmental changes as a result of developments,**
  which may affect the vector population
  Recording environmental changes that may have an impact
  on malaria transmission in the local area; e.g. an increase in
  standing water through man made or natural phenomena

Routine entomological monitoring throughout the islands
should be maintained throughout the elimination efforts. These
activities will characterize the vector population throughout the
islands and provide a baseline vector profile before full-scale
control activities are implemented to push for elimination. The
information gathered will also be used to detect any reservoirs
of infections and transmission foci and help to target control
activities, while also defining the susceptibility of certain areas
to re-infection based on the vectorial capacity and transmission
history of the area.

The majority of the entomological monitoring efforts can
be based around field collections that will be augmented by
laboratory work. Most of these activities are low-tech and can
be carried out by adequately trained field teams. The specific
activities needed are:

- Adult sampling from household knock-down collections
to give an estimation of local vector density and species
  composition;

- Landing or light trap collections to obtain an estimation
  of human biting rate for the different vector species both
  indoors and out;

- Mapping and sampling of breeding sites to identify sites that
  are positive or negative for larvae and obtain larval density
  figures;

- Standard dissection of collected adult specimens to ascertain
  parity (ovarian dissection) and sporozoite rates (salivary gland
  dissection). Additionally, simple ELISA tests can be used to
  identify blood meal origin; and

- Live adults can be collected for WHO cone filter paper assays
  or CDC bottle bioassays to ascertain a measure insecticide
  resistance. Should the technology and staff exist, PCR of
  homogenised adults (following dissection) can also be used
  for more specific resistance genotyping.

Collection activities should be employed by mobile teams
across the islands, with laboratory support as needed, to build
up a vector database for all regions. This database will provide
crucial information outlining transmission foci and areas highly
susceptible to re-infection, which can be fed into the programme
planning cycle to better target control measures and ensure
they are effective; especially in terms of insecticide resistance.
Moreover, the database will provide information on any changes
in vector behaviour as a result of intensified control measures. For
example, the vectors may begin to rest and/or feed outside rather
than in houses, and this change would require a reorientation in
strategy to ensure interventions are relevant and effective.
It would be prudent to put extra focus on routine monitoring
areas where transit between the islands and the mainland occurs
in order to ensure that any introduced infections are rapidly
detected.

As described above, entomological monitoring is also a key aspect
of outbreak investigation and will help to determine whether an
infection was locally acquired or not, and how far it is likely to
spread based on the vectorial capacity in the area.

**Surveillance of Human and Environmental Factors**
In addition to case surveillance, the ZMCP should also collect or
have access to data related to human and environmental factors.
Often this will require intensive collaboration with different
ministerial departments. We recommend that the ZMCP collects
or has access to the following information (to be included in the
central database where relevant):

- **Inbound and outbound population movements:** Quantification and tracking of inbound population movements from malaria endemic areas can serve as a proxy indicator for importation risk. These figures will also enable design and planning of potential active case detection rates at the border.

- **Meteorological and climate data:** Excessive rainfall and floods should be monitored. Collaboration with the meteorological agency should be initiated and the forecasting of possible unusual events should be notified in order to intensify surveillance and alertness for possible local outbreaks.
• Data on (potential) vector breeding sites: Geo-referenced data should be collected on permanent water bodies and irrigation schemes (both functional and non-functional). Construction works (e.g., roads and buildings) are potential breeding sites and should be inspected by environmental health engineers and the data collected should be incorporated in the ZMCP managed GIS database. This information would allow for (rapid) environmental measures to decrease potential anopheline breeding sites.

CONCLUSION
A strong surveillance system will arguably be the most important component of the Zanzibar elimination program. The system will need to detect, register and report every single malaria case. A robust analysis of the data will allow for an appropriate outbreak response and might enable the prediction and/or identification of foci. There are three main methods used to collect data for surveillance: passive case detection, re-active case detection and pro-active case detection. The MEEDS, which will cover all public health facilities by 2010, provides a unique opportunity to improve the passive case detection system and should be further scaled up to also include relevant private health care facilities. Re-active case detection is an entire part of outbreak response, initially triggered by an increase in cases for two consecutive weeks but eventually by one single RDT and/or microscopy confirmed malaria case. Depending on the risk of onward transmission, mainly defined by whether the index case is probably locally acquired or not, the scale of the response will differ—large for locally acquired cases and limited if the case is probably imported. Pro-active case detection, like border screening and testing of high-risk groups or areas, often complements passive case detection in elimination program. We do not recommend starting pro-active case detection for the moment. More operational research is needed to help define both high risk areas and groups. The surveillance system will also need to include entomological surveillance and the surveillance of human and environmental factors such as population movements, meteorological data, and the mapping of breeding sites.

MONITORING AND EVALUATION (FROM CONTROL TO ELIMINATION)
Monitoring and evaluation will guide the reorientation of the program (from pre-elimination to elimination to prevention of reintroduction) by documenting progress towards the goals of each phase. In the end phases of elimination, robust monitoring will be needed to demonstrate that transmission has been interrupted. The WHO guideline for malaria elimination specifies phase-specific goals, programmatic milestones, M&E interventions, outcome indicators, and impact indicators. The table below brings together the most relevant information on M&E in an elimination program.

The WHO also proposes a set of indicators for the pre-elimination and elimination phase for five program components (enabling environment, surveillance, case management, vector control and entomological surveillance). Targets are only specified for a limited number of indicators and some, such as the “formal endorsement by the government” indicator, even seem to be variables that do not require continuous follow up.

| TABLE 6: M&E FOR CONTROL AND THE DIFFERENT PHASES OF AN ELIMINATION PROGRAM |
|---------------------------------|------------------|------------------|------------------|
| Goal                            | Control          | Pre-elimination  | Elimination      |
|                                 | Reduce morbidity and mortality | Halt local transmission nationwide | Halt local transmission nationwide |
| Activities                      | Prompt and effective treatment, high coverage with preventive measures | Improve diagnosis (confirmed), surveillance, epidemic preparedness and response | Active case detection, case investigation, targeted control interventions (foci) |
| Milestone (data, indicators, threshold) | # of cases tested | Origin of each case | Number of locally acquired cases (zero) |
| M&E Tools                       | Routine data collection Surveys | Routine data collection Surveillance data (including evaluation of quality of reporting) Malaria risk stratification Surveys | Surveillance data (elimination database; quality of reporting) Case investigation reports Genotyping (strain database) Sero-prevalence survey (baseline) Sero-prevalence surveys |
| Selected Variables              | # Fever cases    | Population at risk | # Parasitological confirmed cases |
|                                 | # Positive slides/ RDTs | # Reports received on time | Origin of cases Strain of each case |
|                                 | Coverage indicators (LLINs, IRS, …) | | |

<table>
<thead>
<tr>
<th></th>
<th># Fever cases</th>
<th>Population at risk</th>
<th># Parasitological confirmed cases</th>
<th>Sero-prevalence &lt; 3 years and/or general population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The table brings together the most relevant information on M&E in an elimination program.
When moving towards elimination, M&E objectives do not change. The phase specific activities will still need to be monitored and evaluated, but they shift from a “population” level approach to a “foci” or even an “individual case” type of approach. The former looks at coverage of malaria control intervention and prevalence of malaria in the general population, while the latter evaluates every single case. In terms of service coverage monitoring, outcome and process indicators need to be adapted to the activities they are supposed to evaluate, but in essence the methodologies are no different from those used in a control program. However, demonstrating the interruption of local transmission will require different methods for data collection and will also require proof that any potential case, even if non-symptomatic, would have been detected.

The drafts of the M&E Plan and the Early Detection and Response Plan (2008-2012) of the ZMCP specify the goals and objectives of malaria-related M&E and discuss the different data sources used and variables collected. Although elimination is mentioned, the currently proposed M&E plan focuses on malaria prevention and control. However, recognizing the potential implications of the recently observed low prevalence, the plan also extensively discusses the need for a routine malaria early detection and response system.

When moving towards elimination, some of the proposed indicators and the methods to collect them in the current M&E plan will need to be adapted or changed. Based on the WHO recommendations, necessary changes to the M&E plan if Zanzibar decides to pursue elimination are explored here.

**DATA SOURCES AND INDICATORS FOR MALARIA ELIMINATION**

**M&E Routine Data Collection**

Malaria-related M&E data are collected both through routine reporting and periodic surveys. The routine systems in place are the national Health Management and Information System (HMIS), the health facility-based sentinel surveillance system (HFBSS), and the ZMCP’s malaria diagnosis quality assurance program.

When moving towards elimination, the M&E system will need to demonstrate that all cases have been reported and that the necessary action has been taken to prevent onward transmission. This requirement means that the current system of sentinel surveillance through the 6 HFBSS sites, representing only a sample of facilities and areas, will need to eventually be abandoned. All health facilities will need to comply with the standards currently only applicable to the sentinel sites. In addition, during elimination and maintenance, the malaria burden will no longer be evaluated based on the results of surveys (prevalence), but rather on the number of cases reported from facilities (incidence). The M&E system will need to collect relevant data in order to assess whether incidence is being appropriately measured. Key indicators and data to be collected have been discussed in the surveillance chapter and some practical recommendations are given below (programmatic monitoring).

**Data Management**

The data management will need to be evaluated for completeness, speed, and accuracy in order to prove beyond doubt that all cases have been detected and documented. In addition, all cases will need to be notified as soon as possible to allow for rapid response. Specific indicators will need to be established to evaluate the timelines of the reporting system at all levels of the reporting chain. Potential indicators in this area could include:

- Time between positive diagnosis at the facility level and reception of the notification at the ZMCP
- Time between reception of the malaria case notification and the arrival of the case investigation team at the health facility
- Time between the arrival at the health facility and the start of the preventive measure in the foci

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**TABLE 7: PRE-ELIMINATION AND ELIMINATION INDICATORS**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Indicator</th>
<th>Target (targets between brackets are not WHO defined)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Epidemiology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foci Investigation</td>
<td># Active foci reported per year</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Proportion of reported foci fully investigated</td>
<td>(100%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td># cases within a focus</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Total population at risk within a focus</td>
<td>-</td>
</tr>
<tr>
<td><strong>Surveillance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NMSS</td>
<td>Completeness</td>
<td>(100%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tracking Burden</td>
<td># cases reported per year</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Proportion of cases fully investigated</td>
<td>(100%)</td>
</tr>
<tr>
<td><strong>Case Management</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Total population at risk</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Proportion of case confirmed by microscopy</td>
<td>(100%)</td>
</tr>
<tr>
<td></td>
<td>Microscopy QA/QC in place</td>
<td>-</td>
</tr>
<tr>
<td>Treatment</td>
<td>Proportion of cases treated according to the guidelines</td>
<td>(100%)</td>
</tr>
<tr>
<td><strong>Vector Control</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRS</td>
<td>Number and proportion of at-risk households that have been sprayed</td>
<td>&gt; 90% (but numbers of at-risk households decreases over time)</td>
</tr>
<tr>
<td></td>
<td>Number and proportion of reported active foci that were sprayed</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td><strong>Larval Control</strong></td>
<td>Proportion of breeding sites treated with chemicals/ fish</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td><strong>Entomological Surveillance</strong></td>
<td>Proportion of breeding sites positive for mosquito larvae</td>
<td>&lt; 5%</td>
</tr>
</tbody>
</table>

(Adapted from WHO, 2007)
Standardized data collection forms will need to be put in place to allow for a robust evaluation of the data management. In addition, we also suggest, in line with the WHO recommendations, to set up of a malaria elimination database with the following components:

- National Malaria Case Register
- Malaria Patient Register (records)
- Laboratory Register
- Parasite Strain Bank

**Surveys**

National representative surveys to monitor service coverage indicators will remain an important tool even when elimination has been achieved. The classic RBM indicators for preventive and curative services will need to be gradually adapted as activities change from control to elimination. In terms of methodology, the standard DHS and MIS methodology will remain a valid approach. However, for the monitoring of malaria transmission in an elimination setting the parasite prevalence surveys will require a very large sample size (>25,000). When transmission is interrupted, the current methodologies will no longer be useful, and new prevalence survey methods should be introduced (including serological and molecular biology investigations).

**TABLE 8: METHODOLOGICAL DIFFERENCES BETWEEN CONTROL AND ELIMINATION FOR SURVEYS**

<table>
<thead>
<tr>
<th>Variables/Indicators</th>
<th>Control</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Coverage (LLINs, IRS, …)</td>
<td>Classic DHS, MICS or MIS sampling methods</td>
<td>Classic DHS, MICS or MIS sampling methods</td>
</tr>
<tr>
<td>Prevalence</td>
<td>MIS Methodology (RBM MERG et al., 2005)</td>
<td>Too low to measure with classic sampling methods and diagnostic tools.</td>
</tr>
<tr>
<td></td>
<td>Microscopy and/or RDTs</td>
<td></td>
</tr>
<tr>
<td>Transmission</td>
<td>Estimated based on PPR, using mathematical modeling (Ro, Rc) (Smith et al., 2007)</td>
<td>Alternative sampling methods such as Lot Quality Assurance Sampling (Rabarijoana et al., 2001; Brooker et al., 2005) or other sequential sampling methods to be explored.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Serology (in specific age groups) to demonstrate absence of transmission</td>
</tr>
</tbody>
</table>

The table below gives an overview of all the surveys planned for Zanzibar and provides suggestions for elimination-relevant indicators (and their targets) to be considered for inclusion. The table provides some initial thinking on how surveys, regularly done on Zanzibar, can be best used.

**TABLE 9: ROUTINELY PLANNED SURVEYS IN AN ELIMINATION CONTEXT**

<table>
<thead>
<tr>
<th>Survey</th>
<th>Sample</th>
<th>Period</th>
<th>Elimination Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBM Household Survey</td>
<td>2,500 households</td>
<td>2009/2011 (Biannually)</td>
<td>Access to malaria treatment (100%) Health seeking behavior (all fevers tested) Intervention coverage/usage (100% and &gt;80% respectively)</td>
</tr>
<tr>
<td>RBM Health Facility Surveys</td>
<td>40 facilities</td>
<td>2009/2011 (Biannually)</td>
<td>Records review (including individual case records) (Might want to include a sample of private facilities that are providing malaria treatment and care)</td>
</tr>
<tr>
<td>DHS</td>
<td>Tanzania National Level</td>
<td>2010 (Every 4-5 years)</td>
<td>Intervention coverage/usage (100% and &gt;80% respectively)</td>
</tr>
<tr>
<td>THIS/MIS</td>
<td>2007 (Every 4-5 years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevalence Surveys</td>
<td>2,500 households on Zanzibar</td>
<td></td>
<td>Need to rethink both sample size and testing methods</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Use of serology testing (either in specific groups, such as &lt;3 years and/or school children, or general population)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Detailed follow up of the serological profile in the ZAMRUKI districts in all age groups</td>
</tr>
</tbody>
</table>

Apart from changing the targets for some of the indicators such as access to treatment or the inclusion of private facilities in health facility surveys, we strongly suggest that future surveys consider sampling methods that are adapted to a low prevalence setting and diagnostic tests that are not only more sensitive but also provide information on present and past transmission patterns. Alternative sampling methods can be drawn from those used for other low prevalence diseases such as HIV/AIDS (Myatt and Bennet, 2008) and trachoma (Myatt et al., 2003). Sampling from specific populations, such as school children, should also be considered (Brooker et al., 2005). Serology as a tool to detect trends in present and past malaria infection could be extremely useful to demonstrate the interruption of transmission (WHO, 2007) and recent advances in the laboratory techniques involved have made this a promising tool.

**Programmatic Monitoring**

Programmatic monitoring will need to be adapted to the elimination-specific activities and requirements discussed in the health system strengthening and surveillance chapter. Generally, the activities monitored/evaluated are not necessarily different but will require a higher level of perfection compared to control. The rapid response activities and IEC/BCC programs, both
essential components of an elimination program, will require new M&E activities and indicators. In terms of programmatic monitoring we recommend the following:

- **At the health facility level:** To ensure case management is conducted properly, we recommend increasing the frequency of supervision with more regular supervision visits to facilities that are not performing well. Standardized supervision tools should be used, and health workers should receive feedback after every visit. All levels, including the community using representatives of existing community (health) committees, should be involved in the supervision activities to increase accountability and ownership.

- **At the community level:** IEC/BCC and community-level activities will need to be regularly supervised and evaluated using standardized tools so that activities/messages can be adapted without having to wait for the results of surveys.

- **At the ZMCP level:** The necessary M&E activities will need to be set-up to evaluate the ZMCP. We recommend that the ZMCP should not only be monitored through internal M&E systems but also should be evaluated by either their direct supervisors or external evaluators. These evaluations will be especially important for the activities that the ZMCP is directly responsible for. These include:
  - **Laboratory QA/QC:** As a critical component, the quality of the QA/QC itself needs to be evaluated. We recommend evaluating the QA/QC activities (re-reading of slides and PCR) at least once a year, but more frequent evaluations will be initially necessary.
  - **Data analysis and data base management:** The quality of the statistical and epidemiological analysis should be evaluated at least once a year. In addition, the database will need to be regularly checked for inconsistencies between the different data sources.
  - **Rapid response:** It will not only be important to evaluate how many identified foci have been treated but also how fast the response was to a notified case. We recommend that the team internally reviews the strengths and weaknesses of each intervention each time a team deals with a foci.
  - **Other activities:** The ZMCP will ultimately be responsible for the timely delivery of other monitoring activities described elsewhere in this chapter such as drug resistance monitoring and entomological monitoring including insecticide resistance, even if they are not directly responsible for their implementation.

### Drug Resistance Monitoring

The ZMCP will also be responsible for the monitoring of resistance patterns in both the parasite and the vector. These patterns will define the effectiveness of the drug regimens and insecticides used and therefore need to be carefully followed up. Especially for drug resistance monitoring, the elimination setting will be challenging, and methodologies will need to be adapted.

In the actual epidemiological setting it has become increasingly difficult to pursue regular drug monitoring testing by using the classic modified in-vivo WHO methodology adapted for East Africa (EANMAT, 2002). The protocol requires a relatively large number of malaria cases (between 80-100 children under five years of age) with a parasite load of > 2,000 parasite per µl in each treatment arm to be enrolled. The last drug efficacy study carried out in Zanzibar in two sites (Micheweni and North A districts) was done in 2005. This study showed good efficacy of both ACTs recommended for Zanzibar (Martensson et al., 2005). Since then the case load in the two sites has been too low to enroll enough pediatric cases. There are 2 alternative methods to in vivo tests that can provide indications of drug efficacy or resistance: In vitro testing and genotyping.

In vitro testing on parasite isolates requires samples to be collected from patients before they are treated. These tests provide estimates of trends of possible decrease in susceptibility to drugs. The technology requires good laboratory facilities, and the collection of sufficient samples in an elimination setting will be challenging.

Genotyping of parasites using polymerase chain reaction (PCR) is a more recent but promising technique that can be used for resistance testing. The blood samples required can either be collected in ordinary test tubes or on filter paper. In addition, the Karolinska Institute has developed a method that allows PCR genotyping to be performed on RDT samples, facilitating regular monitoring. Genotyping can detect the presence of genetic alterations associated with resistance to anti-malaria drugs. Recently, markers have been identified which relate to tolerance/resistance to the partner drugs in ACT. These methods have already been used to evaluate resistance on Zanzibar (Sisowath et al., 2005), and there are now emerging reports of potential markers of resistance to the artemisinin compounds. There are some advantages, (simple collection of samples to be tested) and disadvantages, (costs, sophisticated equipment and training), to the implementation of genotyping. In addition, even if markers for detection of mutations towards resistance to artemisinin based drugs have been recently identified, confirmation of the association between given mutations and actual drug resistance remains difficult.

Apart from these relatively complicated techniques, case reports and spontaneously reported treatment failure are potentially useful and simple methods to detect drug resistance. It requires less investment in time, money and personnel and can be done on an ongoing basis in the health facilities. Patients are treated following the treatment guidelines and told to come back to the health facility if fever persists. Cases coming back should be further investigated. Two possible biases should be taken into consideration: adherence to treatment regimen is not guaranteed, and patients can decide to not return on their own to health facilities.
Recommendations:

- Establish a system using standardized forms to document any treatment failure reported at the health facility level.
- Establish a robust methodology for the collection of a random sample of RDTs to be sent to the Karolinska Institute for genotyping using PCR as long as the ZMCP does not have the capacity to perform the tests themselves. (When cases become extremely rare, all positive RDTs should be re-tested.)

CONCLUSION

As the Zanzibar Control Program progresses from control to elimination the M&E system will need to be adapted in order to be able to provide both implementers and policy makers with the necessary information for informed decision-making. Apart from routine programmatic monitoring of the different activities under its responsibility, the ZMCP will also need to establish a malaria database bringing together all relevant malaria information from different sources (health facilities, case investigations, entomological data, laboratory results, etc.). The MEEDS will be the main supplier of good quality data, but eventually the routine HMIS system should be made responsible for malaria data collection and analysis. Routine monitoring of the speed, completeness and correctness of malaria-related reporting will be one of the most important tasks of the M&E unit. In addition, survey methodologies previously used to evaluate the malaria burden and useful tools to prove absence of transmission will need to be adapted both in terms of sampling methods and laboratory techniques. This will also be the case for drug resistance monitoring.

HEALTH SYSTEM STRENGTHENING

INTRODUCTION

To assess the extent to which the health system needs to be strengthened in order to achieve and sustain malaria elimination, we first need to specify what is expected from the health care system in the different phases of an elimination program and how these requirements are different from those for the ongoing control program. The ninth report of the WHO’s expert committee on malaria defined “minimum requirements of the health service to support a malaria eradication program” (WHO, 1962), providing greater specificity than it had previously. These minimum requirements, although not described in detail, can be summarized as “adequate coverage of the population with basic health services in order to detect and treat cases and to provide health education in support of the eradication program”. This approach—defining minimum requirements rather than recommending a perfect health care system—has been used as the overarching framework for considering health system strengthening issues for Zanzibar as part of a potential elimination program. While not diminishing the importance of a strong overall health care system, it is not necessary for Zanzibar to wait until the health care system is optimal to successfully pursue elimination. However, some minimum improvements to basic services and support systems will need to be made for elimination to be feasible.

REQUIREMENTS FOR ELIMINATION

In malaria control, the goal of the national malaria program is to reduce the overall burden of malaria through high coverage of curative and preventive services. As a program shifts to the elimination phase, the goal should be to achieve and maintain interruption of transmission by identifying and treating all parasite carriers and reducing vectorial capacity (WHO, 2007). To achieve this we identified two main tasks that the basic health care system must conduct and that cannot or should not be substituted by implementing vertical systems:

- Passive case detection and notification
- Case management (treatment and follow-up)

It is important to point out that when we talk about the health care system we are focusing specifically on the provision of care to patients and not the management of the system. Management aspects of the malaria elimination program will be discussed below (From ZMCP to ZMEP). Also, passive case detection is discussed in detail in the surveillance section.

The services that will need to be available in both public and private facilities to effectuate these tasks are:

- Quality diagnosis (microscopy, RDT and/or PCR) to ensure parasitological confirmation.
- Prompt and effective treatment (or referral) for both uncomplicated and severe cases.

These services need to be complemented by a near perfect case reporting or surveillance system. Health education is not included because it is felt that, while health providers will be involved in implementation of behavior change communication (BCC) activities, primary responsibility will reside with specific IEC/BCC departments, the ZMCP and the (potential) implementing agencies.

The support systems necessary to guarantee both the availability and quality of these services are listed below:

- Human Resources (skills and numbers)
- Infrastructure and Equipment (coverage and availability)
- Procurement and Supply Management
- Management and Supervision
- Monitoring and Evaluation (including quality assurance and control)

None of the above is specific to elimination, but each differs from control in the level of coverage and precision each requires. To achieve elimination all malaria cases need to be detected in the shortest time delay possible in order to avoid onward transmission. This requires universal access to high quality diagnosis and treatment complemented by a near perfect surveillance system. This chapter considers and analyzes each service and support system component separately to identify essential gaps in the current Zanzibar health system that will need to be addressed if the MOHSW decides to eliminate malaria from the islands.
THE ZANZIBAR HEALTH CARE SYSTEM

THE PUBLIC SECTOR

The organization of the public health care system is based on a district model consisting of a network of primary health care units (PHCU) complemented by a number of secondary (Primary Health Care Centers, District Hospitals) and tertiary referral structures. In theory there are two types of primary health care units: PHCU (basic primary health care services) and PHCU plus (same plus obstetric, laboratory and dental services). In practice there is no difference between the two units, with laboratory and dental services rarely available at the PHCU-plus level (EHCP, 2007). Primary Health Care Centers (PHCC), also known as Cottage Hospitals, provide inpatient care (30 beds), some more advanced services such as x-rays, and they also serve a larger population. The 3 district hospitals are the second line referral level and have surgical capacity. All 3 are on Pemba. Zanzibar has 3 tertiary referral hospitals: Mnazi Mmoja general hospital, Mwembeladu maternity hospital and Kidongo Chekundu Mental Hospital, all situated in Stonetown. The one referral laboratory for both islands is situated on Pemba.

<table>
<thead>
<tr>
<th>TABLE 10: NUMBER OF PUBLIC HEALTH FACILITIES BY LEVEL OF CARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHCU</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>LGBT</td>
</tr>
<tr>
<td>PHCU plus</td>
</tr>
<tr>
<td>PHCC</td>
</tr>
<tr>
<td>District Hospital</td>
</tr>
<tr>
<td>Referral Hospital</td>
</tr>
</tbody>
</table>

All of these facilities have malaria diagnostic capacity—RDTs at the PHCU level and microscopy for PHCC and above—and dispense ACTs. According to the most recent Malaria Indicator Survey, almost 95% of facilities have at least one staff member trained on malaria and IMCI (MIS, 2007). However, the most recent human resource for health development plan has noted that there is a misallocation of the few available health personnel, with the majority of the front line workers earmarked for the PHCUs and PHCCs placed in referral hospitals in urban areas (Revolutionary Government of Zanzibar, 2004). Attrition of qualified health personnel moving outside the islands is also a persistent challenge. In addition, the 2008 Performance Report (MOHSW, 2008) states that staff performance at all levels is inefficient and ineffective. The main reasons mentioned in the report are unexplained absence, unclear job descriptions, staff competencies not properly exploited, no reward or disciplinary system in place, high turnover (especially of highly qualified staff), lack of commitment, and no culture of mentoring and managing junior staff.

The public health care system management is organized by level, with facility management teams at the facility level, district health management teams at the district level, and the MOHSW with its different departments and vertical programs at the central level. Notably, the Zanzibar Strategy for Growth and Reduction of Poverty (MKUZA) (Revolutionary Government of Zanzibar, 2006) and the Zanzibar Health Sector Reform Strategic Plan II (Revolutionary Government of Zanzibar, 2006) both describe the malaria program as a vertical program alongside Reproductive and Child Health programs. This reality needs to be addressed in the context of the strength of the health system to move towards malaria elimination.

THE PRIVATE SECTOR

Zanzibar has a flourishing private health care sector that consists of 3 private hospitals (all in Zanzibar Town), around 100 clinics or dispensaries providing outpatient care, 60 registered pharmacies and more that 200 OTC outlets selling over-the-counter drugs, including malaria treatments. Roughly two-thirds of these private facilities are in and around Zanzibar town. Although the proportion of mothers seeking care through the public sector has been increasing, the private sector remains an important source of treatment for malaria. One-third of mothers use a private facility when their child has a fever, while just under half first visit a public facility (ZMCP, 2007). However, when it comes to acquiring anti-malaria drugs, three quarters of mothers get their treatments from the public sector (ZMCP, 2007).

All of these private facilities, including OTC shops, sell anti-malaria treatments. However ACTs are still expensive and most treatments sold are mono-therapies (ZMCP, 2007). Testing for malaria is available at most private hospitals and at almost 2/3 of out patient clinics. However, there are only 9 facilities where the laboratory regularly undergoes quality checks. Private pharmacies and OTC shops dispense malaria treatment almost always based on clinical (self-)diagnosis.

PERFORMANCE OF THE HEALTH SYSTEM

The MOHSW reviews the performance of the health sector on a yearly basis since 2007. All departments, units, programs and management teams provide reports for the Minister’s annual budget speech to the House of Representatives. The House’s secretariat updates and compiles reports into the annual performance report. The Performance Report is a part of ongoing efforts to strengthen the planning and monitoring cycle in Zanzibar.

The 2008 Public Expenditure Review (PER) identified the following major obstacles in achieving milestones and implementing the Plan of Action (MOHSW, 2008):

- Staff performance at all levels is inefficient and ineffective
- Back-up emergency and contingency resources lacking
- Drugs shortages or irregular distribution to health facilities
- Delays in approval of research proposals
- Poor integration and coordination between districts and programs (activities, resources)
- Planning and reporting processes are suboptimal
- Central support for and will to achieve the annual Plan of Action and milestones is not unified or transparent
- Cost-sharing stalled
These obstacles clearly demonstrate that the Zanzibar health system needs substantial strengthening. Nevertheless, there are also signs that the health system has improved considerably over the last couple of years, with important reductions in childhood and infant mortality and a good performance for both the malaria and tuberculosis programs (MOHSW, 2007). Unfortunately, the PER does not provide details on the performance of the health system in terms of timely delivery of quality health care in general. An overall improvement of the health care system would benefit the move towards malaria elimination. However, the health system does not need to be perfect. Important areas that are essential when going for malaria elimination are discussed below.

**HEALTH SYSTEM STRENGTHENING FOR ELIMINATION**

**ACCESS**

**Financial Access**

To ensure that all fever cases are tested within 24 hours, people must have access to diagnostic services and any barriers to treatment be reduced to an absolute minimum. The 2007 RBM survey revealed that 32% of children under five years old do not seek medical care for febrile illness within 24 hours. Some of these children will eventually seek care but others will not. Table 11 gives an overview by region on the proportion of people that are not seeking medical care when they feel ill and the stated reason for not doing so. Although the relatively wide range seen in some of the results might indicate a flawed methodology, the data show that, unlike many countries, geographical access is not a primary barrier to public sector care in Zanzibar. The major reason for not seeking care is that people feel that there is no need to do so. This attitude is problematic in an elimination setting where all fever cases must be tested. Increasing people’s health seeking behavior, especially for fever, will need to be increased through IEC/BCC and community involvement (see below). In addition, financial access seems to be an issue that will need to be addressed. These data include the private sector so we cannot conclude that the public sector is too expensive. Nevertheless, an important proportion of people do not seek care because they feel that costs are too high. We therefore recommend that fever testing and malaria treatment should be absolutely free in both the public and private sector to ensure maximum access.

**TABLE 11: REASONS FOR NOT SEEKING HEALTH CARE BY REGION**

<table>
<thead>
<tr>
<th>Reason</th>
<th>Kaskazii A</th>
<th>Kaskazii B</th>
<th>Katavi</th>
<th>Kusini</th>
<th>Mbagebari</th>
<th>Mnji</th>
<th>Mtwara</th>
<th>Micheweni</th>
<th>Chake Chake</th>
<th>Mkoani</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Need</td>
<td>69.0%</td>
<td>73.8%</td>
<td>61.5%</td>
<td>79.9%</td>
<td>67.0%</td>
<td>70.0%</td>
<td>54.5%</td>
<td>62.1%</td>
<td>59.5%</td>
<td>69.0%</td>
<td>60.8%</td>
</tr>
<tr>
<td>Too Expensive</td>
<td>23.5%</td>
<td>14.7%</td>
<td>4.4%</td>
<td>9.8%</td>
<td>18.1%</td>
<td>28.2%</td>
<td>36.7%</td>
<td>88.0%</td>
<td>23.3%</td>
<td>22.9%</td>
<td>27.5%</td>
</tr>
<tr>
<td>Too far</td>
<td>2.2%</td>
<td>2.0%</td>
<td>5.0%</td>
<td>1.8%</td>
<td>2.8%</td>
<td>0.7%</td>
<td>2.4%</td>
<td>4.0%</td>
<td>9.9%</td>
<td>1.5%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Other</td>
<td>6.9%</td>
<td>9.5%</td>
<td>28.9%</td>
<td>8.9%</td>
<td>12.0%</td>
<td>2.0%</td>
<td>6.4%</td>
<td>1.5%</td>
<td>5.6%</td>
<td>4.9%</td>
<td>7.7%</td>
</tr>
</tbody>
</table>

**Cost-sharing or user fees**

Cost-sharing or user fees, although mentioned in the Health Sector Reform Strategic Plans, have not been officially introduced but do exist at all levels of the public health care system (Simai et al., 2007). Anecdotal information suggests that consultations and malaria-related diagnostic testing are free of charge in most facilities, but patients are commonly charged for certain laboratory tests (mainly glucose, hemoglobin and pregnancy testing) and other services. These services include referrals which are potentially important for malaria treatment.

These “unofficial” charges vary between facilities and no attempt has been made to standardize practices. User fees are mostly collected at the point of service (for example, the patient pays the lab technician for a test). Only in Chake Chake Hospital are fees collected at a central collection point where the patient receives a receipt that has to be taken to the actual service point (pre-payment). If user fees will be officially implemented, it will be important to guarantee free testing of all fever cases and no charges for a malaria-related consultation and anti-malarial drugs. Additional “hidden” charges will reduce access to health care and should be avoided. For example, if a patient, regardless of the pathology he/she presents with, has to pay for health care provision (as is done in many primary health care settings), the service will not be perceived as “free,” even though the RDT and the ACT will be provided gratis. The same goes for consultation fees. If clinicians keep on charging fees for the actual “consults,” in the assumption that the malaria diagnosis can only be made after having seen a clinician, malaria-related services will not be truly free of charge. We therefore recommend doing a more detailed analysis of the current de facto cost-sharing practices in the public sector in order to make more practical recommendations to ensure free fever testing and malaria treatment.

Guaranteeing financial access will be challenging as many cases of fever will present at the health facility (requiring a test), but few (almost none) will be positive for malaria during an elimination program. In Nigeria, for example, it was clearly demonstrated that poorer households have higher rates of self-diagnosis for malaria suggesting that user fees for malaria diagnosis influence health seeking behavior, especially for the poor (Uzochukwu & Onwujeke, 2004). We therefore suggest the following pragmatic steps to ensure that the goal of free malaria diagnosis and treatment is achieved:

- Triage in the waiting rooms to identify cases of fever or patients with a history of fever to be tested for free (microscopy or RDT). In places where fees are collected at a central point before any services are provided, triage will need to be done before patients are required to pay;
- Positive cases need to be seen immediately without charging a consultation or any other fee;
- Free provision of treatment for positive cases, not only ACTs but also any other drug required including for associated pathologies; and
- Clear communication towards the patients on which services are supposed to be free.

The MOHSW will need to include these recommendations in the necessary policy documents and communicate them to health professional at all levels of the system. The implementation of these recommendations will require strong supervision to ensure that facilities comply with these recommendations.
community needs to be aware that fever testing and malaria treatment are supposed to be free so that abuse or non-compliance can be reported.

**Access to Health Professionals**

Although geographical access is considered to be very good on Zanzibar with 95% of the population living within a 5km radius from a public health facility, this is only the case at certain hours of the day. Not all facilities are open all hours of the day/ all days of the week, and even the official opening hours are often not respected. This is partly due to the fact that not all facilities, especially PHCU’s, are fully staffed. In theory a PHCU should have 9 staff members, but in reality very few are fully staffed. Most, but not all, have 4 staff members (2 technical (medical) and 2 support staff). Unfortunately, no official figures are available on the actual staffing per facility (Hussein Hamsi, personal communication). The reasons for the human resource gap in the public sector are multiple and beyond the scope of this report. Nevertheless, it is important to point out that the gap is not only due to the fact that insufficient numbers of health professionals graduate every year but also because of:

- Better salaries in the private sector (informal interviews indicate up to 50% higher);
- A preference to work in the different vertical programs where there are more opportunities in terms of workshops, travel, training and per diems; and
- An unequal distribution between urban and rural areas and even between morning and evening shifts and an apparent misuse of the “light duty” option that excludes night shifts.

Several projects funded by DANIDA, USAID and ADB are trying to address the different challenges related to human resources in the public health care sector based on the Human Resources for Health 5 year development plan (Revolutionary Government of Zanzibar, 2004). Although a more detailed assessment of the current situation in terms of access at any given time is desirable, a number of general recommendations can be made with the information available. These recommendations assume that geographical access of facilities is sufficient (no new infrastructure needs to be built), but that these facilities will need to operate more frequently if the goal of universal malaria diagnosis and treatment is to be achieved. We also suggest taking advantage of the plan to increase the number of facilities that will be providing emergency obstetric care (24h/7d) in selected facilities (Bijlmakers et al., 2007).

- Before starting the elimination program, all public health facilities should be at least partly staffed (4 minimum) on a daily basis to guarantee access during normal opening hours.
- Train the nurses on duty for emergency obstetric care on the use of RDT for malaria diagnosis.

In addition, facilities should have the necessary means of communication (mobile phone) so that they can notify the relevant people in case of a positive malaria test. It will be paramount to properly inform the catchment population of these facilities.

**Access to Specialized Care**

As the number of malaria cases goes down, the proportion of severe cases with cerebral malaria will increase due to decreased immunity in the population (Greenwood et al., 2008). A functioning referral system including means of transport to higher-level facilities will be essential to deal with these cases in a timely manner. This approach will require adequately trained staff that can both recognize/diagnose severe malaria and provide pre-referral treatment. The availability of a vehicle rather than distance will be the main challenge for quick referral. Today the referral systems are not organized at all and we therefore recommend that the recommendations made in the Review of Essential Health Care Package in Zanzibar (p 80-81) (Bijlmakers et al., 2007) are implemented before elimination efforts are started.

**Access for Minority Groups**

Access to health care is not only a matter of financial and geographical access but can also be compromised if specific groups are excluded or have more difficulty accessing the system. Anecdotal evidence suggests that certain minority groups have experienced difficulties in getting bed nets from mass distributions. These are of course rare exceptions and the ZMCP has strongly acted against these practices but when going for elimination the message must be clear: everyone, including all possible minority groups, immigrants, and even tourists, should have access to free fever testing, and free malaria treatment if necessary. In addition, the provision of these services should never lead to any form of prosecution. For example, an illegal immigrant should receive malaria treatment when necessary without having to fear being reported to immigration services and/or the police. If this is not the case, illegal immigrants might delay or even avoid seeking health care and as such pose a serious risk for the reintroduction of malaria on the islands. Although it will be required to notify the authorities of all cases and a follow up is likely to be done for an epidemiological investigation, the systematic reassociation of these minority groups will be the only way to over time ensure that all cases, regardless of who the patients is, will be detected.

**Access to Quality Supplies**

Access to treatment and diagnostics requires the continuous availability of supplies in all health facilities (including some private facilities). The procurement and supply management of these essential items will, due to the nature and aims of an elimination program, experience an important shift of focus from treatment to diagnosis.

The fact that ideally all fever cases should be tested means that the need for diagnostic tests such as RDT and supplies such as Giemsa will increase over time and eventually reach a plateau only influenced by population growth and potentially a reduction in other diseases that present with fever. For treatments the volume will reduce over time to negligible levels during the maintenance phases. Nevertheless, every facility will be required to have ACT’s for all age groups in stock so that they can treat any positive case without delay. Because ACT’s have a short shelf life, stock management of these rarely-used drugs poses specific problems.
Currently, ACTs are not part of the kit-system that is used to supply the public health facilities, but are instead distributed by the ZMCP based on demand (pull-system). We recommend that ACT supply remains the responsibility of the ZMCP. The teams that will be responsible for case investigation (and that should visit the facility where a case has been identified without delay) can be used to re-supply a facility that has given out a treatment. (Integrated) supervision teams should be encouraged to systematically check the availability and expiry dates of ACT at all facilities.

As mentioned above, as malaria cases become increasingly rare, the proportion of severe cases, especially with cerebral malaria, is likely to go up. Apart from an efficient referral system discussed above, severe cases will often require intensive care and treatment to deal with a variety of complications such as respiratory distress, kidney failure and coma, to name a few. It will therefore be important to:

- Have IEC/BBC activities stressing the importance of prompt treatment through immediate health seeking behavior for every fever case.
- Upgrade the Intensive Care Unit at Mnazi Moja Hospital to deal with the most common complications of severe malaria. In addition, the main referral hospital on Pemba should have adequate capacity to stabilize severe cases before referral.
- Set up a referral system to send cases that cannot be treated at Mnazi Moja to Tanzania mainland and abroad (e.g., Kenya) for live saving treatment. These cases will be extremely rare but will require a special budget to ensure access to these specialized services even for the poor.

We do recognize that the above recommendations are not necessarily elimination specific. Other potentially life threatening diseases require the same level of care. We therefore did not include the cost related to these recommendations in the costing exercise for this feasibility assessment.

The private sector can obviously contribute to increased access to care, but it would be unreasonable to assume that their services will be free. However, private structures that will be included in the elimination program (private hospitals, clinics) should be provided with free ACTs and diagnostics. Free access to malaria testing and treatment in the private sector could increase the likelihood that people would get tested and that they are treated with a quality drug according to the national treatment guidelines. Private clinics would still charge for physician consultations (unless the government decided to reimburse patients for private consultations). The primary challenge to be addressed with the private sector, however, is the issue of quality, which is examined below.

QUALITY

Delivery of quality health care is an overarching goal of the Zanzibar government and as such is not specific to malaria elimination. However, the success of an elimination program will depend heavily on the quality of services the health system provides. If a sufficient level of access to services has been achieved, poor quality of services will be one of the most important barriers to a successful elimination program. Specifically, the quality of clinical care, diagnosis, and medical supplies must all be examined and strengthened in preparing an elimination program.

Clinical Care

To achieve elimination, it will be essential that patients be provided with prompt, high-quality care for all fever episodes, not just malaria. An accurate differential diagnosis followed by appropriate treatment of non-malaria cases must be the cornerstone of moving the population and health system away from the old adage of “fever equals malaria”. To achieve that standard, there must be sufficiently motivated health workers who are provided with the necessary training and tools so that they feel confident in their analysis and treatment of non-malaria fever cases. At the same time, patients will need to be educated so that they understand that malaria will no longer be the main cause of fevers and that they will typically need medicines other than anti-malarials to effectively treat their illness.

We did not find any formal assessments of the quality of care provided in the public and private sector in Zanzibar. The “Zanzibar Health Care Worker Productivity Study” conducted in 2007 evaluated how productive health workers are by cadre, but it did not evaluate the quality of care provided to patients (Ruwoldt & Hassett, 2007). However, the main challenges identified by that study-low productivity at the PHCU level and a decline in productivity over the course of the day-are relevant and important to malaria outcomes. As a result, it is recommended that the main recommendations of that study, notably the strengthening of the Human Resources for Health Technical Working Group and supervision systems, and the establishment of time management procedures for health workers, should be implemented as part of a malaria elimination effort.

Capacity and Motivation

Strengthening supervision of the health facilities was included in the latest GFATM malaria proposal as a way to increase and sustain the quality of case management at the periphery of the health system. Even though the ZMCP has already achieved strong success in case management through the introduction of ACTs and training of health care workers (94% of all facilities have at least one staff member trained in malaria case management and IMCI), there is still room for improvement, especially at the PHCU level. This was clearly mentioned in the last Health Sector Performance Review (MOHSW, 2008), and anecdotal evidence, including from a visit to a PHCU by the assessment team, confirms that practices in these facilities can be well below standards and likely inhibit the quality of care provided to patients.

These weaknesses are due in part to the low motivation of health workers as well as the consistent understaffing discussed above. The standard of care that is needed for an effective elimination program (e.g., careful differential diagnosis, explanation of illness, and appropriate treatment to patient, etc.) requires more time workers and precision from health workers than the current standard of presumptive anti-malarial treatment. As such, it is important that workers have the necessary motivation to consistently employ this approach despite often challenging
The shift from presumptive treatment of frequently malaria-positive fever cases to strong differential diagnosis in an environment with little or no malaria will require important changes in both pre-service and in-service training of health workers. As malaria cases become rare, health workers will lose their experience in diagnosing and treating the disease. Yet continued ability to recognize and appropriately treat malaria will be critical even after elimination due to the continued imported cases and potential outbreaks. Training programs will therefore need to include modules on malaria that give the disease a more prominent position than it would merit based on its prevalence.

One of the drivers of the current frequent presumptive treatment of fever with anti-malarials is that it is considered unacceptable to miss a malaria case due to the potential rapid and severe consequences. While this attitude may be justified in holo-endemic settings, the negative impact of overtreatment (i.e., mortality from other severe febrile illnesses treated with anti-malarials) will often be greater than that of untreated malaria infections in an elimination environment. As such, all training programs, guidelines, job aids, diagnostic tools, and supplies will progressively need to be adapted to ensure that health workers have the knowledge, tools, and necessary supplies to identify and treat non-malaria-related fevers.

**Changing Patient Perception**

Patients need to be informed about the fact that when they present with fever, the likely cause will be not malaria but something else, something that will not always have a name. This might give the impression that their fever is not taken seriously, and that they are not really sick. Qualified and confident health workers will be able to deal with this but it will be equally important to include adapted messages in IEC/BCC campaigns and materials to address this challenge. These messages should explain the importance of malaria testing for all fevers, the fact that most of these will be negative, and they should also provide an overview of the alternative illnesses that can cause fever (and potential treatment). Changing the patient’s perception or preconceptions in regards to fever—fever often being a synonym for malaria—will be as important as changing the health care workers behavior. This is further discussed in the section on community involvement and on the restructuring of the ZMCP.

**The Private Sector**

While often overlooked, quality of care in the private sector will also need to be considered and addressed. As discussed, there is little existing evidence in this area. An assessment of the private sector funded by the African Development Bank (Revolutionary Government of Zanzibar, 2004) only evaluated its current status and looked at opportunities for the private sector in the overall health system. Anecdotal evidence suggests that quality of care varies considerably in this sector depending on the type of facility and its staffing. Regulatory bodies are in place, but their mandate does not necessarily include on-the-job supervision to evaluate the quality of care provided. The table below provides suggestions on how quality of care could be defined and achieved at facilities of a particular type in the context of an elimination program.

**TABLE 12: QUALITY OF CARE IN PRIVATE FACILITIES**

<table>
<thead>
<tr>
<th>Type of Private Facility</th>
<th>Targeted Service Quality</th>
<th>How to Achieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shops (informal outlets)</td>
<td>All fever cases encouraged to get tested</td>
<td>IEC/BCC material available at the shops; incentives for referral to public facilities</td>
</tr>
<tr>
<td></td>
<td>No anti-malaria drugs sold OTC</td>
<td>Impose by law; mix of enforcement and incentives to ensure compliance</td>
</tr>
<tr>
<td>Pharmacies</td>
<td>All fever cases encouraged to get tested</td>
<td>IEC/BCC material available in the pharmacy</td>
</tr>
<tr>
<td></td>
<td>ACTs only sold based on an official prescription</td>
<td>Introduction of “official” prescription papers</td>
</tr>
<tr>
<td>Clinics</td>
<td>All fevers are tested</td>
<td>Potential subsidized supply of RDTs</td>
</tr>
<tr>
<td></td>
<td>Only positive cases are treated with anti-malarials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Severe cases are recognized and immediately referred</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All positive cases are immediately notified</td>
<td></td>
</tr>
<tr>
<td>Hospitals</td>
<td>All fevers are tested for malaria</td>
<td>Training of health workers; potential subsidized supply of RDTs</td>
</tr>
<tr>
<td></td>
<td>Only positive cases are prescribed (or treated with ACTs)</td>
<td>IEC/BCC Campaigns targeting both patients and health workers</td>
</tr>
<tr>
<td></td>
<td>Severe cases receive adequate treatment</td>
<td>Appropriate training; incentives for clinics that properly refer</td>
</tr>
<tr>
<td></td>
<td>All positive cases are immediately notified</td>
<td>Incentives for clinics that notify all cases</td>
</tr>
</tbody>
</table>
As discussed, private facilities that will be allowed to treat malaria will need to be included in the surveillance and supervision system. Appropriate training of health workers in the private sector combined with aggressive IEC/BCC campaigns both targeting the patient and the health worker should also be a core component of case management efforts in an elimination program. Quality of care is difficult to assess, but it will be important that a number of relevant metrics be established and regularly monitored to ensure that the private sector is meeting the necessary standards for elimination.

**Diagnosis**

The current target of having 90% of all malaria cases seen in health facilities to be microscopy or RDT confirmed by 2014 is sufficient for a control program (GFATM Malaria Proposal for Round 8), but a more ambitious—and challenging—target will need to be established as an elimination progresses. Specifically, **100% of malaria cases seen in both public and private health facilities will need to be confirmed by RDT and/or microscopy.**

Adopting and implementing an appropriate algorithm for malaria diagnosis, including the use of different tools within the system, will be central to achieving that target. Given the current state of the health system and workforce, we recommend the following algorithm (see Table 13):

1. All fever cases, regardless of the facility where they present, should be tested using an RDT.
2. All positive RDTs should be tested by polymerase chain reaction (PCR) at the central level.
3. A 10% random sample of all negative RDTs should be tested by PCR for quality control.
4. Where microscopy is available, all patients with a positive RDT should be re-tested at the facility using microscopy on both thick and thin films for species identification and parasite density quantification.
5. All positive slides should be re-read for quality control at the central level.
6. All negative slides (discordant results) will have to be re-read for quality control, the result should be compared to the PCR testing on the initial RDT taken (which indicated a positive result) and, if possible, the patient should be traced and tested again with PCR using a new sample. It will be very important to document these discordant results and to investigate the causes of the conflicting results.

**Diagnosis**

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1. All fever cases, regardless of the facility where they present, should be tested using an RDT.
2. All positive RDTs should be tested by polymerase chain reaction (PCR) at the central level.
3. A 10% random sample of all negative RDTs should be tested by PCR for quality control.
4. Where microscopy is available, all patients with a positive RDT should be re-tested at the facility using microscopy on both thick and thin films for species identification and parasite density quantification.
5. All positive slides should be re-read for quality control at the central level.
6. All negative slides (discordant results) will have to be re-read for quality control, the result should be compared to the PCR testing on the initial RDT taken (which indicated a positive result) and, if possible, the patient should be traced and tested again with PCR using a new sample. It will be very important to document these discordant results and to investigate the causes of the conflicting results.

**Figure 23: Algorithm for Malaria Testing in an Elimination**

Although the WHO guidelines recommend 100% of cases to be confirmed by microscopy, the above proposed algorithm was established taking into account the local context and new diagnostic tools available. We recommend all fever cases to be tested (i.e. not only suspected fever cases). As pointed out above, this will increase the number of tests performed considerably over time and will create a high workload on the health professionals at all levels of the health care system. We therefore recommend using RDTs for all fever cases. The sensitivity of these tests makes them good enough to be used as a screening tool, especially when compared to microscopy under field conditions (de Oliveira et al., 2009). In addition, RDTs have also been shown to be the most cost-effective methods to correctly diagnose malaria in a primary health care setting (Chanda et al., 2009). Massive use of RDTs will require robust systems for quality assurance (batch testing) and quality control. We suggest using PCR for quality control of all positive RDTs and a 10% sample of negative RDTs. The results of the PCR tests can also be used for the parasite strain database (see M&E section). The requirements related to the use of more complicated diagnostic methods such as PCR are discussed in the section “From ZMCP to ZMEP.”

In addition to ensuring broad coverage of diagnosis, both RDTs and microscopy will need to be performed with a high degree of precision. The quality control system (see Figure 24) will need to be rigorously implemented. Fortunately the basis for such a system already exists and a budget to cover all public and private health facilities was developed for the unsuccessful health system strengthening component of the round 8 Global Fund proposal. In the proposal, the ZMCP was responsible for quality control in the public sector. The ZMCP will need to find the necessary funding—one option would be reapplying to the Global Fund—to ensure that the proposed system becomes operational as soon as possible. For the private sector, capacity development, training of private facility technicians, the development of guidelines, and supportive supervision will be done through ZAMELSO (Zanzibar Association for Medical Laboratory Scientific Officers) funded through the Rapid Funding Envelope and PACT Tanzania. It will be important regularly evaluate the system and to guarantee sustainable resources for this activity.
A key challenge will be that as an elimination program progresses a growing proportion of slides will be negative. Once elimination has been achieved, laboratory technicians will no longer see positive cases and will lose experience in detecting malaria, particularly when the patient has low parasitaemia. Frequent quality control of negative slides and RDTs will therefore be important. In addition, laboratory technicians will need to be regularly trained on malaria diagnosis to make up for the lower exposure to the disease on the job. Quality control of tests can, as has been done in Oman, be centralized to the national reference laboratory, but we would only recommend this for the later stages of the elimination program when the volume of tests has declined.

Medical Supplies
Treatment and diagnosis can only be as good as the quality of the supplies that are used. A system for quality assurance for diagnostic tests (RDTs, PCR reagents and equipment) will need to be established. For both the public and private sector, the responsibility for drug quality assurance falls under the Zanzibar Food and Drug Regulatory Body (ZFDRB), part of the Procurement Unit of the Central Medical Stores of the MOHSW. Currently, quality testing is often limited to scrutinizing the importation documents, and laboratory testing is not routine. The ZFDRB recently received mini-kits for drug quality testing, but insufficient resources in other areas (e.g., staff) will impede progress in this area. The unsuccessful HSS component of the latest GFATM malaria proposal, addresses some of the weaknesses of the ZFDRB, including building a more rigorous system of drug quality testing. Unfortunately, as long as there is no funding, these services will remain inadequate. The ZFDB is also responsible for the supervision of private facilities and checking if standards for infrastructure, staffing and drugs are respected. They have the authority to, after a series of warnings, close any facility that doesn’t meet the necessary requirements. Especially in the private sector, substandard quality drugs remain a concern and additional funding will be necessary to allow for batch quality control of incoming medicines through the provision of laboratory equipment and reagents for the Government Chemist Laboratory. If the MOHSW decides to eliminate malaria, it will be paramount to ensure that these systems are adequately funded to guarantee quality diagnostics and treatment.

CONCLUSION
The Zanzibar Health Care System will need considerable strengthening before embarking on malaria elimination. Passive case detection, case notification and case management—the health care system’s main tasks—will need to be near perfect. Health facilities therefore need to be able to provide quality diagnosis and treatment, ideally free of charge to ensure access for all. On Zanzibar, geographical access to public health facilities is good, but the necessary human resources are not always in place to ensure access to treatment for the population. Ensuring the necessary human resource capacity, in terms of both skills and numbers, at all levels of the health care system will be the main challenge. The MOHSW will also need to clarify its current policies and future strategies in regard to user fees. These fees are officially not in place but in reality a barrier to access. In addition, the necessary mechanisms need to be put in place to ensure that minority groups, including tourists and illegal immigrants, have access to free malaria treatment.

Assuring high quality diagnosis and treatment will be equally important. This will not only require motivated and regularly trained staff, but it will also require that the necessary quality supplies are available at any given time at all levels of the health care system. Training and motivating health workers alone cannot achieve this. The patient will also need to be informed that in an elimination setting getting tested for malaria for any fever is extremely important, and both health providers and receivers need to be convinced that not every fever is a malaria fever. We also suggest using a new algorithm for malaria diagnosis that is simultaneously relatively easy to implement and of high enough quality for an elimination setting.

We are not arguing that the Zanzibar Health System needs to be perfect before embarking on a malaria program. Certain activities will need to be executed with a high(er) degree of perfection. These activities will require important investments, mostly in terms of human resources. The implementation of important recommendations from important strategic documents such as the essential health care package and the human resources for health reports will substantially facilitate achieving and maintaining malaria elimination. Their progressive implementation will be a first and essential step in Zanzibar’s move towards elimination.
“He should have the quality of LEADERSHIP, because during a number of years he will be the chief of an army that must win a difficult war. He needs COURAGE, because he must dare to recognize the faults of his organization, to correct his mistakes, to dismiss the wrong men, to face unpopularity and to fight continuously against the lukewarm, if not definitely cold, attitude of a number of officials whose routine administrative habits are disrupted by his request for punctuality, and who sometimes happen to be superior in rank, and/or may have a say as regards to his future position when eradication is complete. He must have FAITH, because a number of influential people in his country think they know better and will look at the program as at an unrealistic, extravagant and costly enterprise; and because if he has not faith in the success he will not be able to inspire his staff, to stimulate them to sustain those efforts and hardships that are their lot. He must show PERSISTENCE, because it is only too likely that during all the 8 or more years of the malaria eradication program, new problems will arise, trained men will leave, the cooperation of the population will deteriorate, the enthusiasm of his own staff will gradually disappear; while that degree of the perfect of the work, necessary for success, must always be maintained during all those long years. To those four virtues must be added the ABILITY TO ESTABLISH GOOD RELATIONSHIPS with the critics and dissenters.”

–Emilio Pampana, 1969, on the qualities of a Director of a National Eradication Program.

INTRODUCTION

When moving towards elimination, the ZMCP will be faced with different requirements related to the administration of the national program. Today, the ZMCP has sufficient capacity to implement the control interventions specified in their national strategy. However, the shift in focus from the classical control measures, such as the distribution of impregnated mosquito nets and ACTs, to more intensive surveillance will require a shift in competencies and capacity within the program. An important difference from control as illustrated by Emilio Pampana’s quote lies in the program leadership required. In addition, the program will need to be provided with the necessary tools and competencies to implement a far more complicated M&E system.

This chapter compares the current capacity of the ZMCP with the requirements for an elimination program and identifies gaps in terms of human resources, equipment and infrastructure that will need to be addressed before embarking on elimination.

STRUCTURE AND RESPONSIBILITIES OF THE ZMCP

The ZMCP is responsible for the coordination of all malaria activities on Zanzibar. It is a sub-Unit of the Directorate of Preventive Services and Health Education of the Ministry of Health and Social Welfare. The latter are the principle recipient of the Global Fund grants but the day-to-day management of the grants has been delegated to the ZMCP. The set-up of the ZMCP can be seen in the organizational chart below (Figure 24).
The ZMCP is relatively well staffed with departments responsible for the coordination—and sometimes implementation—of different activities related to the objectives of the strategic plan. The program is financially supported by the MOHSW and through funding from different grants that provide not only financial support but also technical assistance. Under the Global Fund Round 8 grant, the ZMCP has asked for technical assistance to strengthen its capacity in a number of areas, including quality control of laboratory services.

- **QA/QC of laboratory services** to ensure that the recent physical upgrade of the central referral laboratory is complemented by technical capacity upgrading for QA/QC in order strengthen the system and expand coverage to all private and public laboratories.

- **Pharmaco-vigilance** to allow the MOHSW to collect information on drug adverse events for not only antimalarial but also other products and provide the ZMCP and other relevant health sector programs with information for evidence-based decision making.

- **Strengthening the HMIS** at central and district level over a two year period.

- **Community systems strengthening** to develop a community-based BCC communications tool kit and train community and health facility resource persons in order to ensure consistent activities (in terms of quality and effectiveness) at the community level and enhance linkages with the peripheral facilities.

Although not elimination specific, all of the above will further enhance the ZMCP when moving towards elimination. More specific requirements for the ZMCP and the necessary strengthening related to these requirements are discussed below.

**REQUIREMENTS FOR AN ELIMINATION PROGRAM**

Historically, the GMEP was mainly focused on IRS, and the programmatic requirements for the elimination program were strongly related to the management of the spray teams at all levels by what was called the “Division of Operations”. Pampana (1969) further proposed a Division of Epidemiology (or Evaluation) and a Division of Administration composed of an entomological, parasitological, epidemiological, statistical and administrative, health education, and public relation section, respectively. He also stressed the importance of strong leadership and the need of independence of the NMEP, with preferably a direct management link between the director of the eradication program and senior management in the MOH.

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**FIGURE 25: ORGANIZATIONAL CHART PROPOSED BY EMILIO PAMPANA IN “A TEXTBOOK OF MALARIA ERADICATION”, OXFORD UNIVERSITY PRESS, 1969**

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**Scheme of an Organizational Chart of a National Malaria Eradication Service**

<table>
<thead>
<tr>
<th>GOVERNMENT</th>
<th>Ministry of Health</th>
<th>Ministry of Finance</th>
<th>Other relevant ministries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime Minister</td>
<td>National Malaria Eradication Board</td>
<td>Malaria Eradication Co-ordination Committee</td>
<td></td>
</tr>
<tr>
<td>Malaria Institute</td>
<td>Health Education Chief Education Officer</td>
<td>Health Education Chief Education Officer</td>
<td></td>
</tr>
<tr>
<td>and/or other institutes</td>
<td>Health Education Chief Education Officer</td>
<td>Public Relations Public Relations Officer Information Officer</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Division of Operations</th>
<th>Division of Epidemiology (or Evaluation)</th>
<th>Division of Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chief of Operations</td>
<td>Chief Epidemiologist</td>
<td>Chief Administrator</td>
</tr>
<tr>
<td>Inspector(s)</td>
<td></td>
<td>Budget Officer</td>
</tr>
<tr>
<td>Statistician(s)</td>
<td></td>
<td>Accountant(s)</td>
</tr>
<tr>
<td>Sanitarian Draftsmen</td>
<td></td>
<td>Personnel Officer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Registry Officer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supply Officer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transport Officer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Storekeeper(s)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mechanics (Central workshop)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zonal Administrative Officer (Accountant)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zonal Storekeeper(s)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Zone workshop)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zonal Health Educator</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zone</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Zonal chief of operations</td>
<td>Zonal Epidemiologist</td>
</tr>
<tr>
<td>Field supervisors</td>
<td>Senior laboratory technician</td>
</tr>
<tr>
<td></td>
<td>Microscopists</td>
</tr>
<tr>
<td></td>
<td>(Laboratory technician)</td>
</tr>
<tr>
<td></td>
<td>Microscopists</td>
</tr>
<tr>
<td></td>
<td>(Field laboratory)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Field</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sector chief of operations</td>
<td>Assistant Chief of Sector</td>
</tr>
<tr>
<td>Supervisors</td>
<td>(Sector chief of surveillance)</td>
</tr>
<tr>
<td>Squad leaders</td>
<td>Surveillance supervisors</td>
</tr>
<tr>
<td>Spraymen, seasonal</td>
<td>Surveillance agents</td>
</tr>
</tbody>
</table>

**NOTES:** Secretaries, typists, junior clerks, drivers, servants, guardians, and so forth have not been mentioned. In brackets are posts that are necessary in large programmes.
The current WHO guidelines give recommendations on the requirements for the different phases of an elimination program but do not, as such, propose a structure for the malaria program for each phase. The table below brings together a number of essential requirements (adapted from WHO guidelines) and identifies areas where the ZMCP might need to be strengthened when moving towards elimination. The areas to be strengthened were not identified based on a robust analysis of the ZMCP but rather through comparing the current organizational chart (and competencies in the ZMCP) with the requirements in terms of HR, infrastructure and equipment for case management, vector control & prevention, and M&E for an elimination program.

**TABLE 13: INTERVENTIONS BY PROGRAM TYPE (ADAPTED FROM THE WHO, 2007)**

<table>
<thead>
<tr>
<th>(Pre) Elimination Requirements</th>
<th>Strengthening of ZMCP Required</th>
<th>Human Resources</th>
<th>Equipment</th>
<th>Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Management</td>
<td></td>
<td>HR (skills and/or numbers)</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>QA/QC</td>
<td></td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Active case detection</td>
<td></td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Monitoring drug resistance</td>
<td></td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Geographical reconnaissance</td>
<td></td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Perfect case detection system</td>
<td></td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Reducing vector capacity (VC) in foci</td>
<td></td>
<td>YES</td>
<td>YES</td>
<td>YES (!?)</td>
</tr>
<tr>
<td>Outbreak preparedness and response</td>
<td></td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Entomological surveillance</td>
<td></td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>M&amp;E</td>
<td></td>
<td>Genotyping</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Malaria elimination database</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

The recommendations made in this chapter only try to provide a general framework for the management of an elimination program. The actual implementation will depend entirely on key decisions made by the MOHSW. For example, the MOHSW might decide that some of the proposed departments should not sit under the ZMCP or that existing departments apart from the ZMCP need strengthening to achieve elimination. However, we strongly suggest that the elimination program, whatever its form will be, has a robust central management, with a direct link to the leadership of the MOH and a strong mandate based on a legal framework approved by the Government of Zanzibar.

**HUMAN RESOURCES**

“The ZMCP is overly reliant on external partners for particular areas of expertise... and is inundated with external visiting partners, leaving little time to monitor activities or integrate them across MOHSW programs.”

–GFATM Round 8 Proposal on “Missing Skill Sets in the ZMCP”

The ZMCP will need to be strengthened over time in terms of human resources, not only by increasing/adding positions but also by changing/adapting the existing skill set within the program. With no long-term guaranteed funding for a disease that will become increasingly rare, the ZMCP will need to build the necessary in-house capacity in terms of technical expertise to replace the current technical assistance from donor agencies such as CDC PMI. This will not only contribute to the sustainability of the program but will also increase the ownership by the ZMCP of the elimination program.

Over time (and this will depend on how fast elimination will be achieved), we propose to increase and adapt the human resource capacity so that the ZMEP will be able to effectively implement the core activities of an elimination program. The current structure with four major departments and an administrative support unit could be retained, but the tasks/responsibilities would be adapted and renamed to fit the four key activity categories for elimination. These include:

1. **Vector Control Unit**
2. **Surveillance and Response Unit**
3. **Monitoring & Evaluation and Operational Research Unit**
4. **Communications Unit**

We suggest creating a separate sub-department for administration, responsible for the financial and human resource administration of the program, allowing the program manager to focus more on the management of the operational units and his/her work related to reporting/advocacy to senior management in the MOHSW. A deputy program manager who would lead the Pemba sub-office would assist the program manager.

The responsibility and human resource requirements for each of the 4 operational units or cells is further discussed in detail below.

**Vector Control Unit**

Vector control using IRS and LLINs will initially need to be continued due to the relatively high vulnerability of Zanzibar. The ZMCP has demonstrated that with the help of CDC and partners such as RTI, it is capable of implementing all necessary IRS activities to achieve high coverage levels. In the later stages of the elimination program IRS will change from a purely preventive control tool to a more targeted foci elimination tool and might need to fall under the responsibility of the epidemiological response unit instead of the vector control unit. It is up to the ZMCP to decide which department will ultimately be responsible for spraying activities, but a strong collaboration between both units will be paramount in any case. In addition, the more

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4. The WHO insists on “microscopy” confirmed. However, the feasibility assessment proposes an alternative algorithm for diagnosis using RDTs and PCR.

5. The QA/QC mechanisms proposed are adapted to the tools used for diagnosis: RDT, microscopy and PCR.
elaborate entomological surveillance recommended in the surveillance section above will require the necessary human resource capacity for entomological surveillance (mainly assistants for field work) and for the management of the necessary entomologically evidence-based vector control activities.

SURVEILLANCE AND RESPONSE UNIT

Surveillance Unit

The Surveillance Unit would be responsible for all activities needed to achieve high case detection rates. For passive case detection this implies that they would not only be responsible for the analysis of the data coming from the different health facilities but also for the training of staff and QA/QC of the different tests used in collaboration with the M&E and Operational Research Unit. The unit should also have a focal point for all active case detection activities if operational research suggests that active case detection of high risk groups or specific areas is required.

The number of cases that need treatment will go down over time (to almost zero), but all fever cases will need to be tested to ensure that every case is identified to then avoid onward transmission. This will lead to an increased number of tests to be done, with few being positive and increased need for QA/QC of all tests used. The introduction of DNA PCR, as proposed in the HSS chapter, necessitates the hiring of competent laboratory staff at the central level. The constant need for fever testing, most probably in an environment where health workers might be less motivated as most tests will be negative, justifies the need to have training on malaria diagnosis on a regular basis. Training capacity should ideally be decentralized with training coordinators at the district level and a laboratory trainer of trainers for each island under the coordination of the ZMEP laboratory focal point. Ideally QA/QC (PCR Unit) capacity should be established on each island under the overall coordination of the laboratory coordinator of the ZMEP. This might not be possible from the start, as the program will need to build up the necessary expertise at the central level before establishing a PCR Unit on each island.

Response Unit

Once a case is detected, the foci will need to be investigated and treated in the shortest delay possible to avoid any onward transmission or, in the worst case, an epidemic in a population that over time will become non-immune. The response unit we propose should be lead by an epidemiologist and consist of two sub-units: A unit for rapid investigation/analysis and a rapid response unit. The coordinator of those units should be given full authority to start an investigation every time a case is detected and, based on the epidemiological assessment and analysis, start the appropriate and necessary malaria control interventions to clear the foci and avoid onward transmission. This obviously assumes that data on any detected case are transmitted immediately to the central unit. Where possible and appropriate (remote parts of Pemba, for example) capacity should be built at the district level to start the epidemiological investigation so that no time is lost. Both units would have to closely collaborate with the surveillance and vector control units respectively. For example, the epidemiological investigation should include an entomological assessment, and the necessary staff should be drawn from the vector control unit to help do this.

A separate active case detection unit only makes sense if the program decides to do pro-active case detection. In case the final recommendations, based on operational research recommended in this report, only suggest to do re-active case detection (case detection based on a passively detected index case) we suggest to collapse the active case detection and rapid response unit into one.

M&E AND OPERATIONAL RESEARCH

The M&E and Operational Research Unit will need the competency to manage complex databases and use complex geo-statistical software (see Surveillance and M&E sections in Chapter 3) and will need to hire and/or train additional staff for these tasks. We also recommend establishing a special reporting unit to respond to the often complicated financial and narrative reporting requirements of international donors.

Operational research will be an important component of the elimination program and will most likely be done in collaboration with international partners/research institutes like ZAMRUKI and the CDC. Often these organizations employ their own staff, but close collaboration with the ZMEP and its different departments will nevertheless increase the program’s workload. We therefore suggest creating a position to coordinate all operation malaria-related research so that overlap is avoided and to ensure an efficient collaboration with the different departments within the program.

COMMUNICATIONS DEPARTMENT

We recommend that the ZMCP start a separate communication department. This department will play an essential role not only to achieve elimination but maybe even more to maintain it. It should be responsible for health education, both at the health facility and community level, and for mass communication campaigns explaining certain unpopular measures such as border screening, prophylaxis in migrant workers or a malaria elimination tax on tourists. While the latter can be easily coordinated from the central level, we propose to have at least one health education coordinator for each island. They should work in close collaboration with the districts and the communities and further decentralization in this unit is strongly encouraged. Initially the campaign should focus on achieving elimination through the testing of all fever cases and the continuous use of preventive measures while in the end stages the campaign will have to address the fact that for a disease that no longer affects the population, certain measures/health seeking behavior will still be required.

We also believe it will be extremely important to have a public relations department responsible for all communications related to potential border screening, prophylaxis in at-risk groups and imposed malaria elimination taxes. The ZMEP should develop a communications strategy targeting the tourism industry at
all levels. This includes communication to prospective tourists through brochures (in collaboration with major all travel agents in Europe and North America), information on achievements and the reasons for taxation in media such as in-flight magazines, billboards and flyers at the point of entry, and even promotion of the malaria elimination program (and fundraising) in hotel brochures.

DECENTRALIZATION

The proposed organizational charts do not provide details on decentralization other than positions needed on both islands. However, we strongly suggest decentralizing responsibilities, wherever possible and appropriate, to the relevant levels (island, district or even Shehia). This does not mean that every single unit should be represented at the district level, and we strongly argue against decentralization for the sake of decentralization. Geographical access in Zanzibar is very good with a road network that reaches most villages. For certain units decentralization to the island level will be sufficient while others might want to decentralize to the community level to increase community awareness and ownership. We suggest discussing this in more detail with all stakeholders once all activities for the elimination program have been fully defined.

EQUIPMENT

A full assessment of the ZMCP’s assets (and future funding to buy equipment) has not been done for this feasibility exercise, and the recommendation below only discuss major needs in terms of equipment for some of the proposed departments.

We propose to strengthen the ZMEP in terms of IT so that all databases can be easily shared between departments and secure backups ensured. The set-up of a central database in the M&E unit will require high processing power and sufficient memory capacity not only for the central server but also for the individual computer units. All necessary licenses should be bought to guarantee high quality and legal software packages not only to run and protect (anti-virus, firewalls) the server but also for GIS and any audiovisual/publishing needs.

The surveillance and response unit will need their own transport means at any given time in order to react immediately when a case is identified. The unit will also be responsible for QA/QC and will, as per the proposed algorithm in the HSS chapter, need a PCR unit with all necessary reagents and maintenance equipment. In addition, quality control of microscopy slides and training of microscopists will remain important. The ZMEP will need to assess how far their current set-up is sufficiently equipped to execute these tasks. The same will need to be done for the entomological department.

INFRASTRUCTURE

The infrastructure of the ZMCP is currently being upgraded, and it is unclear in how far the program will be able to accommodate the staffing proposed. It is likely that the set-up of a laboratory with PCR capacity might require adaptations to existing infrastructure and/or building new rooms. We propose to do a full assessment once the current construction is finished and the set-up of the elimination program agreed upon.

COMMUNITY INVOLVEMENT IN MALARIA ELIMINATION

INTRODUCTION

In recent years, there has been growing consensus among the global malaria community that approaches that engage the communities they target (community-directed intervention or CDI) are essential to the achievement of treatment and prevention targets (WHO/TDR, 2008). Such approaches will be even more important for elimination programs than for control. With a high burden of disease and a short period of implementation, it may be possible to have communities accept interventions they don’t fully support. For an elimination program, however, it will be very challenging to achieve and sustain the necessary levels of coverage at low levels of disease if communities do not support the goal and approach. As discussed in the legal section, attempts to force compliance with interventions are discouraged and may be counterproductive, reducing support for the elimination program. In contrast, if communities feel ownership of and engage in the elimination activities, many key activities will be easier to implement and coverage targets more likely to be achieved.

Community involvement is not a science, but rather must be carefully designed to fit the mores and conditions within each country and area. As such, relatively little central guidance exists on specific approaches to community involvement in malaria control and elimination programs. This does not diminish its importance, and in this chapter we consider the role of community involvement in a potential elimination program on Zanzibar.

THE ROLE OF COMMUNITY INVOLVEMENT

Participation is often used to denote the community’s simple acceptance of actions that are being presented to–and sometimes forced upon–them. This chapter uses an alternative definition that considers participation as a process of community involvement in the planning, organization, operation, and control of health activities (WHO, 1984). With this approach, community members play an active and direct role in project development and are involved in a range of relevant decisions, including distribution of health services and tools (e.g., drugs, diagnostics and preventive measures). There is a shift away from monolithic power resting with central decision-makers to allowing communities to play a meaningful and substantive role. Within the paradigm of structural participation, some distinguish between “direct participation” and “social participation”. The former relates to the mobilization of community resources for the implementation of priorities that have been defined by the formal health system, while the latter refers to community involvement in setting priorities for what disease and intervention priorities to pursue (WHO/TDR, 2008). The latter is ideal and should be striven for but may not always be feasible.
COMMUNITY INVOLVEMENT ON ZANZIBAR

Zanzibar had a relatively successful community-based health care program in the early 1990’s. Since that time, however, there has been a significant increase in the fragmentation of community-level services and the interface between communities and the health system. On the upside, this means that a number of skilled and experienced people and structures are already present at the community, but on the downside that coordination of activities has become increasingly complex resulting in inherent duplications and inefficiency of delivery (Suleiman and Borg, 2008). As the recent proposal for health systems strengthening to the Global Fund noted, “at the level of local communities, activities are often conducted in an ad hoc and uncoordinated manner… currently, priority programs are employing multiple community health strategies that respond to programmatic needs but not necessarily to the needs of communities or individuals within those communities.”

Of importance for the community health strategy is that at the community level the country is divided in administrative units, called Shehias (currently 299 in total). While at the district level the District Commissioner (a Presidential appointee) oversees civil services, at the Shehia level the Sheha (a Regional Commissioner’s appointee)-assisted by a ten member Shehia committee—is responsible for the administration at the community level. The Sheha is reporting directly to the District Commissioner on public affairs and is also responsible to maintain a register of vital statistics. A Shehia can contain up to 3 villages and varies in population size.

Current practice of national health programs does tend to bypass the district level and will contact the Sheha directly on community interventions. It then depends on the interpretation of the Sheha for how further contact with the community is established. Moreover, several programs tend to establish their own community “interface” and channels including “extension workers”. This means that several health-related community committees can exist at the same Shehia level. It can be argued that this has led to undesirable fragmentation of health services supply at this level. As a by-product of this fragmented approach a plethora of structures exist at the community level, which make intervention less efficient and effective through a lack of coordination.

Suleiman and Borg (2008) have proposed one single Shehia Health Custodian Committee (SHCC), to replace/transform existing community involvement structures with their varying roles (in most cases initiated by different national programs and external donors).

COMMUNITY INVOLVEMENT IN MALARIA ELIMINATION

Community involvement in the GMEP of the WHO has, to our knowledge, been relatively poorly documented and described. The only direct reference to community participation we found was related to the use of volunteers for spraying activities initiated by a group of students in Pakistan as part of their program of community social service and subsequently used mainly to reduce costs in resource limited settings (Afridi, 1956). The evaluation of this scheme did not only show results in terms of cost reductions, higher coverage and impact on malaria prevalence (demonstrated through reduced spleen rates) but also concluded that community participation (described as “self-help”) can be used to bear a considerable part of the human resource burden for the labor intensive spraying activities.

More recently the WHO and the RBM Partnership have extensively promoted community participation in malaria control, but we were not able to find recommendations related to community participation in elimination programs in any of the recent elimination guidelines. For a disease that will become increasingly rare, involving the community to ensure ownership and buy-in will be essential to achieve the necessary coverage of preventive measures and acceptance for activities such as active case detection or IRS. On Vanuatu, an island group in the Southwest Pacific, a high level of community participation was identified as a key factor in the success of the elimination program. Community involvement resulted in a high acceptance of mass drug administration and bed net ownership and use, without which elimination would not have been achieved (Kaneko et al., 2000). Other elimination efforts in the Southwest Pacific are planning to have strong community involvement based on the above-mentioned results in Vanuatu (Andrew Vallely, personal communication).

Although no guidelines exist on community involvement in malaria elimination, the RBM Partnership has proposed a set of objectives related community participation to malaria control (WHO, 2002). These objectives are equally important for malaria elimination and we believe that the community can actively contribute to their achievement. The table below proposes a number of activities for each of these (control) objectives that could contribute to achieving and maintaining elimination.
In Zanzibar, the above-proposed SHCC can be used to involve the community in malaria elimination. Community involvement will be more relevant for activities that require either individual action (using an LLIN) or acceptance to provide a sample (active case detection) or allow people inside private premises (IRS). For these activities, the health services and its partners could introduce preventive measures for a disease that is rare.

Apart from the SHCC, other community groups such as youth groups, women’s associations, sports clubs, and cultural groups, can be valuable partners for community-directed malaria elimination activities. In addition, traditional birth attendants and traditional healers play an important role and are often the first level when it comes to health seeking behavior. Buy-in from both groups will therefore be a key determinant for the success of malaria elimination, especially related to advice on appropriate health seeking behavior for people with fever. As pointed out above, they should be provided with the necessary technical assistance to fully take advantage of their contribution. Behavior change, both in terms of health seeking behavior and adherence to preventive activities, can also be promoted in schools by including relevant messages on malaria in the curriculum.

### RECOMMENDATIONS

- The results of the different community surveys should be used to identify areas that require community level interventions and participation. Reasons for not seeking care for fever, for example, should be thoroughly analyzed and addressed in collaboration with the community.
- LLIN and IRS campaigns should systematically evaluate reasons for non-usage and refusal rates, respectively. Community-level focus group discussions can be used to better understand the reasons behind non-usage or refusal and to identify potential solutions.
- Aggressive IEC/BCC, with strategies and methods adapted to the Zanzibar context, should continuously repeat the need to have all fever cases tested and to keep coverage/usage for personal protection high. In addition, IEC/BCC campaigns should also be used to explain why certain malaria elimination-specific activities such as case investigations are important and how they can benefit the community.

### TABLE 14: COMMUNITY ACTIVITIES FOR A MALARIA ELIMINATION PROGRAM

<table>
<thead>
<tr>
<th>Objective</th>
<th>Activity (Elimination Program)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encourage appropriate health-seeking behavior of caregivers, family, and community by improving the recognition of malarial illness (including severe illness) and the decision to seek appropriate treatment within 24 hours of onset of illness</td>
<td>Use survey results (DHS, MICS) to identify areas and/or specific groups that have lower rates of health seeking for fever. Evaluate reasons for not seeking health care for fever in collaboration with the community (focus groups discussions) and identify potential solutions. Aggressive IEC/BCC activities with strong community participation and buy-in from community leaders at all levels. Community participation can be achieved by using existing grass-root organizations such as women associations, youth groups etc…</td>
</tr>
<tr>
<td>Strengthen the capacity of health systems, particularly at community level, including access to antimalarial drugs and referral mechanisms</td>
<td>Involve the community in the management and M&amp;E of the local public health facilities through local health committees</td>
</tr>
<tr>
<td>Improve access to insecticide-treated nets, and promote their regular and proper use.</td>
<td>Involve the community in the planning and execution of LLIN distribution campaigns. Use post-campaign surveys to evaluate usage and reasons for non-usage. Evaluate these reasons in collaboration with the community and identify potential solutions. Continuous IEC/BCC, stressing the fact that LLIN usage needs to remain high even in the absence of the disease to protect both the individual and the community as a whole.</td>
</tr>
<tr>
<td>Promote and increase acceptance levels for vector control, including IRS and environmental management wherever appropriate</td>
<td>Involve the community in the planning and execution of IRS campaigns. Document any refusal and invite people who refused to focus group discussion to understand the reasons behind refusal and to find potential solutions. Continuous IEC/BCC on the importance of preventive measures for a disease that is rare.</td>
</tr>
<tr>
<td>Strengthen community self-monitoring and decision-making</td>
<td>Ensure community participation (observers for example) during surveys and/or supervision both at the health facility and for campaigns. Provide feedback to the community and discuss reasons for success or failure. Involve the community in any major changes in strategy through stakeholder meetings both at the district and the central level.</td>
</tr>
<tr>
<td>Build community and local political support for the goal of national malaria elimination and urge leaders to maintain it as a political priority</td>
<td>High level political involvement in malaria elimination advocacy to ensure that malaria elimination becomes a matter of national pride</td>
</tr>
</tbody>
</table>

### TABLE 15: COMMUNITY ACTIVITIES FOR A MALARIA ELIMINATION PROGRAM

<table>
<thead>
<tr>
<th>Role of the health service/partners</th>
<th>Role of the community</th>
</tr>
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<tbody>
<tr>
<td>Explain the rationale behind pro-active case detection to the community in the SHCC meetings.</td>
<td>Use community knowledge to identify areas of high risk for malaria transmission (know breeding sites) to be targeted for active case detection.</td>
</tr>
<tr>
<td>Explain the different strategies/activities that can be used for pro-active case detection.</td>
<td>Evaluate the level of acceptance by discussing these strategies/activities with community members in the SHCC meetings and propose solutions to potential bottlenecks.</td>
</tr>
<tr>
<td>Offer technical support (training/equipment) to allow the community to actively participate in the pro-active case detection activities.</td>
<td>Identify resources available in the community and define roles and responsibilities in collaboration with the health service and other partners.</td>
</tr>
<tr>
<td>Explain the indicators used for the evaluation of the activities related to pro-active case detection.</td>
<td>Identify key resource people in the community that can participate in supervision activities and data collection.</td>
</tr>
<tr>
<td>Provide feedback on the results of pro-active case detection and the strengths/weaknesses of the activities/strategies used.</td>
<td>Discuss the results and find solutions to identified bottlenecks.</td>
</tr>
</tbody>
</table>

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• Communities should, as far as possible, be involved in the planning and implementation of any activities at the community level such as LLIN distributions, IRS campaigns, surveys and case investigation for surveillance.

• Apart from working together with the Shehia Health Custodian Committees and the Village Health Committees, the ZMCP should also engage with existing community groups such as women associations and youth groups and involve them in strategic planning for malaria elimination by inviting them to relevant stakeholder meetings.

CONCLUSIONS
Community involvement and participation will be essential not only to achieve elimination but also to maintain it. It will be important to ensure community ownership and buy-in to avoid elimination fatigue due to the disappearing disease burden. Communities will therefore need to be involved in planning, implementation and evaluation of relevant malaria elimination activities. Their representatives will need to be provided with the necessary information and technical capacity to make a relevant contribution to the elimination program. However, community participation should not be a bottleneck and needs to be carefully targeted to areas where the community can truly make a difference. Also, community interventions should, where possible, not only be based on information obtained from community representatives but also on hard data from relevant surveys. Continuous IEC/BCC activities will need to ensure that communities remain informed about the importance of activities for a disease that is no longer present.

LEGAL CONSIDERATIONS FOR ELIMINATION
INTRODUCTION
Many public health interventions have legal and human rights implications. Historically, individuals and vessels were commonly quarantined to restrict the spread of infectious diseases. The recent threats of Severe Acute Respiratory Syndrome (SARS) and avian influenza have renewed interest in and discussion of the legal tools that countries can employ to control disease. Malaria control generally does not require any restriction of human rights to effectively achieve its goals, although governments commonly use their authority on regulation and oversight to shape certain practices (e.g., restricting the drugs that can be imported and sold to treat malaria). Malaria elimination, however, due to its need for greater precision and coverage of some interventions, may lead to actions that have important legal implications. For example, a country may wish to make it mandatory for individuals to provide blood to surveillance officers or accept indoor residual spray teams into their homes in order to achieve the necessary coverage of these interventions to prevent an emerging outbreak. This step would infringe on individuals’ rights of privacy and choice and therefore requires legal analysis before putting into practice.

This chapter considers the legal principles that would apply to relevant malaria elimination decisions, including as articulated in treaties that Zanzibar has signed, and analyzes several of the restrictive interventions that the country may wish to employ in an elimination program against this framework. This chapter does not seek to foresee every potential legal decision the government of Zanzibar may have to make in an elimination program nor does it present detailed legal analysis to guide firm decisions on particular issues. Rather, it provides an overview of the relevant issues, principles, and considerations to provide a foundation for more detailed analysis later as relevant. The principal international treaty on public health measures is the International Health Regulations (IHR), which was recently updated in 2005 to reflect the evolving needs and challenges of the increasingly interconnected world. As is explored in detail in this chapter, the IHR provides considerable leeway for governments to take restrictive action if there is a significant threat to the health of its populace. However, the view and recommendation of this expert group is that those measures should generally only be used as a last resort, with the greatest focus instead being placed on increasing the willingness of the target populations to comply with the needed interventions. As the legal expert David Fidler stated, “the best way to promote and protect public health is to promote and protect human rights.”

PRINCIPLES
Under a number of international treaties that the Republic of Tanzania has ratified (and that also bind Zanzibar),4 States Parties commit to respect, protect, and promote individual human rights, including non-discrimination; the right to life; the prohibition on torture or cruel, inhuman or degrading punishment, or of medical or scientific experimentation without consent; freedom from arbitrary arrest or detention; liberty of movement; privacy; freedom of thought, conscience and religion; and, among others, freedom of association.

States may derogate from or otherwise limit obligations under human rights treaties in two ways. Prior to ratification they may make a reservation to a specific provision, as long as the goal or purpose of the treaty is not defeated by the reservation. Once the treaty is in place, States may limit or restrict certain rights in

4 The Republic of Tanzania is a State Party to, inter alia, the International Covenant on Civil and Political Rights (ICCPR), the African (Banjul) Charter on Human and People’s Rights (ACHPR), the International Convention on the Elimination of All Forms of Racial Discrimination (ICERD), the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW), the Convention on the Rights of the Child (CRC), the International Covenant on Economic, Social, and Cultural Rights (ICESCR), the Convention relating to the Status of Refugees, the Rome Statute of the International Criminal Court (ICC), Freedom of Association and Protection of the Rights to Organise Convention, Right to Organise and Collective Bargaining Convention, and the Convention Governing the Specific Aspects of Refugee Problems in Africa. It is also a Member State of the World Health Organization.
order to secure others by way of exercising a treaty’s limitation or derogation clause. However, a number of human rights are non-derogable, including the right to life; the prohibition of torture or cruel inhuman or degrading punishment, or of medical or scientific experimentation without consent; the prohibition of slavery, slave-trade and servitude; the prohibition of imprisonment because of inability to fulfill a contractual obligation; the principle of legality in the field of criminal law; the recognition of everyone as a person before the law; the right to a fair trial; international humanitarian law; and the freedom of thought, conscience, and religion (although the manifestations of belief and certain practices may be restricted).

While public health may be invoked as a ground for limiting certain rights in order to allow a State to take measures to deal with a serious threat to the health of the population, legal principles limit the extent to which public health measures can curtail human rights. The most widely applied principles are the Siracusa Principles read in conjunction with the International Health Regulations, which require that limitations on human rights be:

1. Determined by law or, at the time the limitation is applied, there must be a legal basis and the law imposing them cannot be arbitrary or unreasonable.

2. Necessary and proportional: A public health measure limiting individual rights must be necessary to achieve the public health objective, and the burden an individual bears in terms of the restriction of his liberty must be proportional to the risk the public faces. This principle can further be broken into three criteria:
   - Does scientific information justify the measure as necessary?
   - Is the measure proportional in its impact on individual rights compared with the health threat posed?
   - Is the measure the least restrictive that can be used to protect against the health risk?

3. Non-discriminatory: A restrictive public health measure can only be taken for the purpose of securing general public health, safety, and social order. It cannot be applied discriminatorily or non-transparently. The measure must not disproportionately impact or benefit a group that is distinct on the ground of race, color, sex, language, religion, social origin, or geographic concentration.

4. Related to a compelling public interest (e.g., a significant risk to public health).

A detailed discussion on these principles can be found in the appendix below.

INTERNATIONAL HEALTH REGULATIONS

The International Health Regulations (IHR) are a chief resource to help States determine best practices in derogating or limiting rights in response to an international public health crisis. The IHR were enacted in the wake of the Severe Acute Respiratory Syndrome (SARS) outbreak in 2003 and came into force on June 15, 2007. They aim to prevent, protect against, control, and respond to the international spread of disease, while avoiding unnecessary interference with international traffic and trade. The IHR are also designed to reduce the risk of disease spread at international airports, ports and ground crossings. The IHR encompass surveillance, sanitary, and quarantine requirements designed to prevent the international spread of disease. States must notify the WHO of any public health event in its territory that constitutes a public health risk to other States through the international spread of disease and potentially requires a coordinated international response (a public health emergency of international concern, or “PHEIC”), and the WHO may share information among States and may also use non-governmental sources of information about such events. States must develop, strengthen, and maintain core capacities to detect, assess, notify, and report disease events and respond promptly and effectively to public health risks and emergencies of international concern.

The IHR also set out a series of health measures that States may apply to travelers and goods, such as inspection, examination, vaccination, and documentation requirements. If more reasonable available alternatives that would not be more restrictive of international traffic or more intrusive or intrusive to persons are not sufficient, States may take measures that are stricter than those provided for in the IHR, but the IHR lays out the conditions such stricter measures must satisfy. Principles restricting the limitation of human rights in the IHR mirror those in international human rights law generally, as the IHR was drafted to be compatible with these agreements. The IHR, however, specifies more explicitly that scientific evidence must be used to assess risks and that measures can be taken only in response to actual threats and not “merely because of an apprehension of potential danger.”

LEGAL IMPLICATIONS OF MALARIA ELIMINATION INTERVENTIONS ON ZANZIBAR

The technical working group has made a number of recommendations that have/may have legal and human rights implications. To achieve elimination they recommend that

7The Siracusa Principles note that “due regard shall be had to the international health regulations of the World Health Organization” when a limitation to a human rights provision is made for public health reasons.

8The 2005 IHR revised the 1968 IHR, which followed international sanitary conventions dating back to the 19th century. Early regimes (e.g., the 1951 International Sanitary Regulations) required that countries notify each other of outbreaks of cholera, plague, yellow fever, smallpox, typhus and relapsing fever and maintain adequate public health capabilities at points of disease entry and exit (seaports and airports). Over time, only cholera, plague, and yellow fever remained on the list; now, under the new IHR, there is no list of specific diseases, but rather the requirement that states notify the WHO of any event
preventive measures, mainly related to vector control, achieve high levels of coverage and usage. To mop up the last cases and to maintain zero transmission, every locally acquired new case and all imported cases must be identified as soon as possible to avoid onward transmission and, important in terms of public health, to avoid malaria epidemics with potentially devastating effects in a non-immune population.

Any response to a public health event necessarily relies primarily upon a population’s willingness to comply, which in turn requires trust between the public and the public health system. The balancing act embodied in the MSEHPA requires a recalibration every time American values evolve in response to local and world health events. Following the anthrax scare and the events of September 11th, the dangers of public health emergencies increased and, more importantly, Americans’ perception that the threat had increased made them more tolerant of privacy infringements. It was this shift in the public’s perception that allowed the government to adapt its public health codes to meet this changing environment and the public’s perceptions.

Similarly, for a malaria program on Zanzibar, it will be essential to ensure the population understands and perceives a high risk of malaria resurgence despite the fact that the disease is no longer visible.

VECTOR CONTROL

Similar to herd immunity as a result of high vaccination coverage, preventive vector control measures such as IRS and LLINs not only protect the individual but also the community as a whole. As discussed in the technical feasibility chapter, in the absence of a perfect surveillance system, low levels of vector control coverage will lead to the resurgence of malaria on Zanzibar. Over time, the population in Zanzibar will lose its immunity to malaria disease and malaria resurgence can therefore lead to explosive malaria epidemics with high levels of mortality in all age groups. The technical working group thus recommends maintaining high coverage with IRS until high levels of coverage and usage with LLINs has been robustly demonstrated.

To achieve high IRS coverage, individuals and private companies must allow IRS teams to access their premises to spray the walls with an insecticide. The nature of spraying activities, which often requires moving furniture out of the house, can easily be seen as a violation of people’s privacy and refusals, although not common in the Zanzibar context, have been documented, especially in upper-class residential areas. The coverage required to have impact on the community level for IRS is > 85%. In line with the principle of “necessary and proportional” and results of the previous IRS campaigns in Zanzibar (overall coverage > 95%) legislation enforcing the acceptance of IRS will most probably not be required in the short-term. However, ultimately IRS will only be used in the management of foci and acceptance might weaken over time given the reducing disease burden. In addition, when trying to cut transmission in a newly identified focus, coverage levels would ideally be close to 100% (in a limited area) and the risk of resurgence and its consequences in the absence of other control measures might justify legally enforced acceptance or fines in case of refusal.

LLINs pose an additional challenge, as coverage does not equal usage. As mentioned above, IRS can only be scaled back when LLIN coverage will be close to 100% assuming that this will lead to usage levels of > 80% which is required to have the required impact on transmission. While distributing nets is far less intruding people’s privacy compared to IRS, obliging people to actually use them can clearly be seen as a breach of privacy. In addition, given the high transmission potential and high importation risk in Zanzibar, prevention using LLINs will be a long-term initiative that requires consistent implementation. As such, it will always be better to secure the voluntary compliance or “buy-in” of the population (e.g., through a widespread education campaign) than to force behavior change and compliance through restrictive measures. Such restrictive measures might initially yield the intended results, but could lead to increasing popular resentment against the intervention and the entire program and corresponding declines in compliance below the starting level. In other words, achievement of public health goals requires public informed consent. The overall approach therefore recommended by this group, which is also required under international law as described above, is for the government to first try the least restrictive measures that might achieve the objectives of a malaria elimination program before employing other options in order of increasing restrictiveness.

CASE DETECTION (SURVEILLANCE)

Rapid case identification is both important to achieve elimination and to maintain zero transmission. There are three requirements related to case detection and surveillance that might have legal implications:

- All fever cases must get tested to ensure high malaria case detection rates.
- All positive cases, with or without symptoms, must be treated to avoid onward transmission and notified to the central health authorities.
- All cases will require further investigation, including travel history and contact tracing.

The first requirement is highly influenced by the population’s health seeking behavior. While people can be encouraged to seek care when having a fever through IEC/BCC campaigns, it is almost impossible and, in our opinion, not desirable to use law enforcement to ensure people to go for testing. Once at the health facility, people should provide oral informed consent before being tested and the results should obviously remain confidential.

When a person tests positive, treatment should be given not only to cure the patient but also to avoid onward transmission. While it is unlikely that a symptomatic patient refuses treatment, asymptomatic carriers might be reluctant to take drugs for an infection that has so far not caused any symptoms. Pro-active case detection, explained in Chapter 1, specifically aims at identifying asymptomatic carriers, and keeping in mind the above mentioned principles, it is probably justified to either enforce treatment or penalize refusal of treatment. The treatment
has very few side effects and is beneficial to the patient (who might become symptomatic in a later stage), while not treating poses a serious epidemic risk with high morbidity and mortality in the population. Enforcing treatment or penalizing its refusal is therefore both necessary (to avoid secondary cases and even deaths) and proportional. We recommend that legislative options for enforcing treatment or penalizing its refusal are explored. We do not recommend any form of isolation, admission or quarantine as this is against the principles laid out in the IHR and technically not justifiable. However, infected people should be encouraged to use an LLIN, not only to protect themselves but also their family and community.

Once a case is identified, the proposed surveillance mechanisms require not only immediate notification but also a thorough case investigation. Malaria is a notifiable disease but Zanzibar has currently no legislation related to surveillance activities. While it may be legislated that residents must admit health officials into their dwellings to collect blood and/or travel and health information, it will be far more effective to educate and encourage public support of a campaign involving these methods. In addition, case investigations will be complemented by re-active case detection using mass screening in the population around an identified case. In keeping with the principle of first trying less restrictive approaches, the program should consider methods such as only screening people with fever or a recent history of fever that would more easily accepted and that would have a similar impact.

Finally, one of the most important individual rights considerations in the process of conducting surveillance is privacy. In the modern information age, health information sharing has become particularly effective in developing strategies to promote public health and to combat specific health threats; however, the handling of this information must be vigilantly administered, as its mishandling can have consequences ranging from loss of employment to embarrassment and harm social stigma. It is important to ensure that aggregated data is stripped of personal identifiers, surveyed persons are provided with a copy of local privacy of medical information law to know their rights, and adequate controls are put into place to prevent public disclosure of personal information.

BORDER SCREENING

Health measures to which travelers are subjected generally require their prior oral informed consent. However, this is not the case when there is evidence of an imminent public health risk, in which case travelers may be advised or compelled to submit to examination, vaccination or other measures—but only to the extent necessary to control the risk. A traveler possessing valid proof of prophylaxis may only be denied entry if there is verifiable evidence that the prophylaxis was or is ineffective. Under the new IHR, if a traveler fails to consent to a health measure, he may be denied entry. The IHR also require that measures not be more restrictive of international traffic and trade than reasonably available alternatives that would achieve the appropriate level of health protection.

Many of the border screening interventions that might be employed in an elimination program would arguably not meet these criteria. For example, a single infected individual does not pose a major risk of reestablishing local transmission—he might not go to areas with significant vector activity and/or he might present with symptoms and be cured at a health facility before coming in contact with a vector. As such, requiring every traveler to undergo a test might not be proportionate to the risk. Moreover, simply relying on the surveillance system to detect cases once they are in the country and trigger an appropriate response might be an equally or more effective approach than trying to detect all cases at the border. Lastly, care must be taken to avoid potential discrimination in screening programs especially when screening is targeting a high-risk sub-group. In that case a robust scientific justification will be required to ensure that the selected sub-group has not been identified based on prejudicial biases. In addition, all other rights such as the right to privacy and the dignity of those being screened should be upheld.

If a border screening approach is deemed technically necessary to prevent resurgence, it is recommended that, as with other interventions, travelers initially be offered a clear explanation and provide informed consent to participate. Only if this clearly undermines the effectiveness of the intervention should the testing be made compulsory.

PRIVATE SECTOR

A State has much greater latitude to regulate commerce within the country and to control activities of private businesses, including the storage and distribution of medications. Making contractors legally and financially accountable for preventing and eliminating mosquito-breeding habitats at their worksites, for example, would not be considered a rights intrusion. But the government will have economic considerations that should drive it to regulate commerce only to the least extent necessary to accomplish the public health objective. For example, requiring that private hotels both spray all buildings and cover all sleeping spaces with LLINs would impose an additional cost on them, while the additional health benefit might be limited. Any requirements of private businesses should also consider the recommendations on other interventions discussed above, e.g., if businesses are required to regularly screen their migrant workers, they should provide those workers with informed consent prior to testing.

Another factor to consider in the imposition of public health measures that benefit the many sometimes at the expense of the few is a government compensation program. The U.S. government enacted several compensation programs whereby individuals who were injured by a vaccine could sue the government rather than the manufacturer. The MSEHPA also requires that a State compensate private owners for the temporary or permanent use of their materials or facilities by authorities during a state of public health emergency. For an elimination program, this might include compensating private pharmacies for prohibiting them from selling anti-malarials (if a decision is taken to restrict anti-malarial use to public facilities) or compensating individuals for the effects of adverse reactions to drugs and/or insecticides.
CONCLUSIONS

This chapter considers the legal principles that would apply to the recommended malaria elimination decisions and analyzes several of the restrictive interventions that the country may wish to employ in an elimination program. It provides an overview of the relevant issues, principles, and considerations to provide a foundation for more detailed analysis later as relevant.

The overall approach recommended by this group, which is also required under international law as described above, is for the government to first try the least restrictive measures that might achieve the objectives of a malaria elimination program before employing other options in order of increasing restrictiveness.

Legislation enforcing the acceptance of IRS will most probably not be required in the short-term. But in the end stages of elimination and during the maintenance period, the risk of resurgence and its consequences in the absence of other control measures might justify legally enforced acceptance or fines in case of refusal.

People should be encouraged to seek care when they have a fever through IEC/BCC campaigns, and it is not desirable to use law enforcement to ensure people to go for testing. Once at the health facility, people should provide oral informed consent before being tested and the results should obviously remain confidential. Enforcing treatment or penalizing its refusal is both necessary (to avoid secondary cases and even deaths) and proportional. We recommend that legislative options for enforcing treatment or penalizing its refusal are explored. We do not recommend any form of isolation, admission or quarantine as this is against the principles laid out in the IHR and technically not justifiable. However, infected people should be encouraged to use an LLIN not only to protect themselves, but also to protect their family and community.

In terms of screening for active case detection, the program should consider methods that would be more easily accepted and that would have a similar impact if only a portion of the individuals are screened such as people with fever or a recent history of fever in stead of the general population. If a border screening approach is deemed technically necessary to prevent resurgence in the future, it is recommended that, as with other interventions, travelers initially be offered a clear explanation and provide informed consent to participate. Only if this clearly undermines the effectiveness of the intervention should the testing be made compulsory.

It will always be better to secure the voluntary compliance or “buy-in” of the population (e.g., through a widespread education campaign) than to force behavior change and compliance through restrictive measures.
CHAPTER 3: FINANCIAL FEASIBILITY

INTRODUCTION

The previous chapters have shown that malaria elimination in Zanzibar is technically feasible, though significant operational challenges will need to be overcome for malaria-free status to be achieved and sustained. However, the government of Zanzibar and its donors are also fundamentally interested in whether pursuing elimination will be financially feasible before they invest in this new strategy. There is no doubt that if funding were limitless, elimination would be worth pursuing. But in an environment of funding constraints, competing priorities, and uncertain future financing, the question of how much elimination will cost relative to alternatives, notably the maintenance of interventions and disease burden at roughly current levels (“sustained control”), is critical to decision-making. This chapter examines that question, first analyzing the estimated cost of different elimination scenarios and then exploring the challenges and potential solutions to sustainably financing an elimination or sustained control program.

In most cases elimination will be more costly than sustained control in the short- to medium-term. Surveillance activities will be intensive and vector control activities will need to reach nearly universal coverage to ensure a path to zero prevalence. Both of these activities are manpower and commodity intensive, requiring significant resources. The question of financial feasibility therefore revolves around the magnitude of that initial increase and the degree to which costs will later fall, particularly after elimination is achieved. While it is likely that some activities could be scaled back, many interventions (e.g., surveillance, diagnosis and treatment, etc.) will need to continue for decades to ensure that malaria is not reintroduced. Estimating these ongoing costs of preventing reintroduction, while challenging, is thus central to determining whether and the degree to which elimination will be cost-saving.

In order to determine if elimination is cost-saving in the medium- to long-term, the cost analysis extends over a 25-year period beginning in 2009. However, due to challenges in predicting key inputs such as changes in malaria transmission on the mainland and urbanization, which affect vulnerability and receptivity respectively, programmatic costs beyond 5-7 years in the future are more imprecise estimates. As such, this analysis should be considered a decision-making tool, providing general projections of cost trends between different programmatic scenarios, and not used as a basis for detailed planning or budgeting.

The core methodology employed for this analysis is to compare the cost of interventions for an elimination program with those for a sustained control program. Zanzibar has recently conducted several in-depth analyses of the costs of its current program, including a five-year needs assessment supported by the Roll Back Malaria Partnership and a comprehensive proposal submitted to the Global Fund in Round 8. As these analyses take into account the total needs of the program to achieve its control targets, they are used as the sustained control baseline. The costs of an elimination program are then estimated using the outputs of the models and other analysis in the technical and operational feasibility sections. Due to the imprecision of the estimates, the core output of this analysis is not the absolute amounts that sustained control and elimination will cost, but rather the change in costs over time as shifts in interventions occur.

This costing approach has substantial limitations that should be taken into account when interpreting this analysis. The optimal information to provide to policymakers to guide their decisions would be robust comparative cost-effectiveness or cost-benefit analyses between elimination and sustained control. It was not possible, however, to conduct those analyses for this exercise. The benefits of malaria elimination beyond its direct effect on morbidity and mortality are poorly understood and quantified. It is likely that eliminating malaria will have positive effects on tourism, education, workforce productivity, health system performance and foreign investment, but none of these effects have been quantified reliably and thus cannot be compared to the cost of elimination.

A traditional cost-effectiveness analysis, while possible, is not an appropriate metric for assessing this decision. Standard cost-effectiveness measures such as cost per marginal case disability-adjusted life year averted will trend toward infinity as malaria prevalence approaches zero in an elimination program. If elimination is achieved, the malaria program costs will not be contributing to a further direct reduction in morbidity or mortality, but it will be preventing an increase in morbidity and mortality resulting from the resurgence of malaria. Since this effect will not be captured, a traditional cost-effectiveness analysis is not a good decision-making tool for elimination. The lack of benefits is important to bear in mind when interpreting and acting on this analysis. If elimination is marginally more expensive than sustained control it does not necessarily mean that it is a bad investment especially in the light of recent reports on resistance to first-line treatment (Dondorp et al., 2009) and insecticides (Nwane et al., 2009). In the absence of a clear quantification of benefits, the MOHSW will have to weigh the magnitude of costs shown here against its own understanding of the potential benefits of elimination. It is also clear that developing a framework for assessing the benefits of elimination should be a priority for the global Malaria Elimination Group to assist Zanzibar and other countries in overcoming this challenge. After analyzing the costs of eliminating malaria on Zanzibar, this chapter examines the challenges and solutions to financing a potential elimination program. Since Zanzibar’s malaria program is heavily donor-dependent, a choice to pursue...
elimination will raise two major financing challenges. The first will be to secure sufficient funds to implement the initial increase in interventions to achieve elimination. The second will be to ensure that funding is both long-term and consistent. This second requirement is not specific to an elimination program—maintaining the high level of intervention coverage that Zanzibar has recently achieved will require a steady source of long-term financing as well. In either scenario, a significant withdrawal of financing—and an accompanying easing of vector control and surveillance—could trigger a devastating resurgence of malaria as discussed in Chapter 1. Unfortunately, the incentives and mechanisms of the international health financing architecture are not currently structured to support this requisite sustained funding in the context of a low level or absence of disease. As such, regardless of what strategy Zanzibar chooses to pursue, it is imperative that it begins working with its donors and partners to address this challenge, including through the development of innovative financing mechanisms.

SUSTAINABLE CONTROL

Although it is now an established concept in malaria program planning, there is no precise definition of sustained control. The term “sustained control” implies that malaria is kept steady at a low level of malaria prevalence through the consistent implementation of a package of interventions. There is currently no guidance on what such an “acceptable” level of prevalence should be or what level of coverage of key interventions should be targeted on an ongoing basis. Given this absence of clear definitions, we, for the purposes of this exercise, established a definition of sustained control on Zanzibar in order to enable an effective cost comparison.

As described in Chapter 1, Zanzibar has already achieved a high degree of control, achieving a prevalence rate of around 1% and IRS coverage of 96% of households. This situation could qualify as an effective sustained control baseline. However, Zanzibar is already planning on building on this success through the implementation of an additional grant from the Global Fund (Round 8). Specifically, with the support of that grant and funding from other donors such as the President’s Malaria Initiative (PMI), Zanzibar will aim to:

- Achieve universal LLIN distribution (100% coverage, >80% usage) through tri-annual mass campaigns;
- Continue IRS coverage of 100% of households for two more years. IRS would be progressively scaled back to eventually only be used in outbreak control;
- 100% of malaria cases treated with an ACT;
- 100% of fever cases presenting in the public sector are diagnosed for malaria;
- 100% of pregnant women receiving ANC receive IPT;
- Expand the Malaria Early Epidemic Detection System (MEEDS) to all public health facilities.

Since Zanzibar’s strategic plan still has a goal of control and the morbidity targets through the enhanced activity in the new grant do not yet approach elimination levels, we decided to define sustained control (SC) on Zanzibar as the achievement and maintenance of the objectives outlined above. While arbitrary, these levels have been set by the ZMCP following careful planning and are clearly at or near the threshold at which further intervention would only be warranted if the goal were to fully interrupt malaria transmission. Moreover, as the purpose of this feasibility assessment is to help the MOHSW determine whether to pursue elimination and therefore increase its activities and investment accordingly, it makes most sense to use its current plans as the baseline. This increased level of control activity already entails substantially higher annual expenditure than in recent years (the grant will provide an average of $2.7 million each year), which it is important to consider when interpreting the final analysis.

The most important activities under SC from both a programmatic and cost perspective include the universal coverage with LLINs (i.e., 80% usage) and the prompt and effective diagnosis and treatment of malaria-related fever. IRS constitutes an important proportion of the current budget (>40%), but consensus has been reached that plans will most likely only include full coverage of IRS for two years, followed by three years of targeted spraying in malaria “hot spots” (North B, Central and Micheweni districts), followed by focal spraying of clusters if an outbreak is detected.

Other activities that currently contribute more modestly to expenditure, but are important aspects of the program include behavior change communication (BCC) and surveillance. Surveillance activities under sustained control include seven sentinel sites around the islands and the expansion of the Malaria Early Epidemic Detection System (MEEDS), currently implemented in 52 facilities, to all public health facilities. The analysis of data collected from sentinel sites as well as the collection and analysis of data gathered through a strengthened HMIS are also costed as part of sustained control (these are included under M&E). ZMCP objectives for BCC beyond communicating the importance of early treatment with ACT and continued usage of LLINs include increasing usage and adherence to confirmed diagnosis.

The total cost of managing a sustained control program is based on the detailed gap analysis and a costing exercise of these activities, conducted by the ZMCP when preparing the Global Fund proposal. The RBM Needs Assessment estimated the total needs for the sustained control program to vary from $5 to $5.5 million between 2006 and 2014. However, this estimate includes both universal coverage with LLINs and IRS, a scenario that is neither recommended in the technical feasibility chapter nor likely to be implemented in a sustained control program given current conversations with donors. After the initial 2 years, when IRS is no longer recommended, we deducted IRS from the total estimated need. This resulted in an average cost of sustained control of roughly $2.9 million per year, which was used as the baseline against which to compare the costs of an elimination program over the next 25 years.
COSTING ELIMINATION

As described above, the costs of a potential elimination program were calculated by modeling the financial implications of the technical and operational recommendations using two scenarios: one which includes the core recommendations of this report and one which includes the lowest possible level of intervention that could feasibly sustain elimination (assuming dramatic reductions in importation risk).

TABLE 16: ASSUMPTIONS OF 2 ELIMINATION SCENARIOS USED FOR COSTING

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2020</th>
<th>2030</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention (LLINs)</td>
<td>75% coverage</td>
<td>75% coverage</td>
<td>75% coverage</td>
<td>No LLINs</td>
</tr>
<tr>
<td>Importation</td>
<td>2/1000/year</td>
<td>1/1000/year</td>
<td>2/1000/year</td>
<td>0.4/1000/year</td>
</tr>
<tr>
<td>Surveillance: Active Case Detection</td>
<td>50% of all infections detected</td>
<td>77% of all infections detected</td>
<td>50% of all infections detected</td>
<td>77% of all infections detected</td>
</tr>
<tr>
<td>Surveillance: Reactive Active Case Detection</td>
<td>100 households screened/ detected case</td>
<td>100 households screened/ detected case</td>
<td>100 households screened/ detected case</td>
<td>100 households screened/ detected case</td>
</tr>
<tr>
<td>Surveillance: Proactive Active Case Detection</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Border screening at ports</td>
</tr>
</tbody>
</table>

The assumptions and calculation related to LLIN coverage and surveillance are explained below. Assumptions on the risk of importation are based on estimates from the technical feasibility chapter and assume that control on the mainland will reduce importation by 50% by 2030. In addition, scenario 2 assumes a further 60% reduction through further control on the mainland and implementation of border screening on Zanzibar (see below).

LONG-LASTING INSECTICIDE-TREATED NETS

The need to sustain universal coverage with LLINs and/or IRS was one of the central recommendations of the technical feasibility assessment. As it is expected that IRS will be reduced to focus on just “hot spots,” it will thus be important to maintain LLIN coverage at a substantial level throughout the program, including after interruption of transmission has been achieved (scenario 1). However, if vulnerability is reduced and the surveillance system is strong enough to detect the majority of cases that do emerge on the islands, it is possible that LLIN coverage could be scaled back over time and eventually abandoned altogether (scenario 2). The specific timelines and assumptions used in the costing are detailed in the table below.

TABLE 17: PROGRESSIVE SCALE DOWN OF LLINs FOR SCENARIO 2: COVERAGE OVER TIME BY LEVEL OF MALARIA TRANSMISSION RISK

<table>
<thead>
<tr>
<th>ITN Coverage</th>
<th>2011-2020</th>
<th>2021-2023</th>
<th>2024-2026</th>
<th>2027-2029</th>
<th>2030-…</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Risk (3 districts)</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Medium Risk (5 districts)</td>
<td>100%</td>
<td>100%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>No/Low Risk (2 districts)</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Overall (Population-adjusted)</td>
<td>100%</td>
<td>62%</td>
<td>40%</td>
<td>18%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Both scenarios keep 100% coverage until 2020 to ensure that the 75% usage (effective coverage) that is needed to reach elimination is sustained. Under scenario 2, LLINs will then be progressively scaled down, first in districts that are estimated to be at no/low risk, followed by districts at medium and high risk, with all areas having abandoned LLINs beginning in 2030. Risk was estimated at a district level from the ZMCP 2007 Malaria Indicator Survey, assuming districts with 0% prevalence were at no/low risk, those with prevalence between 0% and 1% were at medium risk, and those with prevalence >1% were at high risk.

It is assumed that, as with sustained control, LLINs under each scenario will be distributed through mass campaigns every three years. To facilitate interpretation, the costs associated with these campaigns are smoothed over the full three-year period.

As illustrated in Figure 26, scaling back LLINs will reduce cost considerably. As coverage in scenario 1 is equal to sustained control, this reduction represents cost savings compared to both the elimination and sustained control phases.

FIGURE 26: COST OF LLIN DISTRIBUTION FOR ELIMINATION SCENARIOS: EXPECTED REQUIRED COVERAGE AND LOWEST FEASIBLE COVERAG
INDOOR RESIDUAL SPRAYING

As noted above, IRS under sustained control includes full coverage for two years, followed by three years of targeted spraying in malaria “hot spots” (North B, Central and Micheweni districts), followed by focal spraying of clusters if an outbreak is detected. For costing purposes, we consider “targeted spraying” to be the equivalent of 20% of households and “focal spraying” to be the equivalent of 10% of households per year. An IRS program under elimination would be very similar, with the additional assumption that focal spraying would decline to zero under the elimination scenarios due to a reduction in the number of foci to be treated.1

Since IRS is withdrawn in the short-term for both sustained control and elimination, it is not included in the long-term costing of both phases. However, a recent review suggests that a combination of IRS with LLINs provides a higher protective effect than both of the interventions implemented individually. If the recently documented reduction in malaria burden on Zanzibar is indeed due to a combined effect of IRS and LLINs, sustained control will require continuation of both interventions, making it on average 40% more expensive compared to the sustained control scenario assumed in this analysis. This addition would change the cost comparison between sustained control and elimination, potentially resulting in elimination being cost saving in the short- to medium-term.

DIAGNOSIS & TREATMENT

There are four major differences between the diagnosis and treatment approaches under sustained control and elimination:

1. Testing of all fever or history of fever cases: While this is also recommended under sustained control, the elimination scenarios assume almost universal health seeking behavior for fever and testing rates over time. This results in a continuous increase of the number of RDTs needed and makes RDTs the main cost driver of case management for elimination.

2. Inclusion of formal private sector: Under sustained control, the program’s objective is to test every febrile client in the public sector for malaria and treat all positive cases with ACT. The elimination program will need to expand this to include testing and appropriate treatment of all fever cases in the private sector as well. This will be a challenging policy to enforce and will likely require that the government provide ACTs and RDTs free to private sector facilities to encourage compliance.

3. Treatment only in formal facilities: Since it is imperative that all malaria cases be captured by the surveillance system and appropriately addressed, the ZMCP will need to ensure that all fever cases are tested and treated in formal health facilities, including the many patients that currently seek treatment in the informal private sector. This will further increase costs related to ACTs and RDTs because a higher fraction of the population will be treated in facilities than under sustained control.

4. Quality assurance with PCR: Unlike sustained control, it is recommended that an elimination program include use of PCR to consistently check the quality of RDT diagnosis conducted in peripheral facilities. The recommended approach would PCR test every positive test and 10% of negative RDTs and blood smears collected from the public and private sectors.

The starting point for this analysis (including treatment seeking behavior, diagnosis rates, etc.) is taken from Zanzibar’s Roll Back Malaria Needs Assessment as well as its 2007 MIS survey. The main assumptions about the current state of treatment seeking behavior, and diagnostic/treatment practices are presented in Table 18.

<table>
<thead>
<tr>
<th>TABLE 18: ASSUMPTIONS ON HEALTH SEEKING BEHAVIOR AND DIAGNOSTIC/TREATMENT PRACTICES USED TO COST ACTS AND RDTS FOR ELIMINATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2009 (Estimates based on the 2007 MIS Survey)</strong></td>
</tr>
<tr>
<td><strong>Health Seeking Behavior</strong></td>
</tr>
<tr>
<td><strong>Health Seeking Behavior</strong></td>
</tr>
<tr>
<td>50% public sector</td>
</tr>
<tr>
<td>26% private sector</td>
</tr>
<tr>
<td>24% seek no care</td>
</tr>
<tr>
<td>74% public sector</td>
</tr>
<tr>
<td>26% private sector</td>
</tr>
<tr>
<td>0% seek no care</td>
</tr>
</tbody>
</table>

Using these assumptions, the cost of case management increases four-fold over the course of an elimination program (see Figure 27). The main drivers of this increase are greater volume of RDTs and the cost of quality assurance/control of those tests. Over time, almost all fever or history of fever cases are assumed to seek care from public and private facilities requiring a corresponding significant increases in the number of tests performed. In contrast, with the case load reducing over time, the cost of treatment will be very modest, representing less than 1% of the total cost of case management.

Under both elimination scenarios, the number of confirmed malaria cases will constantly reduce over time. However, this is not the main driver of the reduction in the cost for treatment. Rather, this is primarily explained by the cessation of presumptive treatment in the private sector.

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1 It is important to note that some continued costs of IRS under elimination are built into the costing of surveillance, as input costs for outbreak response.
SURVEILLANCE

A robust surveillance system is one of the most essential components of an elimination program and, as such, the resources that must be devoted to surveillance under elimination will be substantially greater than under sustained control. There are three main differences between the surveillance approach assumed for elimination compared with that of sustained control:

- **Inclusion of Private Sector:** Since it is essential that all malaria cases be tracked under an elimination program (including those that do not present in public health facilities), an elimination surveillance program in Zanzibar must include all private facilities. We thus assume that the MEEDS system would be expanded to all public facilities under sustained control and all cases, including cases detected in the private sector, trigger an appropriate response.

- **Case Investigation:** Under an elimination program, all suspected or reported malaria cases must be investigated. This costing includes district case investigation teams that travel to the household of the malaria patient, determine the likely source of the malaria infection, and screen surrounding households. As discussed in the technical feasibility section, we assume 100 households surrounding each newly identified case will be screened.

- **Outbreak Response:** Successfully achieving elimination will require that malaria outbreaks (>3 secondary cases) that do occur are halted as quickly as possible through focused vector control, screening and treatment.

While the costs of the first priority are fixed (i.e., the functioning of the MEEDS system) and therefore should be constant over time, the costs of case investigation and outbreak response will depend on the number of malaria cases. The estimates of the expected number of cases that will require case investigation are based on the simulations described in Chapter 1 and vary based on the two core scenarios costed here. To calculate the number of surveillance teams that would be required to conduct this response, the number of expected cases and corresponding number of households to be screened were extrapolated. These variables were adjusted based on the heterogeneity of transmission on Zanzibar, with the highest transmission risk districts (>2% prevalence) receiving one team additional to the number indicated by the estimated households requiring screening each year. It is assumed that one team of 3 can screen 20 houses per day and would work for 24 days per month. Districts with no transmission risk would not conduct active surveillance. For both costing scenarios, it is assumed that two districts are high risk, six are medium risk, and two are no risk until 2020. After 2020, it is assumed that 1 district shifts from high to medium risk. Salaries of surveillance officers, transport costs (one vehicle per team, including maintenance), and administrative overhead are all included in the costing. The surveillance cost also includes the cost of RDTs used to screen all households. The simulator from the technical feasibility chapter suggests that screening 100 households for each detected case is extremely likely to prevent an outbreak but we still included a contingency budget for outbreak response of initially $100,000 (the cost of a targeted IRS campaign in a single district) and $50,000 once elimination is achieved (outbreaks are even less likely to occur following elimination because of the assumed reductions in importation risk).

The technical feasibility chapter describes how the main cost driver for surveillance—the number of cases that will trigger household screenings—depends heavily on assumptions of importation risk. It is expected that reductions in malaria transmission on the mainland alone will not be sufficient to achieve the very low levels of importation risk assumed in scenario 2. As such, targeted screening of travelers entering the islands at the main seaports (Stonetown, Mkoani or Wete, and Mkokotoni) is also assumed and costed for this scenario.

As there is no technical guidance and few experiences in other countries on which to base the assumed approach to border screening, the costing of this added intervention is inherently rough. It is assumed that cost drivers would include ongoing human resources, RDTs, other basic consumables, and management overhead. Assuming that screening would be conducted on board the vessels with an average travel time of 4 hours per trip and that a team can screen up to 30 passengers per hour, it was estimated that 25 teams would be needed to deal with the maximum ferry capacity of around 3,000 passengers a day.

It is important to emphasize that this approach is intended to only be used for the purpose of the costing of reduced importation risk and not as a basis for operational decisions; if the MOHSW wishes to explore implementation of border screening in the near-term, the authors recommend that a much more detailed
As cases decrease, the MOHSW will be able to correspondingly reduce the number of teams and therefore surveillance cost. However, under the second scenario, this modest decline in active surveillance costs will be offset by the assumed introduction of border screening.

**FIGURE 28: COST OF SURVEILLANCE FOR 3 DIFFERENT SCENARIOS: SCENARIO 1 (LLINS REMAIN > 75%), SCENARIO 2 (PROGRESSIVE SCALE DOWN OF LLINS; BORDER SCREENING) AND SCENARIO 2 WITHOUT BORDER SCREENING**

As illustrated in Figure 25, surveillance will be considerably more expensive when pursuing elimination (2012 onwards). The initial high cost (2012-2020) is mainly explained by the high number of cases that will require an investigation and thus a relatively high number of investigation teams needed per district. As cases decrease, the MOHSW will be able to correspondingly reduce the number of teams and therefore surveillance cost. However, under the second scenario, this modest decline in active surveillance costs will be offset by the assumed introduction of border screening.

**HUMAN RESOURCES**

Human resources make up a significant fraction of the additional cost of elimination, as surveillance and M&E activities are manpower-intensive and are crucial to the success of an elimination campaign. The additional human resources needed for an elimination program (e.g., surveillance officers at the central level, entomologists, M&E specialists, etc.) have been outlined in Chapter 2 and their salaries, administrative support, and transportation expenses (e.g., gas, insurance, etc.) are all included in this costing. The human resource costs of the case investigation teams are not included here, but rather under surveillance. Additional human resource expenses crucial to elimination are related to training, notably of the new outbreak response teams, lab technicians (on PCR), and private sector health professionals. It is assumed that the approach to training—and therefore the costs—will be the same as is currently used by the ZMCP. We also include in this category the cost of the elimination technical advisory meetings and steering committee meetings that have been recommended. These expenses are not expected to decline over time because the training is costing as annual or bi-annual refresher sessions and the annual meetings are expected to continue in perpetuity. We therefore estimate that the additional human resource cost of elimination is just below $300,000 annually (roughly 50% for salaries, 35% for training and 15% for meetings). This additional cost for elimination was kept constant over time. However, the baseline human resource and training cost was assumed to represent similar proportions over time as for sustained control as per the Global Fund budget proposal (i.e., 1.5% on salaries and 2.9% on training). The total of cost of human resources therefore increases gradually in line with growth of other program costs.

**EQUIPMENT**

The additional equipment requirements for an elimination program are mainly those that will be needed by the new personnel, including cars and computers for the ZMCP (for district ACD teams these cost have been included in surveillance). We also include GPS machines for surveillance and M&E, the cost of setting up a data server for the ZMEP, and a lab with PCR capacity. Equipment costs are amortized over the expected useful life of the equipment (8 years for cars and 4 years for GPS) with an assumption of zero resale value at the end of the amortization period. Equipment expenses are not expected to decline and are assumed to continue to represent 1% of the total budget for sustained control plus the additional elimination specific equipment.

**BEHAVIOR CHANGE COMMUNICATION (BCC)**

It is difficult to know exactly how much more BCC will cost under an elimination program than under sustained control, but two requirements are certain. First, BCC campaigns will need to be adapted and expanded to cover the private sector to promote compliance with policies on diagnosis and treatment. Second, activities will need to become more intensive due to the limited margin of error under an elimination program; even a small minority of people continuing to seek treatment from informal sources or denying spraymen entry to homes can jeopardize the effort.

It is not possible at this stage to concretely identify the specific changes in BCC activities and therefore costs. For the purposes of this exercise, we took the estimated annual cost of BCC under sustained control and multiplied the amount by five. While clearly a rough estimate, the ZMCP will need to reach at least double the number of facilities it currently targets if the private sector is included, and a more elaborate effort will need to be made at the community level. Moreover, as BCC is not a significant driver of overall program costs, it is unlikely that changes in this area will have more than a modest impact on the overall comparison between sustained control and elimination so a precise analysis is less essential.
MONITORING & EVALUATION (M&E)

As discussed in Chapter 2, current and planned methods for M&E would not be sufficient if Zanzibar were to embark on elimination, including due to inadequate sample sizes and inappropriate parasite detection methods. An additional serological prevalence survey, conducted bi-annually, is thus recommended with a sample size large enough to detect very low levels of parasite density. Based on the costs of typical malaria indicator surveys with a sample size of roughly 8,000 and assuming that this sample size would need to at least double and that serological testing would be added at roughly $2 per slide, we estimate that these surveys would add $100,000 per year for M&E of an elimination program. In addition to these surveys, an elimination program will need to implement a range of other core M&E activities. It is assumed that these will represent a similar proportion of the overall budget as M&E does for sustained control in the latest Global Fund proposal (8%). As the surveys and other M&E activities will be consistently implemented throughout the program, we do not expect that this cost will decline over time.

TOTAL COST IMPLICATIONS OF ELIMINATION

Figure 29 shows a comparison of the annual difference (%) in expenditure for two elimination scenarios compared to sustained control, over the course of the 25 year period analyzed. This figure presents a clear answer to the core question asked in this chapter: elimination will not be cost-saving in the short- or medium-term in Zanzibar. The additional investment needed to move towards elimination initially results in an almost 85% increase in average annual expenditure compared with sustained control, with costs remaining 45-50% more expensive over the course of the remainder of the effort to reach elimination. Contrary to expectation, costs do not dramatically decline once elimination is achieved and the country enters the prevention of reintroduction phases: in the most likely scenario, costs in this phase are 5% higher than during the elimination period. This is because as long as importation risk remains at current or modestly reduced levels, interventions will need to remain constant in order to prevent rapid resurgence.

For the purposes of comparison, the best possible elimination scenario is included in this costing although the authors believe it is unlikely the necessary reduction in importation risk will be possible. Under this scenario in which LLINs are withdrawn entirely, annual costs during the prevention of reintroduction phase will decrease substantially. The degree of this reduction depends on the assumed implementation of border screening: if comprehensive screening is introduced in order to reduce importation risk to the necessary level, ongoing costs will be roughly equivalent to (4% higher than) sustained control, while if screening is less extensive or not conducted at all annual costs could fall as low as 20% below sustained control.

As shown in Figures 30 and 31, the higher costs of both elimination and prevention of reintroduction are driven primarily by increased surveillance and diagnosis. This is particularly evident in the second elimination scenario where these activities combined comprise 47% and 65% of total costs in the elimination and prevention of reintroduction phases respectively compared to just 15% for sustained control. In the more likely scenario where universal LLIN coverage needs to be maintained, case management and surveillance represent 45% and 35% for the elimination and prevention of reintroduction phases respectively, which is in line with experiences from other countries. For example, Mauritius continues to spend $2.15 per capita to prevent the reintroduction of malaria, 39% of which is devoted to surveillance activities (Tatarsky, unpublished data). The estimated average per capita costs of prevention of reintroduction on Zanzibar varies between $1.73 and $2.27 depending on the elimination scenario, aligning closely with the benchmark provided by the Mauritius case. One of the only other available benchmarks is the report of the Eighth WHO Expert Committee on Malaria, which estimated in 1961 that the cost of prevention of reintroduction was roughly 65-75% of the “attack” (elimination) phase (WHO, 1961). Given that Zanzibar is facing higher transmission and importation risk than most of the countries considered at that time, the second elimination scenario, with the prevention of reintroduction phase between 69% and 88% of the elimination phase, appears to be largely in line with this benchmark.

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2This ratio is also in line with the requirement of most donors that 5-10% of total program budgets be spent on M&E.
The annual cost of the second elimination scenario (including border screening) is modestly above that of sustained control by the end of the period considered in this analysis. If the least expensive scenario is assumed (no border screening), the cost of an elimination program will fall below that of a sustained control program, indicating that, in the long-run, elimination may be intrinsically cost saving if conditions on the mainland enable LLINs to be withdrawn. However, given the initial increased expenditure and relatively modest (20%) annual savings, the MOHSW would not yield savings from elimination on a cumulative basis until well after 2050.

The authors do not believe that such long-term estimates are valuable beyond providing broad indications. The approach to and cost of border screening is too uncertain to make concrete estimates of cost savings. Moreover, there are many other uncertainties in the long-run that could fundamentally affect costs, including changes in transmission risk (i.e., Rₜ) that could enable relaxation of interventions, development of insecticide and drug resistance, introduction of new technologies, and basic economic and demographic changes, among others. It is also important to note that the cost estimates provided here are not discounted and therefore do not take into account the time value of money—greater expenditure now followed by reductions later has a higher opportunity cost than smoother costs because those funds could be used for other priorities in the short-term (e.g., another disease control program).

In conclusion, this analysis suggests that an elimination program on Zanzibar will not be cost saving in the medium-term. In the most optimistic feasible scenario, the annual cost of preventing reintroduction will be modestly lower than sustained control. However, these annual savings would only be realized after many years of substantially higher expenditure so the cumulative cost of an elimination program would remain well above those for sustained control over the period analyzed. This conclusion does not preclude the Ministry of Health from deciding to pursue elimination for other reasons. The average additional cost of elimination would be $1.3–1.9 million per year, which the MOHSW may decide is a worthy cost for the expected benefits from elimination. Those benefits, which are not examined or quantified in this assessment, could range from the reduced burden on the health system, increased tourism and/or foreign investment, the national pride associated with having eliminated malaria, and of course the end of morbidity and mortality from a largely preventable disease. If the MOHSW is not comfortable making this decision without a more concrete estimation of those benefits, an in-depth follow up research project could address these questions while recognizing the significant technical challenges involved.

FINANCING SUSTAINED CONTROL AND ELIMINATION

Regardless of whether or not the Zanzibar MOHSW decides to pursue malaria elimination or to maintain a high level of control, consistent financing for the malaria program will need to be secured for many years to come. As discussed in the Technical Feasibility Chapter, a resurgence of malaria in Zanzibar is nearly assured if control and surveillance measures are scaled back considerably. Because the Zanzibar government has accomplished such a great reduction in malaria exposure, acquired immunity to malaria has most likely declined, and the mortality and morbidity impact of resurgence may be quite substantial. Perhaps the most important component in preventing resurgence is a plan for steady, long-term financing for the malaria program.

CHALLENGES

Aid Dependence

Financing malaria control or elimination will be particularly challenging in Zanzibar for a number of reasons. Most of Zanzibar’s health programs, including malaria control, are very donor dependent. This means that ZMCP’s ability to continue investing in malaria will be highly contingent upon the ability to secure substantial foreign aid. Zanzibar has been successful at attracting substantial funding for its malaria program over the past five years, but securing such a high level of funding is likely to become increasingly difficult for reasons outlined below.

Should Zanzibar decide to pursue elimination, such a high level of financing will most likely not be required in the long term. We discussed above various conditions under which it may be possible to reduce costs significantly, for example through the scaling back of vector control programs. However, a steady level of financing will be required over the long term to maintain...
the surveillance programs, response teams and other programs associated with preventing the reintroduction of malaria.

**Aid Volatility & Unpredictability**

Securing steady financing for the ZMCP will be a serious challenge regardless of the level of funding sought. Volatility is a ubiquitous problem with Official Development Assistance (ODA) for health. Lane and Glassman (2008) analyze the magnitude of this volatility, illustrating that over the past decade health aid has deviated by almost 20 percent from trend. Health aid to Rwanda, for example, was roughly $27 million in the late 1990s, fell to $4.5 million a few years later, then climbed again to $21 million in 2006. Health aid and spending in Zanzibar has been volatile over the past decade as well. ZMCP disbursements climbed from roughly $250,000 to $3.2 million between 2004-2005, and then back to $1.1 million in 2006. While the volatility of aid is a challenge, so is the frequent deviation of disbursements from the level of aid that was pledged. This deviation can often be large. Celasun and Walliser (2008) found that, among International Development Association (IDA) eligible countries between 1990-2005, deviations of disbursements from commitments were on average 2-3 percent of GDP, and for some countries as large as 10%. This lack of predictability poses problems for donor-dependent health programs, but it is a particularly serious challenge for malaria elimination/sustained control programs such as that in Zanzibar. Predictable and consistent financing are particularly important now for the ZMCP because the gains that have been made are tenuous, and malaria could easily come back on a wide scale if funding for key control and surveillance activities slips for even a year or two. As it is extremely uncommon for donors to commit to smooth and predictable funding, Zanzibar will need to plan innovative solutions to the challenge of financing its malaria program.

**Changes in Government/Donor Priorities**

Another reason why securing malaria financing will be particularly challenging for Zanzibar is because, at very low rates of malaria prevalence, the MOHSW will face significant pressure to reallocate funds to other priorities. With tight budgets and a vanishing impact of malaria on the health and wellbeing of its population, the MOHSW will inevitably find it difficult to protect malaria funding from diversion to other needs. Even if the MOHSW is committed to continuous malaria funding, donors are likely to begin prioritizing funding for diseases and other issues that have a more direct and immediate impact on public welfare. Of course, continued funding for malaria programs will have an important impact on public health as it will facilitate the prevention of malaria resurgence. Convincing constituents and donors of the dangers associated with drawing back malaria funding—a lesson that should be learned from repeated episodes of resurgence—should be a top priority for the Zanzibar MOHSW. It is important to point out, however, that the urgency of continued funding need not be a negative message. The ZMCP may choose to frame its fundraising efforts around the life-saving benefit of continued control, even though malaria is no longer widespread. This motivation should be familiar to western donors, whose countries continue to vaccinate their populations against absent diseases such as polio and measles.

Finally, just as successfully eliminating malaria and preventing its reintroduction will require the continued focus and enthusiasm of the ZMCP team and the Zanzibar population, the MOHSW will have to fight fatigue and shifting priorities from the donor community as well. Elimination programs require many years of stamping out final malaria cases and donors may get tired of funding the program as the time it takes to achieve elimination lingers on. Donor foundations are also under constant pressure to demonstrate the impact of their funding and to respond to emerging priorities. As malaria imposes less of a public health burden on Zanzibar, donors may be compelled to shift scarce funds to other public health programs. This possibility has already been made salient by the reluctance of PMI—a leading donor for the ZMCP—to continue funding IRS campaigns in Zanzibar. Traditional measures used by donors to allocate resources, such as dollars per disability-adjusted life year (DALY), will make elimination and sustained control programs appear unattractive investments relative to other diseases. In order for malaria to remain a priority, a new framework for prioritizing funding will need to be adopted by governments and donors, incorporating measures such as cost/benefit ratios and resurgence risk.

**POTENTIAL SOLUTIONS**

The severity of these financing challenges is evidenced by the fact that some donors are already questioning the value of continuing to fund malaria programs in low-prevalence areas such as Zanzibar. It will be necessary for the Zanzibar government to work with donors on developing new forms of financing more suitable to an elimination program. Given the magnitude of malaria program costs and the challenges of changing financing systems and donors, it may be hard to fund all—even or the majority of activities—through innovative mechanisms. However, the case can probably be made to Zanzibar’s traditional donor agencies for some continued funding of malaria programs. If new financing methods can provide a solid foundation for ZMCP funding, the pressure to secure traditional funding can be lessened and the impact of withdrawal of traditional funding sources can be mitigated. Also, a strong foundation of steady funding through innovative sources can help ensure the maintenance of essential malaria activities, such as surveillance and vector control in known “hot spots.” If innovative financing can be secured for those core interventions deemed necessary to prevent resurgence, then an annual drop in funding devoted to less essential activities will not impose a serious risk.

Fortunately, the idea that aid donors and recipients will need to adopt “innovative financing for health” (IFH) is gaining currency in the global health community and a number of examples of this type of financing are being proposed. Most of the mechanisms currently under discussion by the global community seek to increase the magnitude and/or predictability of resources raised from donors. While these approaches are a welcome addition to the global health and malaria effort, they will not address the challenges faced by sustained control and elimination programs articulated above. These challenges require new mechanisms that increase the predictability of funding disbursement rather than funding generation. A number of such mechanisms, some of
Tourism Tax

Generating funding for a health program through taxation is one form of IFH that is already being tried on a large scale. Taxation is the basis of the UNITAID model, an international facility operating since 2006 that uses revenues from an airline ticket tax to purchase drugs for HIV/AIDS, TB and Malaria. An airline tax is an attractive funding source because it is based on a steady, predictable form of revenue and because the tax is progressive—impacting higher income people the most. Another example of tax-based financing for health is the “black lung tax,” an excise tax on the purchase of coal that is used to compensate miners suffering from black lung disease. A malaria tax would follow the same principle: just as coal companies generate the burden of black lung, travelers create the risk of malaria resurgence and therefore would be required to contribute to the cost of mitigating that risk through a modest tax.

Both the airline and the black lung taxes are earmarked, meaning that the revenue they generate is required to go to a specific purpose (the treatment of ill coal miners in the case of the latter). Should Zanzibar consider funding its malaria program partly through taxation, it is essential that this tax be earmarked and that the purpose is transparent (e.g., by calling it a “malaria prevention tax”). Earmarked taxes are often criticized because of the lack of flexibility they impose on public funds—they prohibit policy-makers from reallocating revenues from the tax to changing priorities. However, this is precisely the benefit of such a tax for Zanzibar’s malaria control program. If the revenues are not earmarked, this source of financing runs the same risks as traditional funding sources—being diverted from malaria to other priority programs in response to political pressures. In order to serve the vital function of preventing malaria resurgence in Zanzibar, tax revenues must be protected and used exclusively for this purpose.

A natural opportunity for taxation in Zanzibar is tourism. A modest tax on airline tickets into Zanzibar could provide a steady, predictable source of funding for the malaria program and could be instituted without much risk of a reduction in tourism. The current taxation of tourism in Zanzibar is quite low ($5) and, since it is equal for all tourists, is a form of regressive taxation. A tax on air travel on the other hand would be progressive, since higher income tourists arrive by plane. We anticipate that tourists would be willing to pay an additional tax of at least $10 on airline tickets, since: 1) Zanzibar is a highly attractive tourist destination; 2) this is a very small sum relative to the cost of traveling to Zanzibar; and 3) maintaining malaria-free status is in the economic self-interest of travelers. Tourists typically pay well above $10 for malaria prophylaxis to come to the island. The home countries of most of Zanzibar’s tourists require a prescription, and thus a doctor’s visit, for prophylaxis. Tourists must thus typically pay at least $15-30 for the doctor visit, and an additional $30 for the medicine—costs that could be avoided if they were visiting a malaria-free Zanzibar. Thus elimination, even with a $10 tax, would be significant net saving for tourists if they are able to stop taking prophylaxis. Of course, tourists also planning to visit the mainland on their trip to Zanzibar will still have to buy prophylaxis, but the substantial number of tourists coming only to Zanzibar will be able to avoid these costs.

Tourism in Zanzibar has been increasing over the past two decades, with an especially rapid increase of nearly 100 percent since 2003. At roughly 130,000 annual tourists (a tiny fraction of which come from mainland Tanzania), a malaria prevention tax of, for example, $10 per visitor would provide the ZMCP with roughly $1.3 million per year. We use the $10 tax for illustrative purposes only. The actual level of the tax that is optimal for the ZMCP would depend on more detailed analysis, as should the form of the tax (e.g., whether it should be flat for all tourists or on a sliding scale depending on the cost of airline ticket, type of accommodations, etc.) Also, revenue generated from the tax will have to go partially toward the cost of administering it, so actual funding available for malaria activities will be lower than the total revenue collected.

FIGURE 32: ANNUAL NUMBER OF TOURISTS IN ZANZIBAR

Annual revenues could be put in a fund and either dispersed regularly to cover recurring costs of the malaria program (such as surveillance activities) or kept in an investment fund with good liquidity and used only when sufficient funds through normal channels are not available. The latter option is attractive because it ensures the availability of emergency funds for outbreak response or when other funding dries up and because it generates additional interest income. Although a tourist tax for malaria seems like a natural opportunity for steady, predictable financing for an attractive tourist destination like Zanzibar, the benefits and disadvantages of such a tax must be thought through in more detail. We recommend that, as a next step, the ZMCP and others conduct a more thorough analysis of a tourist tax for malaria, considering issues such as feasibility, administrative burden, revenue potential, etc.
Endowment/Trust Fund

Another form of IFH that has been proposed recently and is commonly used in other contexts such as universities and foundations is an endowment (trust) fund (Lane and Glassman, 2008; de Ferranti et al., 2008). Typically, there is some core level of endowment, established with funds from donors and from government, that is not used for funding, but is invested to generate interest income used to fund recurring costs. Depending on the size of the endowment, the level of returns and the costs that need to be covered, the interest income may go partly to recurring costs and partly to reinvestment in the core endowment fund.

Figure 33 illustrates the concept of an endowment. Panel A shows the level of funding for malaria programs that may prevail in the absence of innovative financing such as an endowment fund. Funds for ZMCP would remain high and potentially increase for the next several years, but as malaria becomes less of a public health burden in Zanzibar, donors are likely to switch to other funding priorities and ZMCP funding is likely to fall significantly. Panel B illustrates the potential funding under an endowment. The endowment would be set up with substantial funds jointly by the Zanzibar government and donors and would not be drawn down from year to year. Rather, malaria funds would come from the investment income generated by the endowment. It is preferable that some of this interest income be reinvested back into the endowment so that, as illustrated, the level of endowment funds and the corresponding investment income generated from it are gradually increasing. It is important to note that there may be years when the endowment makes little or no money from its investments. One way to deal with this is to ensure other types of financing for malaria programs in case investment income is down. The other possibility is to allow some drawing down of the endowment in years when investment income is low as long as, in years when investment income is high, some of that income is re-invested into the endowment.

An endowment fund is used in the South Pacific island nation of Tuvalu. The fund was created with contributions from several partners, including the Tuvalu government, Australia, Japan and the UK. Proceeds from the fund go toward recurring costs in the government budget as well as infrastructure and other economic development projects. The trust fund has a financial advisory committee and a governing board composed of representatives from each of the contributing nations and chaired by a Tuvalu government member. Acceptable uses of the funds are specified in the founding treaty and the fund is audited annually. Other examples of health endowment funds are the Bhutan Trust Fund, which funds essential drugs and vaccines, and the USAID Profamilia endowment in Columbia, which funds health facility upgrading (Lane and Glassman, 2008). USAID, which had been funding family health programs in Columbia, granted this $6 million endowment to provide a continuous source of funding before withdrawing traditional aid. Zanzibar could use this model to appeal to traditional donors such as PMI who are considering withdrawing funding. Contributing to an endowment fund that facilitates future funding for malaria control would likely be seen by the global health community as the most responsible way for a donor to initiate withdrawing funds from a program it has heavily supported.

One of the most appealing aspects of an endowment fund is that it promotes financial autonomy and sustainability. Although this financing mechanism reduces the dependence of government program funding on foreign aid, it does not replace it with a perfectly stable and predictable source of financing. Disbursements from the trust to the government are vulnerable to market conditions, so some way of supplementing the interest income in down years must be put in place. The way the Tuvalu government has dealt with this is by ensuring that a portion of the investment income earned in up years is re-invested in the fund and can be drawn on in years when investments fall short.

An endowment fund could be an excellent way for Zanzibar to secure long-term financing for its malaria program. Contributing toward an endowment may be an attractive option for ZMCP’s donors since it would allow them to make a one-time contribution to Zanzibar’s malaria future that would generate continuous benefits. This would likely be even more attractive to donors if the Zanzibar government also pledged an initial investment in the fund. A good starting point for an endowment in Zanzibar would be a matched-funds model, as used in the Bhutan Trust Fund, in which donors match the level of funds invested in the endowment by the Zanzibar government.

An endowment such as this can only provide an effective financing solution if the funds are protected by law to go toward malaria prevention and if there is adequate accountability in the use of funds. It is also essential that a plan be in place for funding the ZMCP in years when investment income is down. A safe setup for the endowment would be for Zanzibar to follow Tuvalu’s model and reinvest its positive investment income in the fund until a target level is reached. The target level should be set so that it is high enough to generate sufficient expected investment income to fund revolving ZMCP costs (or some pre-determined...
portion of those costs). Before this target is reached, investment income should only be used to fund the ZMCP if it is absolutely necessary and funds cannot be secured elsewhere. Once this target is reached, annual returns can be used to fund revolving ZMCP costs. In years when investment income exceeds these costs, it can be reinvested in the endowment. This will allow for a cushion above the endowment target level that can be drawn down in years in which investment income is too low to cover costs. The fund should allow for the endowment to be drawn down only in the case that other funds, including investment income from the fund, are not sufficient to cover core operating costs of the program.

Emergency Debit Fund

Although some donors may be unwilling to fund ZMCP’s recurring costs when incidence is so low and their attention has shifted to other priorities, they may be more likely to contribute to the costs of controlling a malaria outbreak. A financing option that could interest donors is an “emergency debit fund,” similar to a bank account, that can be drawn on by the Zanzibar government to prevent or control outbreaks. The fund would be donor-managed and, as with a bank account, a certain portion of the fund could be lent out or used for other purposes by the donors. The Zanzibar government would be permitted to draw on this account under certain conditions, such as demonstrated good management of other government funds and a clear, acute need for emergency funding to prevent or control malaria resurgence.

Even though all of the funds would not be kept in reserve at all times, donors would guarantee a certain level of funding that Zanzibar could draw on. Ideally, multiple donors provide this debit account guarantee so that if one donor cannot meet its commitments, others can supplement. To discourage this scenario, poorly performing donors could be required to deposit a larger share of their commitment to the fund or pay a higher portion of administrative costs (Lane and Glassman, 2008).

The primary benefit of a financing mechanism such as this for Zanzibar is that it provides a guaranteed source of funding for outbreak response expenses. This will only be effective at preventing resurgence, however, if Zanzibar maintains a well-functioning surveillance system. This will be particularly challenging if financing for recurring ZMCP expenses is not secured. A risk with this type of financing mechanism is that it could cause the Zanzibar government or foreign donors to place less priority on funding ZMCP’s revolving preventive activities, since there is financial security in case of an emergency. A possibility for discouraging this would be to make disbursement from the emergency fund conditional on a demonstrated effort toward prevention, though this may be difficult to operationalize. For these reasons, this option for innovative financing is least appealing and viable. However, if other sources of financing can be secured, an emergency fund such as this could be a valuable additional security against malaria resurgence in Zanzibar.

Regional Funding Pool

The Zanzibar population would not be the only beneficiary of a sustained control or elimination program in Zanzibar. As tourists and migrant workers can carry malaria back and forth across borders, other populations are vulnerable to the level of malaria in Zanzibar and can directly benefit from its reduction or elimination. For example, many tourists and migrant workers travel between Zanzibar and Oman, a country that has eliminated malaria. When malaria is present in Zanzibar, the Oman government must spend time and money screening tourists returning from Zanzibar. These same arguments apply to other countries trying to control malaria that have frequent population movement back and forth to Zanzibar.

The fact that governments in Oman and other countries experience a direct benefit from malaria elimination in Zanzibar suggests that they might be willing to invest in its cost. A regional funding pool could be set up with contributions from governments who have a particular interest (financial or otherwise) in malaria control/elimination in Zanzibar. Funds from these regional partners could either be donated annually to cover revolving ZMCP costs, or could be used toward the endowment fund or emergency debit fund discussed above.

These regional partners are connected by their joint interests in coordinated malaria control or elimination. Zanzibar experiences a direct benefit from its partners eliminating malaria as well. For example, were mainland Tanzania to embark on elimination, the costs of malaria control and surveillance in Zanzibar would go down significantly. It is thus sensible to set up a regional partnership in which partners contribute to a fund for Zanzibar’s malaria elimination while Zanzibar promises to commit funds to other partners who embark on elimination in the future.

CONCLUSION

The challenges that Zanzibar will face maintaining steady financing for its malaria program—regardless of whether the ZMCP embarks on elimination or continues with sustained control—are significant and should be addressed imminently, alongside deliberations about whether elimination should be pursued. The global health community is becoming increasingly conscious of the negative impact that aid volatility and unpredictability have on health programs and innovative financial mechanisms are being proposed. Zanzibar can make the strong case to donors that even modest setbacks in malaria funding can have serious morbidity and mortality consequences. But the MOH will have to work closely and creatively with donors and advisors to come up with financing solutions that meet the needs of Zanzibar’s malaria program.

The recommended next steps to address this significant challenge include:

1. Begin active discussions with its principal health and malaria donors to agree on the financial needs to achieve its malaria goals in the medium-term and explore approaches to ensure predictable financing.
2. Commission a detailed assessment of the potential use of innovative financing mechanisms, including an earmarked tax and/or endowment fund, to increase the predictability of malaria financing.

3. Develop and secure broad governmental buy-in for a plan to reduce reliance on donor resources for malaria control, including through gradual increases in domestic budget allocations.

4. Explore potential contributions from countries such as Oman that have a self-interest in continued low malaria transmission on Zanzibar.
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