

Revolutionizing Vector Control for Malaria Elimination

A case study series of
vector control approaches
across diverse settings

Key Messages

- High income countries manage vector-borne disease and control mosquitoes in different ways when compared to the methods used by the majority of malaria-endemic countries aiming to control or eliminate malaria
- Successful programs do not rely on a one-size-fits-all approach to control mosquitoes and vector-borne diseases; rather, they adopt a range of complementary tools and strategies that are appropriate for local conditions
- Australia and the United States have diverse mosquito and disease control priorities and health system features, but a key success factor of both is their use of the Integrated Vector Management (IVM) approach—a multi-stakeholder, evidence-based, integrated decision-making framework for sustainable control of disease vectors
- An increasing number of malaria-endemic countries are incorporating IVM into their elimination strategies, but many implementation gaps remain, particularly in evidence-based decision-making and capacity building

Exploring Best Practices for Vector Control Management and Delivery

Insecticide-treated nets (ITNs) and indoor residual spraying (IRS) have contributed to substantial declines in malaria cases worldwide. However, in some settings where these vector control measures have been optimally employed, malaria transmission continues, a problem broadly referred to as residual transmission.^A This has led researchers to look for insights from countries that have successfully eliminated malaria using vector control measures beyond ITNs and IRS to determine whether lessons learned in these settings can be applied elsewhere. Two examples are the United States and Australia, which eliminated malaria in the 1950s and 1980s, respectively, and now focus their efforts on controlling nuisance mosquitoes and other mosquito-borne diseases.^{2,3} It is apparent from these examples that high income countries approach vector control in very different ways when compared to most malaria-endemic countries currently seeking to control or eliminate malaria transmission; despite these differences, there are potentially important transferable practices and learnings from high income countries for consideration by malaria vector control programs around the world.

To explore this issue further, the UCSF Global Health Group's Malaria Elimination Initiative (MEI) identified vector control programs across diverse geographic and economic settings that implement non-traditional tools and supportive systems to monitor and control mosquitoes. Through a series of case studies designed to synthesize challenges, lessons learned, and best practices, the MEI aimed to answer:

1. What tools and strategies do high income countries use to control mosquitoes and mosquito-borne diseases, and why?
2. How are mosquito control programs managed in high income countries, and how are their delivery systems structured?
3. Can best practices in high income countries be successful in countries seeking to eliminate malaria?
4. Are there any middle/lower-middle income countries currently implementing non-traditional approaches that can serve as a model for eliminating countries?
5. How can the findings inform the development and implementation of future vector control field research and program operations?

A Residual transmission is malaria transmission that persists despite high coverage of ITNs and/or IRS, to which a combination of human and vector behaviors contribute (e.g. humans sleeping or active unprotected outdoors and vectors resting and biting outdoors, feeding on animals, and evading ITNs/IRS indoors)¹

The MEI's research team documented the supportive systems and tools used by malaria or mosquito control programs in Australia, Tanzania and the US with a goal of identifying key challenges and factors that drive success across all locations. The case studies were conducted with a mixed methods approach, including extensive literature reviews, program document and record reviews, site visits and observations, and key informant interviews. Essential malaria or mosquito control personnel were interviewed on the main program components, including: interventions, legislation, supply chain, community engagement, governance, operational decision-making, human resources, supervision, management, monitoring and evaluation, financing, intersectoral collaboration, and surveillance. The team also conducted a review of published literature and program documents on the malaria elimination program in Bali, Indonesia.

Common Themes Emerged across Socioeconomic Settings and Diverse Program Goals

While the range of socioeconomic settings and program goals and objectives led to context-specific findings, common themes emerged across case studies.

- There is no one-size-fits-all approach to vector control. The programs examined in the case studies use multiple vector control interventions, targeting different life stages of the mosquito vector and at varying frequency. Despite the diversity of interventions used by each program, all employ larval source management techniques with much success. Stakeholders agreed that the strength of a program is largely determined by a tailored, integrated package of interventions and supportive activities such as surveillance and monitoring, based on local vector biology and ecology, available funding, and human resource capacity.
- Legislation that gives program staff legal authority to carry out mosquito control activities on public and private properties helps ensure the quality, coverage, and timeliness of interventions, but not all programs are able to enforce such laws, rendering them ineffective.
- The programs in Australia and United States are funded through local property taxes, resulting in relatively consistent and predictable budgets from year to year. In Indonesia and Tanzania, activities are supported through local and national government health budgets as well as external funders; while reliance on domestic funding gives these programs more control over their activity selection, budgets are often limited and may be diverted toward other health priorities.
- The most effective programs are flexible and responsive. Empowering local level staff, including field workers, to make operational decisions based on daily realities rather than relying on a top-down,

prescriptive approach ensures interventions are adapted to need.

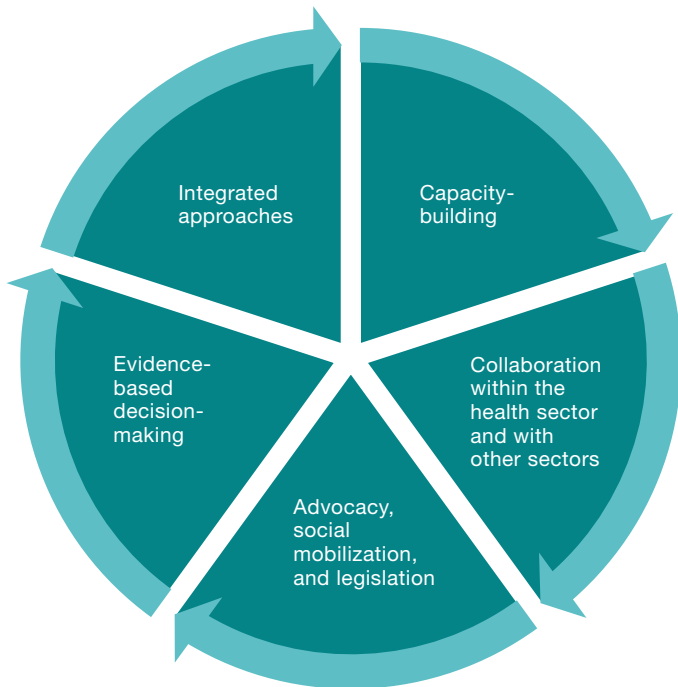
- All programs make use of large cadres of casual/seasonal workers to carry out daily activities, lowering overhead costs; however, challenges associated with this approach to staffing include high turnover, need for constant training, and risk of poor buy-in to the program mission, all of which can negatively impact intervention quality.
- Each country has differing management styles, and program managers have a range of academic and professional backgrounds. Despite this diversity, effective and well-respected managers have shared traits, including encyclopedic knowledge and expertise on all aspects of the program, dedication to the program mission, and avid, vocal support for and trust in his/her staff.
- The routine collection of entomological and epidemiological data to guide operational decision-making allows programs to be responsive and adaptable in deploying the most appropriate vector control interventions. The degree to which programs gather these data varies amongst the case study locations, but the most successful programs collect and analyze a wide range of both entomological and disease indicators on a daily and weekly basis.
- Most community outreach focuses on educating the public on keeping their home environments clear of breeding sites and notifying program staff of problem areas; active involvement of the community in control efforts was noted by the programs as universally important to success.
- The collaboration of mosquito or malaria control programs with academic institutions and/or government agencies creates synergies in research, improves communication and coordination, and generates opportunities for integration and efficiencies. All case study programs have established relationships with research institutions and engage, in some form or another, in data-sharing or research activities.

Strong Vector Control Programs Are Guided by the Five Elements of Integrated Vector Management

While strong infrastructure and ample financial and material support contributes significantly to the strength of the Australia and US mosquito control programs, a major success factor for both countries is their use of an Integrated Vector Management (IVM) approach to guide program operations. IVM is a rational decision-making process emphasizing the roles of advocacy, social mobilization, and legislation; intersectoral collaboration; integration of control methods; evidence generation through surveillance and research; and capacity-building (Figure 1). Increasing numbers of malaria-endemic countries, including Tanzania and Indonesia, are incorporating

IVM principles into their malaria control and elimination strategies per WHO guidance.⁴ However, significant gaps often exist, particularly in evidence generation, intersectoral collaboration, and capacity-building. Other factors essential to the success of any malaria or mosquito control program include driven and capable managers with strong leadership skills, motivated and properly incentivized staff, and an engaged community that supports program operations.

Figure 1. The components of Integrated Vector Management (IVM)^{5,6}



Best Practices for Mosquito Control in High-Income Countries Can Be Applied in Lower Income, Malaria-Endemic Countries

- The strength of mosquito control programs in Australia and the United States can largely be attributed to the use of IVM to inform all aspects of their operations, from intervention choice to data generation to collaborations with the community and other stakeholders. Since IVM is not prescriptive but merely guides decision-making based on local conditions, the approach is applicable in all income levels and eco-epidemiological settings
- Efforts to transfer the IVM model to low income countries controlling malaria have had limited success despite the availability of IVM guidelines and manuals,

and more research is needed to understand why and how to address the gaps

- Districts in Indonesia and Tanzania have used larval source management approaches with success despite an emphasis on ITNs and IRS elsewhere in their respective countries. Malaria-endemic countries need global support and an enabling policy environment in which to select and test supplemental vector control tools as appropriate to local transmission settings
- Another key success factor in Australia and US is adequate, predictable financing which is not easily transferred to malaria-endemic countries that are largely dependent on external funding; malaria programs need more options for sustainable financing, particularly as donor funding declines
- Building capacity at all levels of malaria programs is a major priority—more training in technical and management/leadership skills is essential

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The **Malaria Elimination Initiative (MEI)** at the University of California San Francisco (UCSF) Global Health Group believes a malaria-free world is possible within a generation. As a forward-thinking partner to malaria-eliminating countries and regions, the MEI generates evidence, develops new tools and approaches, disseminates experiences, and builds consensus to shrink the malaria map. With support from the MEI’s highly-skilled team, countries around the world are actively working to eliminate malaria—a goal that nearly 30 countries will achieve by 2020.

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