International Network for Government Science Advice

INGSA WORKSHOP MATERIALS

SWAMPERIA:

Future technology in the fight against malaria

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ANOPHELES ALBIMANUS MOSQUITO FEEDING ON A HUMAN ARM

SWAMPERIA:

Future technology in the fight against malaria

Note: materials in this case are fictional and should not be taken to represent real-life people, places or events.

Swamperia is a country of diverse and beautiful landscapes. It is a lesser known tourist destination for travellers seeking more 'off the beaten track' experiences – with a number of high-end eco-lodges. However the country's reputation as a 'malaria zone' has been an impediment to its further development of its tourist potential. It is rich in freshwater resources including lakes, rivers and wetlands. Swamperia's largest crop (domestic and export) is paddy rice. Economically, Swamperia is among the least developed countries in the region, relying on its limited rice exports, forestry, and its limited tourist sector for economic development. However, there is sadly a very high rate of cerebral malaria in Swamperia, which is due to infection with plasmodium falciparum carried by the anopheles mosquitoes that are endemic to much of the country.

Background and context

In 2019 malaria infection led to 200,000 deaths mainly of children under the age of 5. In total, there were 500,000 cases in the population of 12,000,000. In the past decade, both the ministry of health and international organisations have put considerable effort into health promotion practices such as education and action on eliminating standing/stagnant water near villages and promotion of the use of effective insecticide treated bed nets. Surveys have shown that bed net use has not been widely adopted by the population.

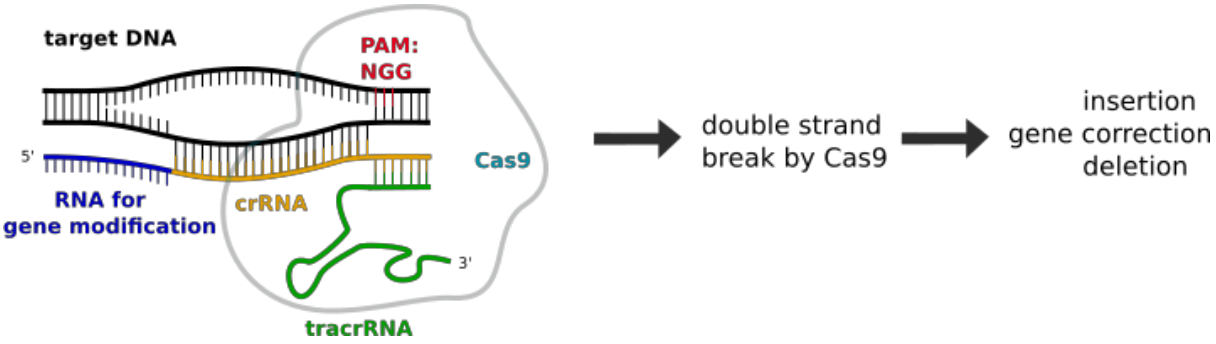
In 2016 a trial of a vaccine against malaria produced by a European drug company had been conducted in Swamperia. This trial involved 4 immunisations over three years and was thus deemed to pose a high burden on the already over-stretched public health system. Furthermore, the trial showed only partial protection. It appeared to reduce the death rate by about 15% and was 30% effective in children. The vaccine use was associated with about a 10% rate of side-effects, which included persistent joint pain in adults.

The local healers claimed that the side-effects are evidence that western medicine is harmful for Swamperians. They advocated for the continued use of an infusion of local herbs, which have long been known to provide analgesic effects, but which have no known properties to combat the *plasmodium falciparum* parasite. The healers remain vocal about the issue.

The dilemma

It is now 2020 and a global consortium of scientists funded by the philanthropically supported Global Anti-Malaria Foundation (GAMF) has announced that 'anti-malarial' anapholese mosquitoes that they created in 2015 are now ready for uncaged field trials in real-world environments. These mosquitoes

were developed using a gene-editing technique called CRISPR-Cas9 and have a highly penetrant gene-drive quality, which means that they can pass the edited gene on to offspring so that the sought-after characteristic will continue in subsequent generations of the mosquitoes. The characteristic in question is the inability of the gene-edited mosquitoes to incubate the *falciparum* parasite that causes cerebral malaria. Scientists are satisfied that the gene-edited mosquitoes pose no danger to humans and have not seen any negative consequences to the controlled laboratory ecosystems in which the gene-edited insects were trialled.



CRISPR-CAS9 MODE OF ACTION

A wider release of the mosquitoes would now be needed to determine their effect on malaria rates and to monitor ecosystem impacts in endemic regions. The Prime Minister has recently been approached by GAMF to consider whether the first field release could be in an area of Swamperia with high infant mortality rates from the disease. A partnership between GAMF and a European university-based biotech company has been established to conduct the longitudinal trial of the modified mosquito (currently planned for 5 years), which is widely seen as the most promising tool in the fight against malaria. They have invited the only medical school in Swamperia to be a partner in the trial, including the joint licensing of eventual IP and commercial products.

GAMF proposes that the trial would need to include a multi-disciplinary team of geneticists, virologists, ecologists, and community health practitioners. The funding is available, the commitment is obvious, and a robust methodology and infrastructure is in place. If negotiations for a Swamperia release fail, GAMF is considering pursuing approval for release in one of two neighbouring countries.

At the same time, malaria vaccine research has continued at some of the most reputable labs in the world (CDC, London School of Tropical Medicine). The aim has been to refine the initial candidate vaccines to improve effectiveness and affordability. Progress has been slow and there is no guarantee that the vaccine will not pose the same pressures on the medical system as previous attempts, but many governments – including Swamperia, are watching closely.

Also watching closely is a well-funded international environmental organisation that is known for its anti-Genetic Engineering stance (in the environmental sector). Traditionally, this group does not protest genetic modifcation for vaccines and medicines but the, but the gene-edited mosquito is an important issue for them because it crosses the boundary from health to environment and the long-term ecosystem consequences are unknown. This organisation is offering to help the Swamperian

Government fund access to a malarial vaccine if they agree to deny approval of the gene –edited mosquito release. It is clear, however, that their funding would be time-limited.

The role of scientific advice

In light of the time pressure to approve the mosquito trial, Swamperian government officials are seeking advice from their science advisor on all the possible scenarios. What considerations would have to form part of a report from the advisor to the Government?

GROUP EXERCISES

Exercise 1: Group discussion

What issues does the Science Advisor need to consider in preparing response?

- Communication of complex science
    - What audiences to consider?
    - How to communicate about vaccines and vaccination schedules
    - How to communicate about gene-editing, inheritance, risk of horizontal transfer

- How secure is the evidence?
    - What elements should form part of a review? Who should undertake it? What process should be applied?
    - Should the science advisor meet with the mosquito study proponents? What are the key considerations in such a discussion?
    - What are the elements of knowledge brokerage that come into play?
        - What we know
        - What we do not know
        - Risks of action or inaction
        - Alternate approaches
        - Trade-offs

- Science advice vs. advocacy
    - Two very different public health interventions are arising (gene-editing, with full deployment still a way off in the future and pursuing the latest vaccine iteration). What is the role of the science advisor in comparing the options?
    - On what basis should they be compared?

- Issue of ethics and social license
    - Is the science stronger or more uncertain for one public health intervention option or any other (including low tech options of bed net use and draining standing water)? What considerations are there about the extent of uncertainty?
    - Potential societal ethical issues could be quite different for the options outlined (e.g. comparing vaccine interventions to genomic interventions within an ecosystem)? Should this be a consideration for the science advisor? If so, what are the ethical drivers and how should these be analysed and communicated?
    - What role might the social sciences play in addressing Swamperia's dilemma?

- Other considerations?

Exercise 2: Role-playing

Listed in no particular order, the following perspectives (participants may identify others) have been outlined for use in a role playing exercise. Participants are divided into groups and encouraged to both consider the perspective of various actors as listed, but also what the science advisor or advisory body might do in each situation.

Perspective 1: Science Advisor

- What perspectives and considerations should be reflected in any advice given?
- Are there limits to the science advice (e.g. how should it address ethical considerations?)

Perspective 2: Media

- The national current affairs programme is preparing an in-depth analysis of the mosquito trial, including the scientific, societal and environmental issues for the country, the region and globally. The producer has requested an interview with the science advisor. What key points will the producer want to explore with the science advisor?
- What challenges and opportunities should be considered by the science advisor in undertaking the interview? How should differing scientific views best be explained to the public?

Perspective 3: GAMF

- You are the principal investigator leading the GAMF consortium and you are aware that the science advisor has been asked to advise the government on the question of approving your field trial of gene-edited mosquitoes. You have asked to meet with the science advisor to help 'advise on the advice'. What would you wish to be conveyed?
- What considerations are there for a Science Advisor in such a discussion? What would be a fair and robust discussion in this regard? How could this be achieved?

Perspective 4: Swamperia University researchers

- You are the director of the Research Office at Swamperia University where an interdisciplinary group of local researchers is supporting the GAMF trial process. You are also in the process of setting up the spin-off company for the trial in anticipation of exploitable IP flowing from the university. You wish to brief the Science Advisor on the market aspect of the GAMF trial.
- What considerations are there for a Science Advisor in such a discussion? What would be a fair and robust discussion in this regard? How could this be achieved?

Perspective 5: Anti GE advocacy group

- You are the regional representative for a global environmental group that opposes the GE mosquito trial. Your regional office is based in the neighbouring country, but your group is nonetheless seeking to engage with Swamperian officials to quash the trial. You would like to meet the science advisor to present evidence supporting the malaria vaccine, which will accompany the offer of support to fund its use in Swamperia.
- What considerations are there for a Science Advisor in such a discussion? What would be a fair and robust discussion in this regard? How could this be achieved?

Perspective 6: Public health officials

- You are the medical officer within the Swamperia ministry of public health. You have been approached by the international group seeking to help fund anti-malarial vaccine use in Swamperia and wish to brief the Science Advisor.

- What considerations are there for a Science Advisor in such a discussion? What would be a fair and robust discussion in this regard? How could this be achieved?

Perspective 7: Politicians

- As Prime Minister you have received the advice and followed the media reports (and social media) on the issue. How are you incorporating science into your thinking? How does science advice figure among the various considerations in your decision-making?

Other perspectives?

PHOTO CREDITS

COVER: Anopheles albimanus mosquite feeding on a human arm.. Credit: James Gathany, via Centers for Disease Control and Prevention Public Health Image Library (PHIL), ID #7861. Public domain, https://commons.wikimedia.org/w/index.php?curid=3045248.

PAGE 3: CRISPR-Cas9 mode of action. Credit: Victoria Anselm, CC BY-SA, https://commons.wikimedia.org/wiki/File:CRISPR-Cas9_mode_of_action.png..

ABOUT INGSA

INGSA provides a forum for policy makers, practitioners, academies, and academics to share experience, build capacity and develop theoretical and practical approaches to the use of scientific evidence in informing policy at all levels of government.

INGSA's primary focus is on the place of science in public policy formation, rather than advice on the structure and governance of public science and innovation systems. It operates through:

- Exchanging lessons, evidence and new concepts through conferences, workshops and a website;
- Collaborating with other organisations where there are common or overlapping interests;
- Assisting the development of advisory systems through capacity-building workshops;
- Producing articles and discussion papers based on comparative research into the science and art of scientific advice.

International Science Council

INGSA operates under the auspices of the International Science Council. The INGSA secretariat is currently hosted by the University of Auckland, New Zealand
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