

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

“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 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 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 malaria³, 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, progress against malaria has flat-lined and remains above pre-COVID-19 levels.³. There have been numerous efforts to curb the deadly disease, but the efficacy of these interventions is decreasing. The Main control methods include insecticides and bed nets, but insecticide resistance is rising and mosquitoes are changing their behaviour to avoid them. Malaria vaccines can reduce infection, but limited access and high costs remain major barriers to 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.

“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

“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



The Method

Researchers at Imperial College London, working through the Transmission Zero programme with the Ifakara Health Institute and Tanzania's National Institute for Medical Research, developed a two-step process to curb malaria. The programme established a mosquito infection facility and biosafety level 3 laboratory at Ifakara to strengthen regional genetic research.

In 2023, Transmission Zero researchers at Ifakara created Africa's first transgenic mosquito, a major milestone toward field trials. These trials will progress in three stages:

- Initial: mosquitoes modified to be malaria-resistant.
- Intermediate: malaria-resistant mosquitoes with a trait-propagation system.
- Full gene drive: malaria-resistant mosquitoes with a self-propagating gene drive.

Benefits

- **Effective & self-sustaining:** Current malaria control methods are becoming less effective. Gene drive mosquitoes are designed to be malaria-resistant and self-propagating, reducing the need for continual releases.
- **Cost-effective:** Global malaria funding in 2022 was about \$4.1 Billion, roughly half of what is needed to meet WHO milestones. A self-sustaining tool could help close this gap.
- **Equitable & easy to use:** Because the trait spreads through mosquito populations, rural and under-resourced communities can benefit without needing to adopt new behaviours or finance additional interventions.
- **Environmentally friendly:** The approach uses natural products already present in the ecosystem to confer malaria resistance to mosquitoes.
- **Africa-owned & capacity-building:** African scientists created the first transgenic mosquito on the continent and established a biosafety level 3 transgenesis facility at the Ifakara Health Institute, which is now training regional researchers and serving as a hub for insect genetics.

“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

Funders

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For more information

Transmission Zero
www.transmissionzero.org/

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/](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(23)01249-7/)
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

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