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Global Development Hub

STEM Development Impact Memos

Transmission Zero

Using Modified Gene Drive Mosquitoes to Eliminate Malaria

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“The solutions we currently have for malaria are not enough – we need something new.”

George Christophides, Professor of Infectious Diseases and Immunity at Imperial College London, UK

The Challenge

— In 2023, there were almost 600,000 malaria deaths in 83 countries.[1] African countries account for 94% of deaths, 76% of whom were children under five.

— Progress in tackling malaria has flat-lined, and cases and deaths have been further exacerbated by disruption to health services during the COVID-19 pandemic.[2]

— Existing malaria interventions are becoming less effective as mosquitoes develop biological and behavioural resistance to insecticides and barrier-based controls, while malaria parasites develop resistance to treatment.[3] New tools to tackle malaria are desperately needed.

— Transmission Zero’s gene drive technology offers an environmentally friendly, economically viable, and equitable intervention to curb the spread of malaria, particularly in rural, under-resourced areas.

— Tanzanian expertise and infrastructure provide a high-technology base for further capacity development and regulatory pathfinding in the region.

The Context

Each year, more than 263-million people contract malaria[3], a life-threatening disease. Certain mosquito species carry the malaria parasite, *Plasmodium*, and transmit it to humans through their bite. Malaria is endemic to 83 countries, but 94% of malaria cases are in Africa. Of the near 600,000 deaths globally, most of them are in Africa and the majority (76%) are children under the age of five.

According to the 2024 World Malaria Report[3], progress against malaria has flat-lined, and remains significantly higher than pre-COVID-19 pandemic levels. There have been numerous efforts to curb the deadly disease, but the efficacy of these interventions is decreasing.[3] Methods include use of insecticides to kill mosquitoes and bed nets to prevent bites, however, resistance to insecticides is increasing, and mosquitoes are adapting their behaviour to avoid barriers to biting. Other interventions, such as malaria vaccines, reduce the likelihood of infection, but the access to and cost of these medications are barriers to malaria eradication.

In 2016, an Imperial College London-led multidisciplinary team established Transmission Zero, an international research programme that develops new ways to halt the spread of the deadly disease. Transmission Zero is co-led by Imperial researchers in the UK, and by the Ifakara Health Institute and National Institute for Medical Research in Tanzania, in collaboration with the Swiss Tropical and Public Health Institute in Switzerland. The project recently received a US$15-million grant from the Bill & Melinda Gates Foundation to substantially expand its operations in the UK and in Tanzania.

Transmission Zero has developed a two-part genetic technology:[4] The first part renders a mosquito unable to transmit the malaria parasite, while the second part has a gene drive that ensures that future generations are also resistant to the parasite. Gene drives propagate a specific trait through a population, ensuring that all offspring receive the trait from their parent.

The second part of the technology has two separate properties: the ability to propagate the malaria resistance trait and the ability for the gene drive to propagate itself. A self-propagating technology allows for the elimination of malaria without additional costly interventions. It could spread to other regions where the parasite-carrying mosquitoes are found, even if these places are inaccessible to humans.

“We want to move at the right speed, not too fast so that everyone is on board and supportive of this new technology but also with urgency, so that we treat malaria as the emergency that it is.”

Nikolai Windbichler, Reader in Genetics at Imperial College London, UK

The Method

— Researchers at Imperial College London developed a two-step process to curb the spread of malaria. As part of the Transmission Zero programme, the institution partnered with the Ifakara Health Institute and the National Institute of Medical Research in Tanzania.

— The programme established a mosquito infection facility at the Ifakara Health Institute, including a biosafety level 3 laboratory, to bolster genetic research in Tanzania and the region.

— In 2023, Transmission Zero researchers at the Ifakara Health Institute made the first ever transgenic mosquito in Africa, a huge milestone towards trialling the technology in the field.

— The field trials timeline has three stages:

  — Initial – trials with mosquitoes modified to be resistant to malaria.
  — Intermediate – trials with mosquitoes modified to be malaria resistant, as well as the technology to propagate that trait.
  — Full gene drive – trials with mosquitoes modified to be malaria resistant, as well as the technology to propagate that trait and the technology itself.

"This is a new type of technology and a first-in-class solution to complement our current malaria control tools."

Nikolai Windbichler, Reader in Genetics at Imperial College London, UK

Benefits

Effective: Current methods to stop malaria deaths, are becoming less effective[3]. Transmission Zero's gene-drive technology offers hope to countries with high malaria burdens.

Self-sustaining: Gene drive mosquitoes will not need to be continuously released as the trait will self-propagate through mosquito populations.

Cost-effective: Total funding for malaria control and elimination in 2022 was estimated at US$ 4.1 billion, compared with US$ 3.5 billion in 2021. This is about half of the amount estimated to keep the world on track to meet the WHO's malaria milestones.[3]

Equitable: The technology self-propagates through mosquito populations, and so no human community will be left behind because they live in rural, under-resourced areas, which may struggle to find or finance other malaria interventions.

Environmentally friendly: The technology uses natural products already found in the ecosystem to give mosquitoes malaria resistance.

Africa owned: the project achieved the first ever transgenic mosquito made on African soil, by African scientists; a huge paradigm shift in emerging technology development and landmark achievement for research in Africa, fostering local ownership.

Infrastructure: The programme established a mosquito transgenesis and infection facility at the Ifakara Health Institute that consists of a biosafety level 3 laboratory and supporting plant room, to bolster genetic research in Tanzania and the continent.

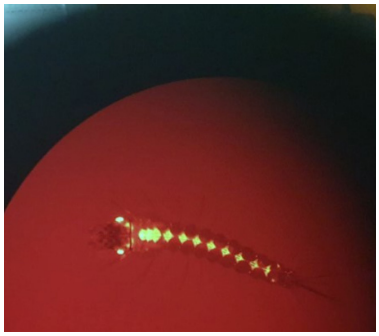
Human capital: The partnership between Imperial College and its Tanzanian partners ensures that there are scientists in Tanzania trained in the latest genetic technologies who are able to develop their own research agenda.

Ease-of-use: The nature of the technology means it would not require any behavioural changes from individuals to be implemented, making it easier to deploy successfully.

Regional hub: African researchers plan to use their facility as a base for training scientists and officials from neighbouring countries in insect genetic technologies.

"There was a strong agreement from the beginning that we had to capacitate local scientists and have buy-in from the government and local communities, which demonstrates the local ownership of the technology."

Dickson Wilson Lwetoijera, Principal Research Scientist at Ifakara Health Institute, Tanzania



“Our technology is equitable: it offers hope in the fight against malaria, and doesn't present economic or social barriers to malaria intervention access.”

George Christophides, Professor of Infectious Diseases and Immunity at Imperial College London, UK

Impact

— **For those at risk of malaria:** The technology could significantly reduce the malaria burden in high-risk countries, saving hundreds of thousands of lives each year, especially among children.

— **For governments:** The self-propagating technology would reduce the healthcare burden of malaria, the costly interventions required to suppress its spread, and boost African economies which can lose an estimated 5–6% of their GDP to malaria impacts.

— **For organisations providing treatment**: This technology could provide a strong complementarity to the existing malaria control toolkit, offering hope for realistic prospects of malaria elimination in high disease burden settings.

Notes

1. World Health Organisation: Fact sheet, ‘Malaria’, WHO. https://www.who.int/news-room/fact-sheets/detail/malaria
2. Poespoprodjo, J.R. et al. ‘Malaria’, The Lancet, Vol. 183, Issue 10419, December 2023. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(23)01249-7/abstract#seccestitle10
3. World Health Organisation: ‘The 2024 WHO World malaria report’, WHO. November 2023. https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2024
4. Hoermann, A. et al. ‘Gene drive mosquitoes can aid malaria elimination by retarding Plasmodium sporogonic development’, Science Advances, Vol. 8, September 2022. https://www.transmissionzero.org/_files/ugd/f5e8ac_2696168ec2664fd2a5471f091c077916.pdf

Funders

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For more information

Transmssion Zero
www.transmissionzero.org

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