Malaria eradication: is it possible? Is it worth it? Should we do it?

The malaria map is rapidly shrinking. In 1900, endemic malaria was present in almost every country. Nowadays, the disease has been eliminated in 111 countries and 34 countries are advancing towards elimination.[1] Elimination is defined as the absence of transmission in a defined geography—typically a country.[2] Successful malaria control programmes in the remaining 64 countries with ongoing transmission have helped to reduce global incidence by 17% and mortality by 26% since 2000.[3] For the 34 eliminating countries, the reductions were 85% in incidence and 87% in mortality.[1] This progress is encouraging, but is worldwide eradication of human malaria possible? If so, is it a worthwhile goal and should we commit to it?

Is eradication possible? Probably yes; however, substantial challenges exist. First, despite progress, the burden of malaria is still great and it is widespread. In 2010, an estimated 219 million cases of malaria were reported and 660 000 people died in 98 countries.[3] Second, drug and insecticide resistance are on the rise. In Burma, Cambodia, China, Thailand, and Vietnam, resistance of *Plasmodium falciparum,* the major human malarial parasite species, to artemisinin, the most widely used first-line drug, has been detected and could be spreading despite efforts to contain it.[3,4] Resistance to pyrethroid insecticides can happen quickly and has emerged after large-scale distributions of bednets in several regions.[5] Although new drugs and insecticides are being sought, none are expected to be available in the near future. Third, increased mobility of people not only makes containment of resistance difficult, but also threatens the introduction or reintroduction of malaria parasites to receptive areas. Fourth, outside sub-Saharan Africa, *Plasmodium vivax,* the second major human malarial parasite species, is the main challenge. *P vivax* is much less researched than is *P falciparum*. *P vivax* is harder to diagnose and failure to successfully treat its dormant liver stage results in relapses that can fuel onward transmission. Furthermore, in Borneo and neighbouring regions, evidence now exists of human infection by a monkey parasite species, *Plasmodium knowlesi*. Zoonotic reservoirs challenge all campaigns for eradication of human infection. Fifth, extreme events, such as wars or natural disasters, greatly disrupt malaria control and elimination activities, and can lead to substantial resurgence. When accompanied by large population movements, these events can introduce malaria into previously malaria-free areas. Sixth, as malaria becomes rare, persuasion of governments to allocate finances to maintain effective elimination or post-elimination programmes is increasingly difficult. Since 1930, 75 resurgences of malaria have been recorded and nearly all are linked to the scaling back of programmes.[6] These six factors present notable challenges on the road to eradication. However, all have potential solutions resulting from substantial international collaborative efforts that range from basic research to improvements in policy and financing arrangements.

Is eradication worth it? Probably yes, but the answer is dependent on the temporal and spatial perspective. From a temporal perspective, the cost–benefit ratio is dependent on whether the comparison is between rampant and no malaria, or between low and no malaria. For rampant versus no malaria, the effort is hugely cost beneficial. However, for a comparison between low and no malaria, and if only the costs and benefits of the last mile are examined, the outcome is less certain and the costs and benefits might be more evenly balanced. From a spatial perspective, a country that eliminates malaria confers substantial benefits on its neighbours and on other countries that no longer are at risk of malaria importation. Additionally, a country that successfully eliminates moves the entire world closer to eradication. Thus, there are regional and global public-good dimensions to the efforts of any individual country. Quantification of these public goods is challenging, but they certainly exist and add to the benefit side of the equation.

Should we eradicate malaria? Yes, because the alternative policies are untenable. If the world is not going to commit to progressive elimination leading to eventual global eradication, what is it going to commit to? Imagine a world in which the goal was merely to control malaria—ie, reduce it to a level at which it is no longer a major public health problem. In countries with good malaria control, pockets of malaria will be left in poor and marginalised populations, whereas in other regions, like the humid

tropics of Africa, control programmes will struggle to keep malaria cases and deaths low. The remaining parasite reservoirs are likely to become drug-resistant and the local vectors insecticide-resistant. These enduring pockets will be the source of malaria that is introduced into receptive, malaria-free areas elsewhere. Thus, malaria-free countries will need to continually maintain expensive vigilance and response programmes to prevent resurgence of drug-resistant parasites.

Such a situation will be expensive, unstable, and is an unappealing policy option for the 21st century. The practical policy option, and the one that will be less costly in the long term, is to pursue a global policy of progressive elimination, aggressive control in the high-burden areas, and eventual eradication. This policy is even more appealing in consideration of recent evidence showing that malaria elimination could be an inherently stable state, unlike sustained control.[7,8] No-one can know when malaria will be eradicated. Our estimate is perhaps 2050 or 2060. The last battles will likely be waged in wet, tropical, and poor areas: against *P falciparum* in sub-Saharan Africa and *P vivax* in Melanesia. Continued vigilance will be needed against zoonotic malaria arising from close human–macaque contact in Borneo and neighbouring areas.[9] Special measures will need to be designed and implemented to control such malaria.

An important driver of the eradication scenario is research. Thanks to the Bill & Melinda Gates Foundation, the US National Institutes for Health, the Wellcome Trust, and others, research in malaria is more vibrant than it has been at any point in the past 50 years. New drugs are in development. Discovery of single-dose drugs that will cure both *P falciparum* and *P vivax* is a real possibility. The first malaria vaccine, RTS,S/AS01 is likely to be launched in 2015. The efficacy of the vaccine is modest, but it could make a useful contribution in reducing malaria in children in high-burden settings and in adults in elimination settings.[1] Development of this vaccine also starts a journey towards other and better vaccines. Diagnostics have improved substantially and rapid diagnostic tests have already replaced microscopy in many countries. Within a few years, portable and field-friendly molecular testing kits could be available that could identify all *Plasmodium* species at very low densities. Renewed efforts are underway to identify new classes of insecticides. Each of these developments will make a huge contribution to malaria eradication.

From roughly 1980 to 2007, speaking of elimination and eradication in connection with malaria was regarded as naive and overambitious. However, speeches by Bill and Melinda Gates on Oct 17, 2007,[10] calling for nothing less than global malaria eradication, radically changed this dynamic. Since then, there has been an upsurge of commitment to elimination and eventual eradication, and these concepts are now mainstream in the international malaria community and embraced by the Roll Back Malaria Partnership and by WHO.[11]

Of the ten leading causes of death in the developing world, malaria is the only one with a real prospect for eradication.[12] Progress is good. Our weapons are effective and continually improving. With adequate and sustained commitment, the task can be achieved.

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