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Target Zero: Why States Choose To Eradicate Infectious Diseases And How They Succeed

Gifty Abraham
Graduate Center, City University of New York

TARGET ZERO: WHY STATES CHOOSE TO ERADICATE INFECTIOUS DISEASES AND HOW THEY SUCCEED

by

GIFTY ABRAHAM

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Dr. Stephanie Golob

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Date Thesis Advisor

Dr. Alyson Cole

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Date Executive Officer

THE CITY UNIVERSITY OF NEW YORK

Abstract

TARGET ZERO: WHY STATES CHOOSE TO ERADICATE INFECTIOUS DISEASES AND HOW THEY SUCCEED

by: Gifty Abraham

Adviser: Professor Stephanie Golob

Realism has remained the dominant paradigm within international relations for most of the modern era, emphasizing the competitive nature of the international arena and the unlikeliness of states to within it to cooperate. The attempts and further still, successes, by states to eradicate infectious diseases—which remain among the most cooperative enterprises—present a number of challenges to realism's assumptions, particularly with respect to the unlikely world historical-times during which the eradication campaigns took place. As such, a two-part puzzle arises. First, why would states, which are natural competitors, cooperate to eradicate infectious diseases given structural and situational incentives not to do so? Second, when states choose to eradicate infectious diseases, what accounts for success? I tackle these questions in turn, proposing three factors: reputational benefits, rational self-interest, and the interplay of state and non-state actors, all of which, in addition to international institutions help explain the involvement and cooperation of state actors in eradication efforts, particularly at those critical periods. To answer the second question, I offer a five-point rubric which features necessary, if insufficient conditions for the success of any eradication campaign. They are: ways to cure, treat or manage the disease and its spread; monitoring programs; political will; community engagement; and agencies tasked, and adequately equipped to deal with the disease. I answer the proposed questions and apply both sets of factors using three case studies; they include the successful case of smallpox eradication, the first failed campaign against malaria of the 1950s and the modern ongoing effort, and the campaign against guinea worm disease today.

Acknowledgements

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I also wish to thank my friends who made the otherwise overwhelming process of research, writing, and revision for this immense undertaking, bearable. I appreciated their willingness to suffer through the many conversations about man, mosquitoes, and malaria that accompanied this thesis.

Most dearly, I must thank my parents not only for their love and support throughout the long and arduous road of graduate school but also for inculcating a deep respect for education from an early age.

Humbly, then, I submit this thesis to the reader; grateful for the chance to have learned so much and hopeful that it may inspire some future student just as the work of all the remarkable people behind it has inspired me.

Table of Contents

List of Tables and Figures

Chapter I: Introduction

As a discipline, International Relations has been dominated by realist strands of thought for most of the modern era. Though its adherents would be careful to point out the theory's philosophical roots run as deep as the 5th century writings of Thucydides and the 15th century scholarship of men like Machiavelli, realism's modern incarnation emerged in the wake of the Second-World War as typified by E.H. Carr and Hans Morgenthau. Born out of such a destructive and chaotic time, naturally, it emphasized the will to power inherent within human nature, the competitive character of states in the anarchical global system, and the consequent and paramount drive of those players for survival within such a context. As described above, realism in the classical sense gave rise to many theoretical offshoots—structural and neoclassical among them. The theory has left an indelible (and not undeserved) impact on the field. Its message is clear: states are competitors. It is from this theoretical starting point that our discussion begins.

The eradication of any disease-causing pathogen is a truly herculean effort. Put simply, a global problem will require resources and perhaps most importantly, a level of cooperation that is proportional to its scale. It should come as no surprise to close observers of global public health, therefore, that despite more than a century of concerted public health efforts and several past and present campaigns to eradicate human infectious diseases only one has yet succeeded. Still, one effort—the Campaign against smallpox—did succeed in dramatic fashion against a disease that, before it could be stopped, claimed the lives of hundreds of millions during the twentieth century alone.[1] This accomplishment should not be written off or taken lightly; instead, it has important implications for other ongoing eradication efforts today.

[1] Koplow 2003: 1

Given this background then, the conceptual puzzle I propose is two-fold. The first challenge deals with resolving the apparent contradiction implied by the two aforementioned stances: the realists' belief in the competition of states and the cooperation required by the successful eradication of an infectious disease. In other words, I will start by answering the question of why states would cooperate to eradicate infectious diseases given structural and situational incentives not to do so.

The mere decision to cooperate, however commendable its intentions and rare its occurrence, is no guarantee of success. There remain, after all, enormous scientific, technical, environmental, and social challenges to surmount in any successful effort. As such, the second part of my puzzle will be to shed some analytical light on what makes these cooperative schemes successful. Though the discussion above has placed significant emphasis on states, it will become clear as the investigation proceeds that the different diseases allow for, or even require different configurations of both state and non-state actors in the eradication process. Assuredly, states and interstate agencies will remain a vital part of any eradication effort, but it will be important to see how the structure of these cooperative ventures changes over time as well. At this point, two important qualifications and reservations are necessary.

First and foremost, though this paper deals heavily with infectious diseases the analysis contained herein represents the viewpoints of a Political Scientist rather than those of, say, an epidemiologist—that is, a trained medical professional working in the field. It is, of course, impossible to conduct any serious discussion of these issues without delving somewhat into the science behind the diseases: the lifecycles of the organisms that cause them; vaccines, medications, treatments and related subjects, but where these matters are concerned, my analysis is only intended to echo the thoughts of leading scientists and experts in the field; it will primarily defer

to their research, offering only secondary input on how to best implement these strategies rather than to interject my own non-technical posturing. Second, with due respect to those who have and continue to work tirelessly in the scientific, humanitarian, and other related fields, I recognize that I may attain new heights only by "standing on the shoulders of giants"[2]

From my study of past and present campaigns to eradicate infectious diseases—both successful and failed, I have gleaned five main components in any successful eradication program. They are: ways to cure, treat or manage the disease and its spread; monitoring programs; political will; community engagement; and agencies tasked, and adequately equipped to deal with the disease.

At this point, a brief note of clarification on each may prove helpful. The first component - ways to treat, cure and manage the disease is often assumed to be the endpoint of many disease management efforts. Eradication, however, goes well beyond most efforts and as such treating or even curing the disease in individuals or communities. To be successful in their efforts, eradicators must take additional measures to monitor the progress of the disease to ensure that it does not return to cleared areas. This means working intimately with local communities and engaging them not only to harness badly needed manpower, but also to keep the programs alive after foreign health workers have left the endemic countries. Two final components prove indispensable to the effort. First, in order for the campaign to be successful, there must be sufficient political will on the part of the relevant actors. It is important to note that these actors will not, in all cases, be states. Nonetheless, those with enough power to decide the fate of a campaign are undoubtedly political actors. Finally and perhaps most importantly, there are the agencies tasked with eradication. These

[2] Turnball 2008: 416

agencies, as we will see are not in all cases synonymous with states and the roles they fill are taken on by non-state actors increasingly or entirely.

Taken together, these form necessary (though perhaps insufficient) conditions for the eradication of certain select infectious diseases—those for which eradication is already deemed feasible by the medical and scientific communities and world health authorities. These five components will form a kind of rough rubric for explaining the success or failure (anticipated, or otherwise) of the three case studies explored in this paper: smallpox, malaria, and dracunculiasis, also known as guinea worm disease.

For each of the aforementioned case studies, we will briefly explore a brief history of the disease to the present day in order to contextualize the discussion. Where appropriate, this paper will also delve into the life cycle of the various microorganisms in order to demonstrate how such factors play an integral role in any successful endeavor. The five-point rubric will then be applied to each case to analyze the corresponding eradication campaign.

In addition to the five point rubric, I briefly introduce three reasons behind the decision to eradicate infectious diseases: reputational benefits, rational self-interest, and the interplay of state and non-state actors. This chapter introduces the theoretical concepts and where applicable, each subsequent chapter will explore how they resulted in the decision to eradicate.

As any student of International Relations knows, reputations matter. Groups ranging from multinational corporations and states to nongovernmental organizations and even terrorist groups all work tirelessly and meticulously to craft specific reputations within and without their own communities. Their reasons are as diverse as the organizations themselves, but what seems clear in the cases of eradication is that given this understanding it is likely that the reputational benefits that participation in such public health crusade conferred upon actors caused competitor states to

get involved in eradication efforts. This becomes particularly important when we consider the world-historical time during which two of these campaigns took place—some of the most the tense periods of the Cold War. As such, gaining any positive reputational advantage during this time would have been incredibly important, particularly to both superpowers which were engaged in campaigns against smallpox and malaria, trying to cast off far more negative images in the international spotlight. It is important to note, however, that the significance of reputations extends well beyond rivalries of the Cold War or the interests of states. Private organizations—particularly large, well-funded ones—which participate in today's eradication campaigns against malaria and guinea worm, decades after the end of the Cold War have every reason to be as concerned with their reputations as did the competing rival superpowers of ages past. Such organizations may be beholden to donors or shareholders rather than taxpayers in the case of states, but much of the logic of reputational concerns remains remarkably similar.

Rational self-interest also played a role in determining the decisions of states. As we will see in certain campaigns—most notably, the effort to eradicate smallpox, rational self-interest motivated both superpowers to invest in a final program of eradication rather than paying to continually vaccinate their own populations every year due to imported cases of the disease. Though the initial decision may have seemed financially unwise in the short term, it has since produced an unprecedented return on investment, sustaining the original logic that states, acting in their own interest, yielded a public good. Conversely, we also see that where rational self-interest does not factor into the calculus of states, the decision to get involved in eradication is far less likely. Here, the case of Guinea Worm Disease proves illustrative. By the time world health authorities decided to pursue global eradication of the Guinea Worm, the loathsome organism sickened many in the developing world but posed no risk of importation to those living in the

security of the far wealthier, industrialized nations. As such, the kind of rational self-interest which motivated states to move against smallpox in the 1960s simply could not be mustered in a comparable show of force against this new target. It left a vacuum to be filled, as we will see, by non-state actors.

Finally, there is the interplay of state and non-state actors. It is here that we will see a particularly important trend over time—a change in the actors responsible for eradication. While in the early campaigns, the effort was conducted almost entirely by states or coalitions of them, there was a clear shift through the years. In a trend that we will explore later, the institutional capacity of non-state actors grew tremendously, even as the nature of the diseases under target changed, allowing this new group of actors to step in and shoulder responsibility. In addition to the old model of state coalitions, this allowed for a new paradigm whereby states paired intimately with many non-state actors and even as we will see, some campaigns were led primarily by non-state actors with states now in the assistive role. The entry of new non-state actors and their cooperation with states, though, still leaves some questions about the cooperation between state actors unanswered—an issue that will be tackled in the next section.

The Role and Importance of International Institutions

At this point then, it is necessary to acknowledge the importance of another puzzle: the explanation for cooperation at that critical world-historical time. Simply put, the years of the Smallpox eradication campaign overlapped with some of the most tense periods of the Cold War, what by all reasonable predictions should have been the least likely time for success—and yet, the effort triumphed. What accounts for this paradox? In a word, institutions.

To be sure, this hardly constitutes a novel answer. It is instead, the standard response of the liberal institutionalist school or neoliberal of international relations, of whose flock I simply count myself a member. I contend, however, that with respect to smallpox and the other cases explored here it remains the best explanation for overcoming a number of barriers to cooperation that, while commonplace in the international arena, would otherwise be fatal for a program like disease eradication which rests on the utmost level of cooperation.

The critic may well ask what qualities of international institutions so enamor neoliberals with them? To this end, Etel Solingen provides a rather comprehensive account of their numerous benefits,

> International institutions...manage growing interdependence, overcome collective action problems, reduce uncertainty, lower transaction costs that impede cooperation, enhance information about preferences and behavior, monitor compliance, detect defections, increase opportunities for cooperation, reduce costs of retaliation, facilitate issue linkages, and provide focal points or salient solutions[3].

It may not be necessary to explore each of the aforementioned benefits, but a few are worth expanding upon. It is important to note that neoliberalism relies on many of the foundational tenets of neorealism. Despite the persistent belief that neoliberals are merely idealists who simply expect states to cooperate for the greater good, they are instead far more pragmatic in their political calculus, arguing that left alone, the international arena is set up to dis-incentivize cooperation, though this outcome is not fixed.[4] Neoliberals therefore contend the payoff structure itself must be

[3] Solingen 2007: 28
[4] Dunne et. al 2010: 121

altered in such a way that it is in the rational self-interest of the states involved to cooperate—in other words, to change the game toward incentivizing cooperation.[5]

In order to understand the kinds of problems that institutions can help overcome, we would do well to consider the classic example of the Prisoner's Dilemma as explained by Kenneth Oye.

> Two prisoners are suspected of a major crime. The authorities possess evidence to secure conviction on only a minor charge. If neither of them squeals, both draw a light sentence on the minor charge (CC). If one prisoner squeals and the other stonewalls, the rat will go free (DC) and the sucker will draw a very heavy sentence (CD). If both squeal, both will draw a moderate sentence (DD).[6]

We are able to determine that in a simple 2-person game, prisoner's dilemma has the following payoff structure: DC > CC > DD > CD.[7] In other words, from the perspective of either player, the best possible outcome is to defect while the other cooperates, but the problem that results is two-fold. First, neither is likely willing to take the punishment while his partner-in-crime walks away unscathed and second, even if one were so selfless, he has no way of communicating his intentions to his partner leading to the fundamental dilemma.

Institutions can overcome this by switching the payoff structure such that it is in the best interest of either actor to cooperate—they do so by changing the game itself. Take the case of the game, Stag Hunt. In this hypothetical case, an individual hunter faces the choice to cooperate with the group to bring down a stag—that is, a large animal which may require cooperation to kill.[8] Alternatively, he may defect from the group and chase a rabbit, a small animal, the hunting of which requires no cooperation but yields less meat than would otherwise be shared if the stag hunt

[5] Dunne et. al. 2010: 121
[6] Miller 2013: 13
[7] Adapted from "Prisoner's Dilemma"
[8] Dunne et. al 2010: 129

were successful.[9] The payoff structure for the Stag Hunt is somewhat different than that of the Prisoner's Dilemma, reading as follows: CC > DC > DD > CD.[10] The notable difference is that since the position of the first two payoffs are switched, cooperation is now incentivized.

The benefits of International institutions hold outside of purely game-theoretic discussions, however and can be applied to real-world situations involving complex interactions between states. It is useful at this time, to consider a few more concrete ways in which these institutions can foster cooperation among such actors.

First, by providing a forum in which state leaders and representatives can meet, collaborate, share ideas, conduct transactions, air grievances and the like, the individual state actors can greatly reduce uncertainty about each other's intentions, actions and capabilities. In this way, international institutions can help states overcome collective action problems. Such problems may be familiar to students of social science: they occur when a particular action would benefit a number of parties, but the costs associated with taking such an action make it unlikely that any individual actor will set about to tackle the challenge alone, thus leading to the decision not to take action. Often, these problems occur because actors are uncertain as to the motives and capabilities of others. Since, as mentioned above, institutions can help actors overcome these challenges, they serve as a useful platform for states involved. Second, the continuing existence of the forum also creates a pressure to comply, at least to some extent, with agreements laid down therein for fear that noncompliance would be viewed negatively by other actors with whom one would have to share a room at a later date. If, for example, Argentina sold beef tainted with the bacterium E. Coli to a fellow World Trade Organization partner state, insisting all the while that it was safe for human consumption, other countries would rightfully be skeptical of Argentina's claims the next time it tried to export

[9] Dunne et. al 2010: 129
[10] Adapted from "Prisoner's Dilemma"

beef. This self-policing mechanism is known as the shadow of the future. International institutions help to lengthen the shadow of the future.

It should be clear then, that institutions help to overcome situational obstacles. From this admittedly oversimplified perspective, the World Health Organization was merely another international institution and the Cold War in turn consisted of a number of structural and situational obstacles. It is telling that in his account of the eradication effort, Dr. D.A. Henderson, who led the WHO's smallpox eradication effort hardly spends two pages in his book discussing the political frustrations owing to the Cold War.[11] He suggests that while the situation was sometimes tense, his close personal friendships with Russian colleagues and ties to their part of the program overrode most of the problems.[12] Henderson may not have realized it, but institutions likely played an enormous role in making all of that possible—the close relationships he describes developing with doctors, epidemiologists, administrators and other professionals, that would prove invaluable along the way, were almost invariably made through the World Health Organization or its associated bodies. In other words, while those friendships were undoubtedly important, it is the institutions that must be given credit for making them possible.

Before moving on, a final note on the organization of this thesis is necessary. Chapter II explores the successful campaign against Smallpox and resolves the first part of the theoretical puzzle elaborated above. Chapter III addresses the campaigns against Malaria, both the first failed campaign in the 1950s and the current effort underway now. Chapter IV examines the campaign against Guinea Worm Disease. Finally, Chapter V re-summarizes the findings above, provides a cautionary note on the difficulty of eradication and offers lessons to future eradicators before concluding.

[11] Henderson 2009: 101-102
[12] Ibid., p.102.

Chapter II: The Successful Eradication of Smallpox

When the World Health Organization finally certified the global eradication of smallpox in 1979, it represented the culmination of one of the greatest cooperative endeavors in human history. The final success marked the end of a journey begun nearly two centuries earlier with the creation of first real weapon against the disease—Edward Jenner's smallpox vaccine.[13] If these statements seem grandiose or overstated, it would serve the reader well to consider some context.

Historical Context

Measured by sheer death toll, Smallpox has had but a few grim rivals. Even apart from its ability to kill or maim unimaginably great numbers of people the world over, this microscopic terror has powerfully shaped the course of human history. Historians explain, for example, that the spread of Smallpox was pivotal in allowing European colonizers to dominate the indigenous peoples of the Americas, including the empires of the Aztecs and Incas, toppling their civilizations with much incomparably smaller military forces military forces and setting the stage for the modern development of those regions.[14] The introduction of such diseases to previously unexposed populations, known as "virgin soil epidemics," can result in mortality rates as high as 95%.[15] A reasonable criticism may be raised, however, that virgin soil epidemics always feature high mortality rates and that such a comparison does not tell us much about the killing power of Smallpox compared with other devastating diseases that also burn through large populations such as measles, mumps, or tuberculosis. A fairer test case, then, may be the twentieth century, by which point most large populations across the world had long been exposed to the pathogen by routes of trade, colonization and migration patterns. It may come as a surprise then that smallpox was

[13] Friedman and Friedland 1998: 79-80
[14] Diamond 2003: 78
[15] Crosby 1976: 289; Diamond 2003: 78, 211-212

responsible for more deaths during the course of the twentieth century than all the wars of that same period combined; as many as 500 million by some counts.[16] The pathogen slated for destruction by World Health authorities could hardly have been more deserving of the ignominy.

All of this should provide us some clues in answering the first fundamental question of why competitor states should want to cooperate given structural and situational incentives not to do so. I contend that states' rationale for cooperation against smallpox was three-fold: rational-self-interest, the immense reputational benefits, and the facilitative power of international institutions.

Rational Self-Interest

As mentioned above, by the time of the call for eradication, smallpox was a two-tier problem. Routine vaccinations, accessibility to a reasonable standard of medical care such as clinics and hospitals as well as the existence of public health bodies to monitor and respond to outbreaks when they did occur meant that the problem was efficiently managed in the developed world whereas the disease remained almost a death sentence and all-too-common occurrence in the much of the remaining world.

Naturally, this will lead the careful reader to a reasonable question: if industrialized nations had ways to control the problem for their own populations, why would they intervene in smallpox-endemic areas of the underdeveloped world? Part of the answer lies in the fact that Variola virus has even less respect for the inviolability of international borders than its human hosts. Because certain nations, notably the United States and the Soviet Union, served as such large magnets for immigrants—from all over the world in the case of the United States and between the Soviet Republics in the case of the Soviet Union, even fastidious monitoring and care by public health

[16] Koplow 2003: 1; Henderson 2009: 12

authorities meant that these nations would have to spend considerable sums of money on such public health programs just to manage the threat of smallpox each year.

In his presentation to the World Health Assembly in 1958, then-Soviet Minister of Health, Dr. Viktor Zhdanov made this clear when he argued that the nature of the viral threat was such that it was in the self-interest of non-endemic countries to get involved.[17] During the speech, Zhdanov explicitly called for "the countries…which are free from smallpox to make considerable efforts and spend large sums on vaccinating and re-vaccinating the population in order to provide constant strong immunity against [that] disease," likely in no small part because "smallpox remained a problem in the Central Asian Republics, because of importations from Afghanistan and Iran."[18] In other words, while countries could successfully vaccinate their own populations each year, the constant migration of unvaccinated peoples from neighboring countries, combined with the enormous size of the USSR meant that the state would have to continually spend money in order to keep its own population safe. As another country with a large immigrant influx, the United States was hardly exempt from this problem. As such, the decision to invest in an eradication effort was far more likely a strategic one than a magnanimous one.

Now, it may be argued that the United States enjoyed a greater degree of separation from the problem of international immigrants as oceanic barriers on either side serve as natural borders as compared to the Soviet Union whose inconceivably larger border with a number of its satellite states in Eastern Europe and Central Asia meant that its government would have to invest even more in smallpox programs each year. What seems clear, however, was that mass vaccination strategies, while helpful were certainly not permanent solutions. For that, a bolder move would be required—one that in the short term would seem prohibitively risky and expensive but in the long

[17] Fenner et. al. 1989: 366
[18] Ibid.

term would actually be remarkably cost-effective. Here, we would do well to consider the long term cost-savings of the successful eradication effort.

Consider, for example, that

> the United States recoups its $32 million investment on Smallpox every two months, simply because Americans no longer need to pay to be vaccinated against it. Because of the money saved by eradication, that investment has yielded a 46 percent annual return in the three decades since Smallpox was eradicated [in 1979]—a better investment than any stock in that period.[19]

Consequently, while estimates on the cost-savings of Smallpox vaccination are not available for the Soviet Union, they are imaginably greater for the simple fact that a larger number of borders and a larger number of satellite states equates to a greater number of vaccinations that need not be paid for each year

Savings reported by the WHO confirms the immense return on savings and return on investment provided by the smallpox eradication program for the global community.

> With the global eradication of smallpox, vaccination stopped and quarantine measures were no longer needed. Annual savings are estimated to be more than US $1 billion, above and beyond the alleviation of a terrible burden of death and disability. The total cost for the programme over the period 1967 to 1980 has been estimated to be about US $300 million of which two thirds was borne by the endemic countries themselves.[20]

What seems clear is that from this perspective, considerations of rational self-interest prove important in the smallpox case.

[19] Kristof and WuDunn 2009: 178
[20] "Statue Commemorates Smallpox Eradication"

Reputational Benefits

For two of these programs, the first effort to eradicate Malaria and the Smallpox program, the historical time period is particularly telling. Consider, for example, that these campaigns took place throughout some of the tensest periods of the Cold War. In the popular collective memory, the era is remembered as a time during which mutual fear and distrust meant that a spirit of competition pervaded nearly all aspects of life—most notably, the Nuclear Arms and Space Races. But this spirit of competition meant also meant that both the United States and the Soviet Union used every advantage to cultivate their image as that of a magnanimous and capable superpower at a time during which any good publicity was vital. This is doubly important when we consider that states likely wanted to project their power in ways other than proxy wars, the puppeteering of weaker states, and the proliferation of nuclear arms. To be fair, the leaders of weaker states hardly needed to believe that superpowers committed to eradication out of a sense of magnanimity in order to reap the benefits of such programs. Those living in the third world were hardly bothered, in other words, by why superpowers should choose to step in to eradicate their diseases.

Malaria, and later, smallpox—went on to fill these voids. Though the rhetoric repeated through the official channels of global health bodies emphasized that the world was coming together to eradicate the scourge of certain diseases, in the late years of the malaria program and the early years of the smallpox effort, both became a kind of proxy war. The United States originally firmly backed malaria eradication—a plan which it believed was far more feasible than smallpox eradication. The Soviet Union, in contrast, backed smallpox eradication. This is not to say that either state did not contribute resources to the other disease but simply that they retained their own priorities in terms of funding and personnel assignments. In the long term, however, this strategy would prove unwise. So long as the resources of the wealthiest and most powerful nations

on earth were divided between two such intensive programs, neither would succeed. It was only after the first doomed malaria eradication program was abandoned and its resources recommitted and efforts redoubled toward smallpox that the latter effort could succeed. Whether it helped mend an image marred by the irresponsibility of nuclear saber-rattling and proxy wars or simply enhanced either state's prestige, the whole lesson should demonstrate that reputational reasons were of significant import to both.

Evaluating Success

Ways to Cure, Treat or Manage the Disease and its Spread

Having accounted for the reasons behind state cooperation on smallpox eradication, it is now useful to shift to the second part—examining why the effort succeeded by using the five-step rubric laid out in the introduction. When eradication efforts first began in the late 1960s, one of the primary techniques used for vaccination, known as the "multiple pressures" method, was sorely in need of reform. It involved placing a drop of vaccine onto the skin and placing a needle lancet parallel to the skin, pressing it fifteen times with just enough pressure to break through without causing any bleeding since medical expertise of the time taught that bleeding would wash the virus out, leading to an unsuccessful vaccination.[21] Other vaccination tools like the rotary lancet, which was widely used throughout India and Southeast Asia, featured five small metal prongs that extended from a small metal and required the vaccinator to press firmly and twist in four different sites on the arm.[22] As a result, many locals often resisted the painful procedure even if it meant foregoing access to the lifesaving vaccine.[23] It was clear that if public health authorities were to

[21] Henderson 2009: 68
[22] Henderson 2009: 95
[23] Ibid.

succeed, they would need more effective and painless ways of vaccinating large groups of people safely and efficiently.

The solution came in two waves. The first was a technological upgrade: a jet injector-gun developed for the military by Aaron Ismach.[24] Ismach's gun was adapted such that it could be fed a 500-dose vial and allowed the user to deliver the vaccine intradermally.[25] Studies conducted in Jamaica, Peru and Tonga during 1964 and 1965 showed that it was now possible to vaccinate as many as 1,000 people per hour with the new gun with a near-100 percent success rate.[26] The final two hurdles, power and cost, were also overcome. Further modifications made it possible to operate the jet injectors with a foot pedal instead of a power source and though the guns cost $600 each, their ease of use and rapidity and success rate made them such worthwhile investments that they were widely used throughout Latin America, West Africa and Zaire[27].

The second wave was a comparative technological downgrade, but in time it proved even more successful than the jet injectors. It came in the form of a simple, unassuming 2 inch stainless steel bifurcated needle. Developed by Dr. Benjamin Rubin in 1967, the bifurcated needle worked in much the same way as the original needle lancet—it required fifteen rapid punctures to the skin, but because the needle was forked at the end, it could not penetrate deeply into the skin and cause troublesome bleeding.[28] Though it may not seem like much of an improvement, its advantages were many and significant. First, the needles themselves cost only $5 per thousand and could be boiled and used indefinitely as compared to the $600 jet injectors which broke down so frequently that a trained technician had to travel with each team and a few backup guns had to be packed on

[24] Ibid, p. 68
[25] Ibid.
[26] Ibid.
[27] Ibid, p. 68-69
[28] Ibid, p. 95

each mission.[29] Second, the bifurcated needle required only a quarter of the amount of vaccine that was required by the jet injectors—with the exception of the bifurcated needle, this more than any single technological innovation, vastly lowered the cost of the entire eradication program, which would prove vital in the cash-strapped years to come. Third, the new bifurcated needles required very little technical training or expertise to use. In as little as 15 minutes, villagers, many of whom were illiterate, could learn to vaccinate their families and communities, providing vital health services where WHO teams might not otherwise be able to reach them.[30]

One of the great recurring challenges to the eradication of infectious diseases in the developing world is overcoming factors of climate. Many countries of the poorest and most remote countries of the global south which feature the heaviest burdens of infectious disease are also the hottest. Since many vaccines require cold-storage, this presents a significant challenge to public health authorities. The answer came in the form of another technological innovation in the 1950s by Dr. Leslie Collier, an English microbiologist working at the Lister Institute of Preventative Medicine.[31] Collier developed a freeze-dried vaccine that, critically, was heat-stable for a month even when exposed to a temperature of 37 degrees Celsius or 98 degrees Fahrenheit.[32] Experimental batches retained effectiveness despite being subjected to temperatures of 45 degrees Celsius or 113 degrees Fahrenheit.[33] The widespread use of Collier's heat-stable vaccine allowed vaccinators to reach isolated populations in regions of the world such as South Asia and Sub-Saharan Africa in which other vaccines would surely perish due to the extreme temperatures and inhospitable conditions.

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[29] Henderson 2009: 95
[30] Ibid.
[31] Henderson 2009: 53
[32] Ibid.
[33] Henderson 2009: 53

Monitoring Programs

The importance of monitoring programs to track the spread of disease and the progress of eradication is often overshadowed by the advantages of other valuable components like technological solutions which seem to be clear, tangible examples of taking steps to combat the disease. Monitoring, however tedious and lacking in glamour though, was no less important. Instead, after the first few programs were instituted in developing nations it soon became clear that if eradication was going to succeed at any level—national, regional or global, it would require steadfast monitoring efforts by committed public health authorities. The reason why it was so important bears elaboration.

Simply put, relying on mass vaccination campaigns alone was a strategy that was feasible in the first world where access to health care was incomparably greater than that in smallpox-endemic states. Before 1967 though, the strategy against smallpox consisted entirely of mass vaccination.[34] As a result, the eradicators had to invent novel ways of combatting the disease. Out of this need was born the technique known as ring vaccination. Writer Richard Preston elaborates on this technique,

> …whenever an outbreak was found, the Eradicators swooped in and vaccinated every person they could find in a community or ring of houses around the outbreak. In this way, they surrounded each outbreak of smallpox with a wall of humans who were immune to the virus. The virus would burn itself out inside the ring and would vanish in that spot. To succeed, ring vaccinations required relentless, meticulous surveillance for new cases.[35]

As Preston mentions, ring vaccination required very careful surveillance—a feature that was sorely lacking in most smallpox-endemic states at the time. This method, also known as surveillance-

[34] Henderson 2009: 90
[35] Ibid, p. 14

containment was vital in stopping the transmission of disease in places where reports of disease were unreliable because of inadequate data or even deliberate suppression—a frighteningly common occurrence. But once Henderson's WHO team worked to establish clear surveillance programs in smallpox-endemic areas, they were equipped with a far more efficient means to vaccinate populations and deal with outbreaks of disease.

With a new vaccine able to withstand even the most intense tropical conditions, bifurcated needles along with an ever-growing army of volunteers trained and ready to use them, and innovative techniques like ring vaccination in addition to mass vaccination helped world health authorities to effectively manage its spread.

Political Will

Though health care providers like those serving in agencies like the World Health Organization are not typically cast in such a manner, it is important to remember that they are also political actors. The World Health Organization, like any other international institution is a complex agency composed of a diverse sets of programs, actors and policies. As such, it is subject to many of the same pitfalls of other organizations we might more typically cast as political.

The result of this implication was that since the eradication of Smallpox was a program carried out by the WHO, some key actors within that agency believed the effort was doomed to failure and acted accordingly, an issue that was compounded by the bureaucratic structure of the organization itself. As then-WHO Director-General Dr. Halfdan Mahler explained to Henderson at the time, "'You have to understand that WHO is, in fact, an Association of Regional Offices, not a World Health Organization'…Gaining or retaining a country's vote required skillful politics and such factors inevitably played a role in important decisions such as the selection of qualified

staff and allocating of budget funds."[36] Mahler's advice notwithstanding, it should still be noted that he was far more amenable to the program than the WHO's previous Director-General, Dr. Marcelino Candau who not only believed that smallpox eradication would fail, but that when it did, its failure would further discredit the WHO—as had the malaria campaign.[37] Additionally, two of the regional WHO directors showed little support for the program, with one ignoring it and the other in active opposition.[38] Success then, came as a result of institutional change. Candau was replaced by Mahler and the regional director who opposed the program lost his seat to a WHO member who ardently supported smallpox eradication.[39] This improved relations between regional offices, helped ease budgetary woes, and vastly improved prospects for the program overall. The lesson became clear, particularly as the campaign wore on: in order for the effort to succeed, political actors that were behind it needed to unflaggingly support it.

Community Engagement

Once the WHO had mustered the political will to proceed with the effort though, there still remained other challenges. After all, even for an organization as well-established and technically capable as the WHO, the campaign would not likely have succeeded without the efforts of indigenous peoples. As such, the presence and initial successes of the WHO served another important function. They inspired a great deal of action among indigenous communities which proved invaluable in bridging the gap.

Consider here a few logistical challenges. First, while the WHO was likely unmatched in terms of technical expertise, in terms of manpower the needs dwarfed the supply. Even with all of

[36] Henderson 2009: 85
[37] Ibid, p. 76
[38] Ibid, p. 85
[39] Ibid.

the innovations discussed earlier, experts knew the simple scale of the problem—as with the population size in the South Asian countries, for example meant that they would need to recruit a veritable army of short term staff-members and volunteers. These indigenous recruits were composed of a diverse assemblage of local health workers, concerned citizens, parents, and students each of whom played some role whether it meant vaccinating fellow community members or reporting on cases nearby. Even young schoolchildren had a role to play in the campaign. Vaccinators found, for example, that while adults remained tight-lipped about known cases of neighbors suffering from the disease, children between the ages of 7 and 12 in smallpox-endemic countries proved knowledgeable and responsive about cases in their own homes and villages and surrounding ones; the vaccinating teams quickly learned to distribute smallpox-identification cards within schools for better results.[40] As the effort continued then, this kind of informal consultation proved immensely valuable in identifying cases and stopping transmission.

Second, as the campaign became more successful, Smallpox retreated into the most remote places on earth. As a result, it was often not possible to deliver large shipments of medical supplies with the use of vehicles due to the lack of roads or bridges in many areas. Where travel was possible, it was often treacherous. In many cases, this turned vaccinators into adventurers as they carried vaccine vials deep into the African bush, wading across waist-deep rivers and clearing paths with machetes as they walked.[41] Civil conflicts and large, mobile refugee populations in a number of the newly formed states also added to the difficulty of delivering vaccines. As such, indigenous vaccinators who were trusted and who knew how to navigate such terrain well, proved indispensable to the operation.

[40]Henderson 2009: 123
[41] Ibid, p. 222

To fully explain the power of community engagement, I offer the reader an illustrative anecdote. By the time he fell ill in October of 1977, Ali Maow Maalin was the last human to ever contract wild smallpox.[42] Ironically, the then-23 year old Maalin had been working as a cook for the smallpox eradication effort and had contracted the virus from guiding a vehicle that had been carrying two sick children.[43] He was initially misdiagnosed with chickenpox and sent from the hospital where tried to hide the illness from authorities because he did not want to go to an isolation camp, but was turned in by a friend who collected a sizeable reward.[44]

The detection of Maalin's case triggered a ring-vaccination frenzy. The WHO launched an intervention to stop the potential reintroduction of the disease throughout the region. Their investigation found that he had come into face-to-face contact with 91 people.[45] Each person who did not present a vaccination scar was vaccinated, anyone entering or leaving the town was searched at one of four checkpoints, and house-by house-searches were conducted monthly throughout the region until the end of the year.[46] In the end, the measure proved successful—the millennia-long reign of terror was over, smallpox was dead.

As for Maalin, what had initially been tremendous reluctance—first, to even receive a vaccination and then to seek treatment, was transformed after the end of smallpox. Ali Maalin would go on to become an ardent advocate and vaccinator for the polio eradication effort in Somalia.[47] "'He would always say, 'I'm the last smallpox case in the world. I want to help ensure my country will not be last in stopping polio,'…So, in 2004, Maalin officially became a polio

[42] "The Last Smallpox Patient on Earth"
[43] "Last Person to Get Smallpox Dedicated His Life to Ending Polio"
[44] "The Last Smallpox Patient on Earth"
[45] Ibid.
[46] Ibid.
[47] "Last Person to Get Smallpox Dedicated His Life to Ending Polio"

vaccinator. He organized volunteers, went door to door immunizing children and helped to convince families the vaccine was safe."[48]

As Maalow told the *Boston Globe*, 'Now when I meet parents who refuse to give their children the polio vaccine, I tell them my story. I tell them how important these [polio] vaccines are. I tell them not to do something foolish like me.' Such tactics helped Maalin and other health workers stamp out Somalia's polio outbreak in 2005. The country was polio-free in 2007."[49]

Maalin worked tirelessly and successfully for the cause of polio eradication in his native Somalia, refusing even to take time to recuperate when he fell ill.[50] Regrettably, his very dedication to the eradication of one scourge, polio, would ultimately prove fatal as he succumbed to a bout of malaria in 2013.[51] Maalin's case may be exceptional but it should demonstrate nonetheless that even while garnering community engagement may at times be difficult, if the initial inertial obstacle can be overcome it is certainly worthwhile. Simply put, the commitment of indigenous peoples to their own communities outperform and outlast even the best advances in equipment, technologies and commitments from without.

Agencies

As mentioned earlier, a final component in the successful campaign to eradicate Smallpox was the agency tasked and adequately equipped to deal with, the disease. Here, an important qualification is necessary. While in the smallpox campaign, the agency behind the effort was the WHO, this is not necessarily the case with all eradication endeavors. For other eradication schemes, individual constituent governments or even non-state actors might lead the charge. An

[48] "Last Person to Get Smallpox Dedicated His Life to Ending Polio"
[49] Ibid.
[50] Ibid.
[51] Ibid.

example we will later explore is the case of guinea worm disease, for which The Carter Center in partnership with other NGOs and groups should be most credited. To be sure, in all cases the World Health Organization will in all cases be an integral part—even in the example of guinea worm disease, it collects data and certifies that countries that have eliminated the parasite.

The most obvious benefit of agency-backing was the enormous resource wealth that came with it. By the time the eradication effort began in earnest in the late 1960s, the smallpox program was backed by the two most powerful states on earth—the United States and Soviet Union, each of which pledged to donate tens of millions of doses of vaccine annually.[52] As the program wore on, the smallpox-endemic countries would become responsible for the production of the majority of vaccine for their own populations, bearing the majority of their costs—but by this point even the poorest countries had seen years of innovations in technology, as with the jet injectors and bifurcated needles, vaccination strategies, as with ring vaccination and still had the technical assistance of the wealthiest nations.[53]

Second, the sheer size and scope of an organization like the WHO bringing its weight to bear on the Smallpox situation remedied another key problem—the issue of technical expertise. Because the WHO served as a meeting place for so many of the world's best qualified experts in these fields, it could and often did respond quickly and effectively to the changing situation in the field. If, for example, there was a serious and unexpected outbreak of smallpox in a country already stretched thin, the WHO could and sometimes did send in a small team of epidemiologists to help handle the caseload. These experts also coordinated closely with existing national and regional health bodies to ensure that they made most efficient use of resources available to them. With each of these five components working in conjunction, the campaign against smallpox succeeded. This

[52] Henderson 2009: 93
[53] "Statue Commemorates Smallpox Eradication"

story of success, however, is not the case with all eradication efforts. Instead, as we will see with the first campaign against malaria, an inability to achieve some or all of these components can result in critical failure.

Chapter III: Malaria

The legacy of malaria is as long and storied as any of the great scourges humanity has faced throughout its tenure. Its historical legacy, cultural imprint, and even genetic impact have shaped human cultures from time immemorial. Though this chapter cannot hope to adequately capture malaria's full story up to the time of the twin eradication efforts, it is necessary to explore some of the background of this truly ancient disease to understand its full impact, why it has been so difficult to eradicate, and where hope for the future lies.

This chapter will proceed in two main parts. First, we will investigate the initial eradication effort which began in the 1950s, exploring the underlying reasons for failure. The second part of the chapter will focus on the ongoing campaign. Though some of the actors involved in the contemporary effort show a measure of reluctance to use the term eradication due to the stigma that remains from that first failed attempt, I argue that the scale and ambitiousness of the endeavor in terms of the number of actors, multifaceted approaches, funding, scientific advances and more, make the enterprise worthy of the title.

As with the other case studies on infectious diseases, an important reservation is required at the outset. In a trend that the perceptive reader will have undoubtedly noticed and one that will become even more apparent with an enormously technically complicated disease like malaria, the forthcoming scientific explanations behind it may at times seem needlessly in depth. Here, I would point out that for the diseases explored in this thesis and particularly with the case of malaria, one of the central reasons that the first eradication attempt failed was the due to the inability of administrators and policy makers to understand this problem adequately from a scientific point of view. Put simply, the reason these explanations detail the disease in such depth is because as we will see, the protozoan parasite behind it, *Plasmodium*, orchestrates a complex series of stages

whereby it hides, changes disguises, multiplies and as recent research shows, can even adapt the behavior of mosquitoes to more effectively infect hosts.[54] As I have stated before, this thesis by no means provides an exhaustive clinical account of the symptoms of the diseases discussed herein or fully addresses the aspects of its entomology, biology, chemistry, pharmacology and so on. It does, however, attempt to provide the reader—that is, policy oriented amateurs and experts, with a more thorough grounding than that to which they are accustomed but one to which they should no doubt be responsibly held.

History of the Disease

In a grim sense, malaria is truly in a separate class from all other diseases. From evidence we are able to piece together from the historical, cultural and genetic record, we see that few other phenomena—famines, wars or plagues of different kinds—even come close to the impact that this loathsome parasite has had in shaping our very tenure here. At first this may seem puzzling. Plasmodium wields neither the near-perfect kill rate of some pathogens like the one responsible for rabies nor can it match the unrivaled speed and ease of transmissibility of the virus which causes measles—and yet, Plasmodium may have contributed to half of all of the deaths in human history.[55] Such a statement will, of course, will seem hyperbolic at first glance. Due skepticism is not unwarranted, but upon careful consideration of the evidence, is dismissed.[56]

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[54] Zimmer 2000: 91

[55] "Baruch Blumberg: Science on TV"

[56] The reason for malaria's devastation lies in its long tenure. Plasmodium and its evolutionary forebears have possibly been infecting the higher primate species via the bites of mosquitoes since that phylogenetic branch diverged from our most common ancestor with chimpanzees 6 million years ago ("When Humans Left Africa, Malaria Came Along"). Further down the line, we find that Plasmodium has been affecting more recent human forebears—that is, members of the genus *homo*, for at least 500,000 years, long before the species *Homo sapiens* had even emerged (Shah 2010: 9). This is a much longer timescale than many of the epidemic or crowd diseases that we are more familiar with today, most of which emerged in the last 10,000 years after the advent of

The genetic evidence reveals that our very genome has adapted in ways to better survive the parasite's ceaseless onslaught. Here, the case of sickle cell anemia proves instructive, demonstrating not only how deep an impact Plasmodium has made but also how long it has been doing so—these kinds of evolutionary mechanisms only become apparent over fantastically long timescales.

The Plasmodium parasite feasts on the oxygen-carrying hemoglobin molecule found within red blood cells.[57] In the case of normal, bowl-shaped red blood cells, Plasmodium invades, taking its meal with no regard for the health of the cell.[58] If one of the genes which controls the shape of hemoglobin should feature a certain mutation, however, it endows carriers with slightly crescent shaped red blood cells instead; these cells are able to ferry oxygen normally but they confer a degree of resistance to the plasmodium parasite.[59] Two copies of this gene, however, result in a severely crescent-shaped red blood cell that is unable to carry the life giving oxygen molecule, a condition commonly known as sickle-cell anemia.[60] The prevalence of sickle cell anemia is almost perfectly correlated with the highest incidence rates of endemic malaria in the world and as such it remains, alongside other conditions like Thalassemia and Ovalocytosis which are prevalent in other parts of the world which also boast high rates of endemic malaria, evidence for the long standing impact the disease on our species.[61]

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agriculture signaled an important paradigmatic shift from hunter-gatherer groups to permanent, sedentary civilizations, thereby allowing the spread of microorganisms among large groups of people. These latter diseases might be more easily transmissible or often have higher case fatality rates—that is a higher proportion of infected people who die, but their shorter tenure means that they simply could not compete with Plasmodium in the grim measure of overall historical death toll.

[57] Zimmer 2000: 41
[58] Ibid, p. 40-41
[59] Shah 2010: 27
[60] Shah 2010: 27.
[61] Zimmer 2000, p. 197

Malaria has also shaped our interactions on a level far more familiar to students of Political Science—through developmental historical trajectories of states. As we have seen with smallpox, diseases can radically shape how states develop. Political Scientists use the term path dependence to refer to junctures which prove powerful in influencing the outcome of later events in a sequence because they came at an early, decisive moment in which many such scenarios were possible.

For example, when would-be European conquerors sought to overtake trading posts on the African continent during the 16th century, their conquests were quickly cut short not by African armies but by falciparum malaria—the deadliest strain, to which they had no immunity.[62] Together with Trypanosome diseases which devastated both humans and horses, malaria proved so deadly that the spread of European colonial powers within the continent itself was likely kept at bay at least until the first effective antimalarial drugs like quinine could be developed and made widely available. It is worth noting for example, that after the loss of their American colonial possessions, Britain refused to exile its convict population to Africa because falciparum malaria meant that the mortality risk to prisoners was so great that contracting the disease essentially amounted to a death sentence; in lieu of such inhumane terms, Australia was chosen instead.[63]

For all but the indigenous peoples of the Americas prior to the Columbian exchange, Malaria was a well-understood phenomenon. Journalist Sonia Shah explains,

> Ancient greeks understood malaria as a seasonal scourge that arrived during harvest time. The physician Hippocrates described it as a disease common around swamps, while the poet Homer referred to malaria when he decried Sirius as an 'evil star' that was the 'harbinger of fevers'[5]. The ancient Chinese called malaria the 'mother of fevers,' while in India thirty-five hundred years ago it became known as the 'king of diseases,'[6] personified

[62] Shah 2010: 35
[63] Shah 2010: 38

> by the fever demon Takman…By the time of Christ, P. Vivax had swept over temperate Europe, and it had entered Europe during the early Middle Ages. By the sixteenth century, P. vivax was deeply ensconced in Europe and Asia, P. falciparum held Africa in its thrall, and the Americas teemed with mosquitoes with pristine, parasite-free guts. As human populations and the Plasmodium parasites in their veins collided during the age of exploration and conquest, malaria's differential killing power shuddered through continents, altering the fate of nations.[64]

Malaria's history-writing hand was evident when it killed four popes in a hundred years; its impact was felt when it sickened Presidents like Washington and Lincoln and it was made known when it dictated the centuries-long path-dependent trajectories of nations as distant and diverse as Scotland and Australia.[65] It is a disease without pity and for most of his tenure, man has been at the mercy of malaria.

Malaria Today

In the simplest terms, the immense global caseload of malaria means that its effects go well beyond the lives and homes of individuals affected by the disease. Instead, it has both direct and indirect effects. The direct effects are fairly straightforward: countless mosquitoes which carry the parasite go on to infect more than 200 million humans a year worldwide resulting in more than 600,000 deaths annually, the overwhelming majority of which are attributed to young children who live in Sub-Saharan Africa where factors of African malarial ecology combine with poor healthcare infrastructure to create this nightmarish scenario.[66]

[64] Ibid, p. 37
[65] Shah 2010: 68, 90 and "Malaria"
[66] "Impact of Malaria"

The indirect effects are harder to calculate but are no less devastating. Consider, for example, the economic impact of the illness. Experts have been trying to make calculations of the economic costs of malaria for more than a century now, with varying degrees of success. No less a malariologist than Nobel Laureate Ronald Ross, for example, made one such inquiry in 1911, writing even then that, "'many such efforts' [had] already been attempted."[67] What should be clear in any case is that those studying the disease have always understood its impact to be multidimensional—that is, malaria's impact on the national economy is every bit as insidious as its impact on individuals and families.

The reasoning is simple: suppose the sole breadwinner in a household of a state in which malaria is remarkably prevalent, like Uganda, falls ill. Her inability to continue working may prove disastrous on a microeconomic level—in other words, in a subsistence economy taking even a few days or weeks off of work can be ruinous to the financial resources of her family. Since almost everyone in this region will at some point become infected, however, the effects of malaria—in the form of a few missed days of work or school will be felt on a much larger scale. In aggregate, this may rob a nation of a substantial amount of productive capacity. Consider, for example, the impact of malaria on the aforementioned state of Uganda. A 2012 study tracking the impact of malaria morbidity on gross domestic product in that state, analyzing time-series data from 1997-2003 found that in 2003, Uganda lost approximately $1.93 per person which amounted to a total loss of more than $49.8 million.[68] Though the example may seem extreme, the results are far from abnormal in Sub-Saharan Africa. The World Bank even estimates that in some African countries, malaria reduces GDP growth by as much as 1.3%.[69] Instead, many countries in that region suffer

[67] Arrow et. al. 2004: 179
[68] Orem et. al. 2012: 1
[69] "Malaria"

from a burden of malaria which is comparable and are therefore robbed of an enormous amount of economic and intellectual potential. This is far from a novel conclusion, but it is important for the reader to note that malaria artificially suppresses the potential not of a single nation or simply of an entire continent, but tragically of the roughly 104 nations which continue to suffer from its endemic burden of disease.[70]

Reputation, Rational Self Interest and the Interplay of State and Non-State Actors

Finally, before exploring the first eradication campaigns, a brief note on reputation, rational self-interest and the interplay of state and non-state actors is necessary here.

The overlapping logics behind reputation and rational self-interest that caused states to begin the malaria eradication effort stems from the Cold War competition was introduced in earlier chapters. Simply put, American officials were essentially convinced that investment in the eradication scheme would achieve two ends—to cultivate a magnanimous image that would provide reputational benefits and to promote development of weak states making them economically stronger and resistant to communism.[71] On this point, Sonia Shah is clear. She notes, "[The] State department committee…convinced them that the eradication scheme was not only relatively straightforward and scientifically urgent but politically expedient as well…[to] counter the Soviet Union's magnanimous foreign aid programs in developing countries."[72] The need then for urgent US action was not lost on policymakers, "…the arrival of bi-annual door-to-door DDT spray teams would provide 'concrete evidence of interest of the U.S. in the well-being of the populations concerned," effectively neutralizing the Soviets' nefarious charm offensive."[73]

[70] World Malaria Report 2012: ix
[71] Shah 2010: 204
[72] Shah 2010: 204
[73] Ibid.

The final reason here deals with the interplay of state and non-state actors. When the second eradication effort began, long after the failure of the first, it seemed unlikely that states would commit resources in the same eager manner they had during the 1950s. The enormous proliferation of non-state actors and particularly their specialization in so many different fields which addressed the many aspects of a multifaceted disease like malaria meant that even if states were reluctant to seize the banner of eradication once again, non-state actors could provide new enthusiasm.

The First Eradication Effort

The reasons for the failure of the first malaria eradication effort are numerous. Using the five-point evaluation plan laid out earlier, however, it is possible to organize these critiques and better understand what makes some scheme successful while others are doomed to failure.

Ways to treat, cure and manage the disease and its spread

Most of the critiques of the failure of the first malaria campaign stem from a lack of appreciation for the depth of the scientific challenges that malaria presented. This critique is well-founded. While eradicators certainly had good intentions, their understanding of the disease and its many complex components was gravely lacking. Eradicators in the 1950s focused exclusively on vector-control—that is, they attempted to destroy Plasmodium by destroying the insects which ferried it: the various species of anopheles mosquitoes. Upon initial consideration, the strategy does not seem unwise. Because of the infectious diseases they carry, mosquitoes are currently responsible for more human deaths than any other animal on earth, including humans.[74] Indeed, even modern day strategies target mosquitoes as some part of the larger process. There are,

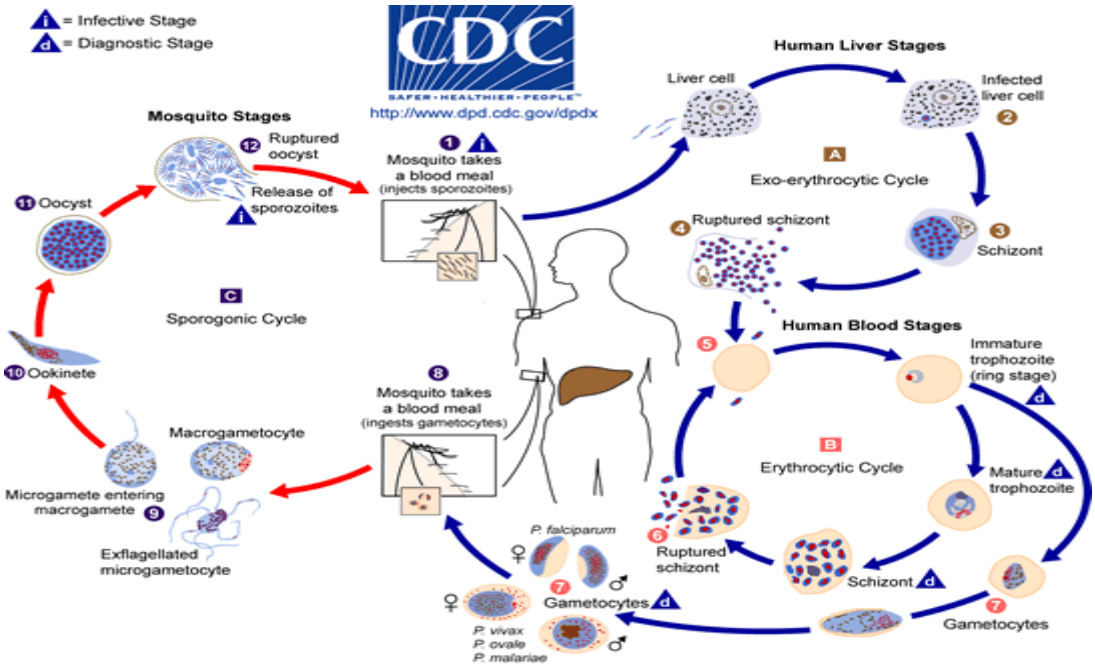
[74] "The Deadliest Animal in the World"

however, a few key differences worth noting. First, the campaign of the 1950s failed to appreciate the exquisitely well-developed system between parasite and vector—that is, plasmodium and anopheles mosquito that had developed over such a long time span. We know today, for example, that there are some 430 different species of anopheles mosquitoes worldwide, 70 of which are capable of transmitting Plasmodium.[75] As a result, adopting a uniform approach to combat mosquitoes is doomed to failure for the reason that each of the aforementioned species specializes in a particular geographic and climatic zone and each faces differential rates of success for carrying different strains of the parasite, itself.[76] Second, while the campaign was successful in ridding much of what is now considered the developed world of the problem of endemic malaria through the use of heavy pesticides, many of the regions of the global south proved a much more difficult obstacle. The single most instructive case is that of the African continent. While the World Malaria Report of 2012 lists some 104 malaria-endemic countries, there is no region more heavily plagued by the disease than Sub-Saharan Africa[77]. The majority of deaths from the disease occur here, and as we have seen the lowly anopheline mosquito can even artificially suppress the GDP of entire nations.[78] What accounts for this disproportionate effect?

Beyond the challenge of the mosquito vectors was the task of taking on extraordinary complexities of Plasmodium itself. It has survived for so long precisely because it has been able to forge a perfect pairing with its carrier, the anopheline mosquitoes and its host, humans. Its many life stages also allow it to develop, and elude the immune system of its carrier even change the behavior of carriers—such as driving mosquitoes which carry the protozoan to seek out twice as

[75] Shah 2010: 60
[76] Ibid.
[77] World Malaria Report 2012: ix
[78] "Malaria"

many blood-meal hosts as parasite-free mosquitoes.[79] The figure below details the many life stages of Plasmodium, demonstrating not only how complex the problem is, but also how eradicators who failed to appreciate this complexity would necessarily have been unable to eradicate the disease.



(Figure 1)[80]

Complex factors of geography and climate interact such that for much of the global south, and for African malarial ecology in particular, the problem is significantly more difficult to solve than it was in other regions. For comparison, take the annual Plasmodium falciparum Entomological Inoculation Rate (aP*f*EIR) which is, "usually interpreted as the number of *P. falciparum* infective bites received by an individual during a season or annually."[81] While Asian and South-American malaria-endemic countries face aP*f*EIRs around 5, that number can easily run

[79] Zimmer 2000: 91
[80] "Malaria – Life Cycle"
[81] Kilama et. al 2014

into the hundreds for countries in Sub-Saharan Africa.[82] The table below demonstrates this phenomenon clearly.

Table 1: Summary of APf EIR estimates by country

Country	N	Average APf EIR
Benin	6	31.5
Burkina Faso	30	100.6
Burundi	5	251.6
Cameroon	14	184.9
Congo	4	186.6
Congo (D.R)	6	231.0
Cote d'Ivoire	2	314.7
Egypt	2	0.9
Equatorial Guinea	2	814.3
Eritrea	8	14.6
Gabon	6	108.4
Gambia	25	34.8
Ghana	1	418.0
Kenya	50	43.4
Liberia	4	21.9
Madagascar	5	39.5
Mali	1	3.6
Mozambique	1	52.9
Nigeria	1	48.0
Senegal	19	25.3
Sierra Leone	14	155.7
Sudan	1	0.6
Tanzania	26	285.2
Total	**233**	**112.2**

(Table 1)[83]

The scientific explanations were undoubtedly complex but the implication at least as simple: without a way to understand this problem, there would be no way to manage the disease within Africa and therefore no way to eradicate it.

Even if the eradicators had managed to deal with the problem of different malarial ecologies, however, they would have faced yet another serious challenge that ran arose directly from their over-reliance on the vector-control strategy of eradication: pesticide-resistant

[82] Hope and McKenzie 2009
[83] Ibid.

mosquitoes. In the war waged against mosquitoes and malaria during the eradication efforts of the 1950s and 1960s, there was no weapon more widely used than dichloro-diphenyl-trichloroethane, commonly known as DDT.[84] Long before its severely negative effects on human and other wildlife were properly understood or made widely known, DDT was used to severely reduce the rates of malaria transmission in a number of countries with malarial ecologies ranging from the Soviet Union to Sri Lanka.[85] DDT unquestionably damaged the ecosystems in which it was deployed but its effects against mosquitoes were undeniable. As one author noted, "by 1966 campaigns using DDT spraying, elimination of mosquito breeding sites and mass treatment had freed more than 500 million people roughly one-third of the people previously living in malarious areas from the threat of the diseases.[86]

Mosquito resistance to pesticides developed quickly. DDT was first widely used as an insecticide during the Second World War to deal with the burden of disease-carrying insects; as early as 1946, 2 species of anopheline mosquitoes were resistant to the chemical.[87] By 1966, however, 15 species had become resistant--a number which mushroomed to 53 by 1991.[88] Other classes of pesticides hardly fared better in later decades. By 1991, for example 10 species of anophelines proved resistant to pyrethroids, 17 to carbamates, 27 to organophosphates and a full 55 to one or more insecticides.[89] The message was clear: so long as deeply troubled vector control remained at the heart of the management strategy, malaria eradication could never succeed.

When it became clear by the late 1960s that vector control was rapidly failing, the strategy was abandoned by the late 60s, it led to an over-reliance on a pharmacological solution to the

[84] Arrow et. al. 2004: 198
[85] Ibid.
[86] Ibid.
[87] Arrow et. al. 2004: 201
[88] Ibid.
[89] Arrow et. al. 2004: 201

malarial problem which ironically led to another, more troubling resistance-related issue: drug-resistant parasites.

When it was first introduced in the 17th century, Quinine proved to be a remarkably effective antimalarial medicine. Made from powdered bark of the cinchona tree found in the distant Andes, the plant from which Quinine was derived was jealously guarded and its exciting history features no insignificant amount of colonial competition, intrigue, theft, and danger. Historians note that quinine was responsible for allowing the non-immune British colonizers to survive excursions into malarial Africa during the 19th century and begin carving up that continent.[90] In the first few centuries, quinine was extraordinarily difficult to come by and reserved only for royalty and the wealthiest elites.

Even after smuggling increased global supply in the subsequent centuries, there remained obstacles to its widespread adoption. Its bitter taste and unpleasant side effects made malaria sufferers like Allied troops facing the malarial swamps of the Pacific Islands, loathe to take the medicine even when they fell ill. When a new drug, Chloroquine, which featured far fewer side effects, no unpleasant taste but boasted the same Plasmodium-killing power of its forebear, emerged just after the Second World War, the announcement was well received.

Chloroquine was so effective at killing the malarial parasite and could be reliably mass produced that its benefits were promoted by health experts and drug manufacturers the world over. As WHO malariologist Jose Najera lamented of health experts at the time, "Chloroquine, it was said, should be treated as a commodity, not a drug."[91] As Shah further explains, "Why bother even trying to diagnose malaria before taking chloroquine? The pill, experts advised, should simply be

[90] Shah 2010: 89
[91] Shah 2010: 102

taken as soon as a fever comes on, as 'presumptive treatment,' by sufferers in their own homes.[92] This over-reliance on chloroquine, especially after the development of pesticide resistance in anopheline species led to the much more daunting and less understood specter of drug-resistant Plasmodium. By the 1950s, Chloroquine-resistant Plasmodium had emerged even though world health authorities were reluctant to admit it.[93] Worse still, the gene which allowed them to survive Chloroquine's onslaught, called pfmdr1, also made the parasite resistant to a spate of antimalarial drugs which came later including amodiaquine in the 1950s, mefloquine in the 1970s and halofantrine and quinidine in the 1980s.[94] Pursuing a strategy of eradication via the pharmacological route alone, then, only seemed to worsen the problem.

Political Will

The problems of political will were two-fold: the challenges of the cold war and those that arise from the evaluation of risk. The first challenge deals primarily with the bipolar world order in which the first malaria eradication campaign took place. As mentioned in the previous chapter, the historical backdrop of the Cold War proved undoubtedly tense and the spirit of competition between the United States and the Soviet Union extended well past arms negotiations and the space race as is remembered in the collective popular memory. Instead, as explained earlier the opportunity to cultivate a reputation as a magnanimous superpower willing and able to flex its muscle was worth reaching for. As such, for a short while, the eradication schemes almost turned into a kind of proxy war with the Soviet Union backing the effort against smallpox and the United States pushing for the destruction of malaria. Such division would prove disastrous and do little

[92] Ibid.
[93] Ibid, p. 108
[94] Ibid, p. 109

more than divide desperately needed funds and personnel between the campaigns. It was only after the United States suspended its eradication efforts against malaria, joining forces with its rival to attack smallpox that either campaign could succeed. In that world-historical moment, cooperation of the superpowers was undoubtedly necessary for success.

The second problem of generating political will to eliminate the problem of malaria in the places in which it is most prevalent is paradoxically the most difficult. For observers in the non-malarious, developed world, this logic will undoubtedly seem curious. As we have seen, malaria is a tragic disease with intolerable symptoms which kills hundreds of thousands of children each year and stifles economic and intellectual potential on a scale that is unmatched by most other diseases. Ridding one's own nation of such a blight would seem a patently good policy move. What explains the reluctance to take measures to eradicate the parasite, then? The answer comes in the evaluation of risk. For people living in areas where malaria is hyper-endemic or even holoendemic, meaning that nearly everyone is infected with the disease, the threat posed by the disease becomes commonplace. We would do well to remember that while malaria's total body count is high, its case fatality rate is fairly low compared to other more exotic diseases, such as, say, that caused by the Ebola Virus. The death toll of malaria comes from the sheer global caseload it carries. As a result, in a country like Uganda where 95% of the population might carry a plasmodium parasite during any given year but only a small percentage of those carriers—likely, young or aged persons will perish—it becomes quite difficult to explain to each individual asymptomatic sufferer why the eradication of what seems little more than a pesky perennial problem is necessary. In the absence of high tech solutions or invested campaigns, indigenous peoples have simply learned to live with the reality of malaria. Consequently, the logic of eradication seems strange. It might be the equivalent of explaining of Africans explaining to

Americans that they ought to eradicate Influenza since that disease robs of the latter group of a great deal of productivity and kills thousands of Americans every year—several orders of magnitude more American civilians than does a cause like international terrorism, on which they spend incomparably more money.[95]

Community Engagement

Beyond the major scientific and political failures explored here was a larger organizational one. Put simply, the approach adopted by the eradicators of the 1950s more closely resembled that of a military outfit fighting to carry out a mission rather than a series of well-coordinated teams working with local communities in diverse regions to solve problems unique to that particular place or even address the needs on the ground.

In the first malaria campaign, the vector control strategy relied on repeated spraying of houses or huts with DDT.[96] This practice, which is used even today is known as indoor residual spraying and it remains highly effective when employed properly and used with proper notification, information, and consent of all parties. A number of factors that plagued the technique's implantation during the first campaign—most notably community resistance and high program costs, which eventually made the practice untenable.[97] Without the support of the community, follow up efforts were of little use. Malaria, like most other diseases also leaves a far deeper impact than a sizeable death toll. It would serve us well to consider the aforementioned impact on the living, both infected and otherwise. Families living under the burden of malaria in hyper-endemic regions, for example, regrettably have a great deal more to contend with than lost

[95] Estimates of Deaths Associated with Seasonal Flu, 1976 – 2007; "Is America Spending Too Much on Homeland Security;" "Flu Epidemic Exposes US Risk Management Flaws"
[96] Arrow et. al. 2004: 198
[97] Ibid.

loved ones. Instead, adults will incur considerable financial hardship; children who bear the brunt of the disease burden undoubtedly miss days of school. Despite the best intentions of the eradicators to drain swamps, spray huts or distribute chloroquine, none of their efforts did much to address this real impact on the living. If this does not seem like a crucially important component, consider the earlier smallpox case for comparison.

Despite all the advances of the smallpox campaign—from jet injectors to freeze-dried vaccines—the campaign ultimately would not have been successful had local communities not become deeply engaged with the process of eradication itself. Remember, reader, that during the smallpox effort, communities became deeply involved with the eradication effort at every step. Adults became vaccinators, children reported on those who were carrying signs of infection, volunteers pitched in to clear brush, construct roads, build bridges and ensure that people within their own communities received proper care. All of this was dependent, however, on understanding that what was most important was not killing the *Variola* virus but on providing quality care for those in the poorest places. When locals could be assured of these intentions, they volunteered in unprecedented numbers. Smallpox, during its tenure and malaria, today, inhabits some of the poorest and most remote places with least access to high-quality health care on the planet. Put simply, for any eradication effort to succeed in these areas, community engagement must make up for these limitations. In fact, it should be noted that many of the successes of the smallpox campaign grew directly out of the policy failures of the malaria eradication effort.

The Second Eradication Effort

The failure of the first effort against Malaria left a deep mark not only against further attempts to limit the disease, but on the feasibility of eradication as a concept in the mind of policy makers and experts. In retrospect, dejection and skepticism was not unwarranted. Despite the

enthusiasm that had undergirded the initial push of the campaign, it was simply the latest in a series of overly-ambitious projects that some of the most-well respected scientific experts criticized as foolhardy endeavors. Any states choosing to participate in an eradication project, therefore, were taking on an enormous risk.

Even today—more than half a century after the doomed first eradication campaign began, some of the biggest players involved in the second campaign show some signs of reluctance to explicitly use the term eradication, even if their methods, monies and manpower are directly geared toward this purpose. In recent years, however, there has undoubtedly been a resurgence of momentum building toward eradication by a diverse set of players far better equipped to deal with the challenges of this formidable disease. As such, I have elected to term this effort the second eradication campaign and will, in this section, apply the same evaluation scheme to assess why I believe it may succeed where its predecessor failed.

Ways to Treat, Cure and Manage the Disease

As mentioned earlier, the mainstay of the first eradication campaign was vector control based on indoor residual spraying (IRS). This strategy, while effective when properly administered often engendered backlash in the communities in which it was used, partly because of the rigid, military-manner in which the program was run. Vector-control of anopheline mosquitoes, however, remained a vitally important component of any eradication effort. The second campaign has largely remedied this problem by resorting to a technological upgrade of a rather old tool: insect-repellent nets. All across the world, humans living in mosquito-heavy areas have been using nets to protect against biting insects since antiquity, but the idea of impregnating them with potent

insecticides that are safe to humans has only become feasible in the modern era.[98] This idea became particularly popular among British soldiers in colonial India, Soviet forces in the Central Asian republics and American troops stationed in the Pacific Theater of the Second World War.[99] Not long afterward, their modern incarnations, the standard insecticide treated net (ITN) was produced. Its benefits are numerous: it can be strung up from any fixture and protect multiple humans from mosquitoes or biting insects while they sleep—that is, when they are most vulnerable. Standard nets cost between $2 and $3, last from 6 to 12 months, and are usually coated with an insecticide such as a pyrethroid which is toxic to insects but non-toxic to mammals; the coating can be reapplied by community health workers or individuals with the use of a simple instruction booklet.[100] Longer lasting nets or LLINs are ensured for at least three years and cost approximately $6 each.[101]

While there still remain some barriers to complete usage, it is important to note that the insecticide treated nets are having an important, measurable impact. A review of 14 cluster randomized and 8 individually randomized controlled revealed that ITNs offered 17% protective efficacy (PE) compared to those using no nets and 23% PE compared to untreated nets.[102] Additionally, for each 1000 children using nets, approximately 5.5 lives can be saved annually.[103] The review goes on to note,

> In areas with stable malaria, ITNs reduced the incidence of uncomplicated malarial episodes in areas of stable malaria by 50% compared to no nets, and 39% compared to

[98] Arrow et. al 2004: 202
[99] Arrow et. al 2004: 203
[100] "Insecticide Treated Nets: A WHO Position Paper;" Price range available via CDC donation page at "Bed Nets for Children"
[101] Price range available via CDC donation page at "Bed Nets for Children"
[102] Lengeler 2004: 3-4
[103] Ibid.

> untreated nets; and in areas of unstable malaria: by 62% for compared to no nets and 43% compared to untreated nets for Plasmodium falciparum episodes, and by 52% compared to no nets and 11% compared to untreated nets for P. vivax episodes.[104]

ITNs provide a simple, cost-effective, scalable way to manage the disease that bypasses the problematic aspects of the IRS approach of the first-wave eradicators.

The enormous technological advances in the intervening decades since the first malaria campaign have also allowed time for the development and improvement of ways to manage the spread of the disease. Yet another measure targets the vector, anopheline mosquito species, but does so in a manner that would have been difficult to implement on such a large scale during the 1950s and 60s: Sterile Insect Technique. This approach is a form of biological control in which health authorities release an overwhelmingly large number of sterilized male insects—in this case, mosquitoes—into a preselected area so that by sheer numerical advantage, they will outcompete the fertile males for female mates and subsequent generation will be smaller as they still are unable to reproduce. The technique requires an enormous number of insects, each of which must be sterilized, usually by radiation, but the process has been used to successfully eradicate insect pests in a number of places including the sleeping-sickness carrying tsetse fly from Zanzibar and the screwworm fly from the United States, Mexico and Libya to name a few.[105] The approach can be applied to anopheline species like those which carry the Plasmodium parasite and it avoids the problem of earlier approaches like pesticide resistance and over-reliance on pharmacological solutions.

As explained earlier, the specter of drug resistance still looms over counter-malaria efforts even today. Plasmodium has long since adapted the assaults of chloroquine and its descendents,

[104] Lengeler 2004: 3-4
[105] Expert Group Confirms: Tsetse Fly Eradicated on Zanzibar;" Bakri A: 2

but the arms race between microbe and man continued uninterrupted. In the 1970s, the balance shifted toward man. Vietcong leaders, whose soldiers were forced deep into the jungle along the Ho Chi Minh Trail by heavy American bombers, faced high casualties not only from bombs but also from Plasmodium Falciparum carrying mosquitoes that proved Chloroquine-resistant. Desperate for a new drug, they turned to Chinese Leader Mao Zedong who launched a secret military operation known as Project 523; its scientists eventually stumbled upon the Artemisia bush, from which was derived a powerful new antimalarial drug—Artemisinin.[106] Though it took time for Artemisinin to gain acceptance in the west, largely because of its atypical origins, it is now one of the mainstay of antimalarial medicine. Artemisinin is particularly important because it is used in combination with other antimalarial drugs in Artemisinin-Combination Therapy (ACT), this use of two different medications makes it significantly more difficult for the parasite to develop a resistance to both independently.[107] The availability of new antimalarial drugs, combination therapies and a significantly better understanding of drug-resistance makes the disease significantly easier to cure and treat, in both small and large-scale applications than during the first campaign.

The final major change in terms of managing the disease's spread is the move beyond the single minded focus on vector control. Though as we have seen with the strategies implemented above and those of the initial effort, it will remain a centrally important part of any successful campaign, the emphasis on mosquitoes only attacks one part of the larger problem of malaria. A better approach is found instead in the older, successful efforts of corporations which have learned to survive and thrive in some of the most resource-rich, if malaria-heavy regions in the world.

[106] Shah 2010: 111-112
[107] Ibid, p. 114.

In the 1930s and 1940s, corporations that relied on resource-extraction had no choice but to face extremely high rates of malaria in order to get at their quarry. As a result, they rested on multi-pronged approaches which circumvented the problems faced by first-wave eradicators. The operators of copper mines in Zambia, for example, drained swamps, cleared vegetation, and modified river boundaries, but also combined these tactics with screens in houses and quinine to lower the malarial incidence rate as much as 75 to 90 percent over 3 decades.[108] In the modern era, foreign multinational corporations are also keen to use similar methods, as evidenced by the actions of Exxon-Mobil in Cameroon and Chad and what is now BP in Angola.[109] These efforts were used in targeted applications originally, but there is little reason why corporations must retain a monopoly over the multi-pronged approach to combatting malaria. That these strategies have been used in malaria-hyperendemic regions for almost 80 years serves as a testament to their staying power and efficacy in managing the disease and its spread.

Political Will and Community Engagement

As discussed earlier, a large part of the reason for the failure of the first campaign was the inability to engage the community properly. The first eradication scheme was orchestrated like a military program with the destruction of the pathogen as the paramount aim, an attitude which left eradicators unable to adequately consider the complexities on the ground and garner the support they needed to make the campaign succeed. One important development since that time has introduced a spate of new players and ensured that the fight against malaria far more deeply engages every community in which it is involved.

[108] Arrow et al 2004: 229
[109] Ibid.

The proliferation of NGOs, Non-Profits and Community Foundations since the end of the Cold War has been nothing short of extraordinary. Though many NGOs and similar groups formed initially formed as temporary relief organizations during the Second World War, the nature of their work was such that providing relief proved to be an ongoing struggle extending their initial commitments long beyond the plans of their architects.[110] The gradual "thawing" of the Cold War and its eventual end led to an even more massive growth in the creation of NGOs, so that there are at least 2,500 international NGOs alone, with one UNDP journalist citing as many as 37,000.[111]. It is difficult to estimate the number of international aid workers, but some estimate that this number may be as high as 200,000.[112] To be sure, only a small fraction of these groups work on problems associated with infectious diseases, and a smaller subset still work specifically with malaria. But the point remains that with such a large number of extra players, additional resources are readily available. Consider just one powerful example. The Roll-Back Malaria Partnership is a global collection of hundreds of coordinated organizations and networks ranging in size from large, powerful IGOs such as UNICEF and the WHO to Universities to small-scale private charitable organizations.[113] Each of these lends not only a great deal of funding to the treatment of malaria, but also helps to manage its indirect burden on communities.

This is particularly important because it marks a shift from the model of eradication seen with the smallpox effort in which the charge was led exclusively by states. The development reflects two changes. The first deals with the nature of the disease. Malaria, is so large and technically complicated an issue that to relegate it to the purview of states or consortiums of them alone—which are themselves, large, slow and unwieldy—has historically proved to be an unwise

[110] Weiss 2013: 21-22
[111] Ibid, p. 23
[112] Ibid.
[113] "Roll Back Malaria Links"

decision. The lesson then is future diseases which bear a resemblance to malaria in this manner will require the participation of both state and non-state actors if eradication efforts are to succeed. The second point demonstrates the growth in capacity of these non-state agencies to offer help substantive help in the efforts to eradicate diseases. As mentioned earlier, the industry as a whole has seen tremendous growth in recent decades and as a result, global public health efforts have benefitted. The case of Guinea Worm Disease in the subsequent chapter will even demonstrate, for example, that the capacity of these groups has grown so much that they may even take the leading role ahead of states.

It is important to note, though that these organizations are hardly monolithic. Instead, they are as diverse as the people who comprise them and provide all manner of technical expertise and aid. They lend credence to the eradication scheme as a whole, particularly because they are staffed by many of the most qualified and scientifically-literate experts in a number of fields. Consider, also the for example the kinds of quantum leaps in scientific understanding: at the time of the first eradication effort, 1955, the idea of DNA was only 2 years old. As such, conceiving of how drug resistance developed, a concept which fundamentally requires a basic understanding of genetics was understandably hopeless. Since then, however, scientific progress has made strides—mapping the genomes of everything from plasmodium to anopheles to man himself.

What is ultimately needed, therefore, is experts who understand how to put that kind of information into practice. Doctors and nurses, to be sure; but remember also, reader, that malaria is a mosquito borne-disease, relegated to the tropics whose incidence is also comorbid with extreme poverty. As such, its eradication will require experts in every one of those fields: entomologists for the mosquito vector, climate and environmental scientists of every kind for the endemic regions, economists and political scientists for advisement on dealing with the poorest

and most politically fragile states. Any failure to address these underlying conditions, insofar as they contribute to the proliferation and persistence of this terrible scourge, then will make this disease ineradicable. The Roll-Back Malaria Initiative features organizations which tackle each part of that challenge and as such, it is incomparably better equipped to face the challenge of malaria than was its predecessor.

It should also be noted that some of these organizations are particularly large and have taken on a leading role. Any serious discussion of malaria, for example, cannot exclude mention of the Bill and Melinda Gates Foundation—the preeminent organization behind the push for eradication of the disease worldwide. Because of its multi-billion dollar endowment, the Gates Foundation is not only able to fund numerous other smaller organizations, it is also able to go beyond the purview of strict philanthropy and into the realm of advocacy, arguing that developed nations ought to act to reduce, eliminate or even eradicate the burdens of disease in developing nations. When organizations such as this have sizeable resource reserves on which to draw, the ability of influential political actors to ignore such calls to action becomes harder to ignore.

To close observers, malaria's story will seem every bit as complex as the disease itself. Plasmodium has, in many ways, changed over time and adapted to its environment, forcing eradicators to develop new techniques, tools, medicines and strategic partnerships to outwit it. What should be clear, however, is that the second eradication campaign differs markedly from the first and has indeed built on the failures of its predecessor. Much progress remains to be seen but the interplay of both states and non-state actors and the increased role of the latter group in this campaign marks a clear departure from the smallpox campaign in which the former group took the leading position.

Chapter IV: Guinea Worm Disease

Though most people in the developed world today have never heard of dracunculiasis, or guinea worm disease, for most of human history the condition has caused suffering for untold millions around the world. Though it has infected and crippled innumerable people over the millennia, the parasite's survives today in only a handful of the poorest countries on earth. In some ways, it serves as an ideal candidate for eradication: it is the only disease transmitted solely by soiled drinking water, which as we will see can be easily remedied, and as with smallpox, humans are the parasite's only reservoir.[114] And while many political scientists eschew or even criticize the practice of making predictions, I will argue, reader, that perhaps within the next decade or two, dracunculiasis will join the contemptible ranks of smallpox and rinderpest as the next disease to be eradicated by human efforts.

History of the Disease

Like Plasmodium, the guinea worm is an ancient foe. Evidence of its crippling power can be found on the skeletons of Egyptian mummies and some have suggested that plagues of so-called "fiery serpents" in The Bible are instead references to guinea worms.[115] Take, for example, the following account which, upon careful reading and an understanding of the clinical symptoms of the disease may even provide a few clues as to why Guinea Worm infection proved so troublesome in this context.

> And the people spake against God, and against Moses, 'Wherefore have ye brought us up out of Egypt to die in the wilderness? For there is no bread neither is there any

[114] "How to Slay a Dragon"
[115] "Dracunculiasis: Historical Background"

> water...And the Lord sent fiery serpents among the people and they bit the people and much people of Israel died.[116]

These fiery serpents are later mentioned in another passage, "...wherein fiery serpents, and scorpions, and drought, where there was no water…"[117] Here, a number of factors are worth considering. First, the occurrence of these so-called fiery serpents around Egypt and the area of the Red Sea suggests that dracunculiasis was common during this time period.[118] Second, the feeling associated with the worm's exit has been described as a painful, burning sensation which drives sufferers to seek relief in pools of water into which new guinea worm larvae will go on to infect more water fleas, beginning the cycle anew.[119] For this reason, the problem of guinea worm becomes particularly pernicious in areas where of water scarcity or where drought has struck since more people crowd around a comparatively small number of drinking sources; this can explain why in both biblical cases, water scarcity is tied directly to the outbreak of dracunculiasis.

The guinea worm may also be responsible for one of the more recognizable symbols in medicine, a single serpent wrapped around a pole—the healing rod of Asclepius—a nod to the universally applied treatment against the disease, a method used to this day.[120]

By the 19th and 20th centuries, the emergence of water treatment facilities and slow but steps in public health helped to drastically reduce the number of cases of guinea worm disease across the world, with the notable exception of a number of developing nations. Until this point, progress against Guinea Worm was simply a happy result of a much less single-minded effort: the

[116] Num. 21:5, KJV
[117] Deut. 8:15, KJV
[118] "Dracunculiasis: Historical Background"
[119] "How to Slay a Dragon"
[120] "Healing Rod of Asclepius"

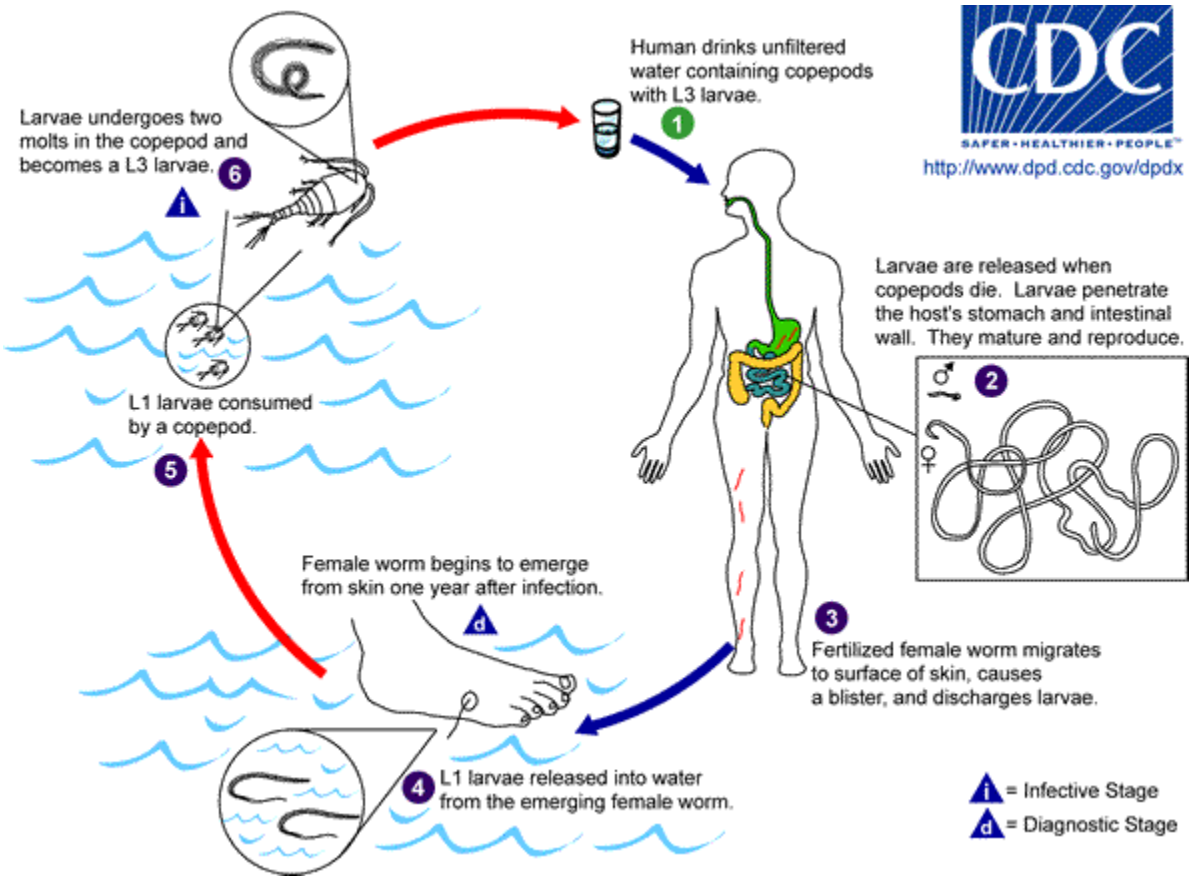
slow and ceaseless forward march of public health and sanitation in industrializing nations. Finally, when the eradication effort began in earnest in 1986, the global caseload of dracunculiasis stood at 3.5 million.[121]. Through the efforts of a coalition of organizations led largely by the Carter Center the campaign has seen an incredible reduction to just 148 cases as of 2013—that is, more than 99.99% since the effort began.[122]

Symptoms

Though the lifecycle of this microorganism is not nearly as complex as that of, say, Plasmodium, at least a basic understanding of the signs and symptoms of the disease are crucial if we are to evaluate whether an eradication campaign will be successful. For this reason, I explore the topic here briefly. Infection begins when an individual drinks water contaminated with copepods carrying the larvae of the nematode, Dracunculus medinensis.[123] Though the copepods themselves will die in the acidic environment of the stomach, their parasitic passengers—the guinea worm larvae will survive long enough to burrow into the lining of the host's stomach and eventually, his intestinal wall.[124] Sexually mature worms can reproduce and fertilized females will begin their long migration where they will emerge a year later, sometimes at an extraordinary length of more than 2 feet from the surface of the skin.[125] As mentioned earlier, the painful sensation is similar to a burn which compels sufferers to desperately try to submerge the affected body part—often a foot, into a body of water in order to relieve the pain.[126] This action, however, is in the parasite's best interest, as it allows thousands of larvae to burst forward from the site of

[121] "Guinea Worm Fact Sheet"
[122] Ibid.
[123] "Dracunculiasis Life Cycle"
[124] Ibid.
[125] Ibid.
[126] "How to Slay a Dragon"

the blister and go on to infect more water flea copepods which will then be taken up by unsuspecting humans. Infection with guinea worm is not usually fatal, but if not treated properly, it can often lead to debilitating or even deadly complications like secondary infections at the site of the blister where the worm will attempt to emerge. The graphic below provides a concise summary of the process described above:



(Figure 2)[127]

Before moving to the evaluation of the eradication campaign, it is again necessary to examine the aspects of reputation, rational self-interest and the interplay of state and non-state actors.

[127] "Dracunculiasis Life Cycle"

In certain ways, the interaction of these three factors was somewhat different with respect to the guinea worm campaign as compared to the examples which motivated states to push for the eradication of smallpox and malaria. Simply put, in the former two cases states were motivated to act as the primary drivers of eradication. In the case of guinea worm however, the situation was more complicated. Here, reputational benefits would still play a role, but as we will see the benefits they confer only become apparent long after eradication is underway and close to completion. Prior to this, many states were reluctant to get involved due to the related issue of the perceived lack of rational self-interest.

As mentioned earlier, wealthier nations had already eradicated the parasite and faced no risk of importation. As a result, the kinds of logic which played a role in, say, the smallpox effort were simply lacking in the guinea worm effort. Additionally, by the time the eradication effort gained serious momentum, the Cold War was drawing to a close—ending the superpower competition which had served as a driver for the malaria campaign. Guinea worm then faced a number of comparatively unwilling states. It is important to note, however that while there may have been a lack of direct self-interest, we will see that there existed the presence of an enabling international environment in the form of the International Drinking Water Supply and Sanitation Decade (IDWSSD).

This development opened the space for non-state actors to move in and fill the gaps left by the now reluctant states. The resulting interplay of state and non-state actors featured a chance for non-state actors like NGOs which had grown tremendously in size and capacity since WWII to handle a greater responsibility than they had ever done before with respect to a concerted global public health effort that required cooperation, technical expertise, funding on such a massive scale. From this vacuum left by states, the Carter Center emerged as the clear leader in the fight against

guinea worm and has continued to lead the effort since 1986. With this understanding in mind, it is now productive to explore the strategies employed in the eradication effort against this terrible scourge.

Ways to Treat, Cure and Manage the Disease

In some ways, the success against Guinea Worm may seem strange. To this day, there remains no vaccine or drugs used against the worm, and not even past infections will confer immunity to sufferers.[128] There remains, however, a time-tested treatment that is perhaps as old as the disease itself: wrapping the emerging worm around a stick, or in this era, a piece of gauze, and carefully winding it out inch by inch over a period of days or weeks, taking great care to neither let the wound become infected nor let the worm break and allow anaphylaxis to set in.[129] As mentioned earlier, the worm will make its push toward the surface of the skin and in doing so, attempt to drive the sufferer to further infect others through sources of drinking water. Managing the spread of this disease, then, consists of a simple two-step process: preventing healthy people from drinking water contaminated by copepods and disallowing those who are currently infected with guinea worms from transferring larvae back into communal sources of drinking water.[130]

Monitoring Programs and Community Engagement

Given the life cycle of the guinea worm, it is not difficult to see why monitoring programs and community engagement would remain vital components of the eradication scheme. Here, two points are worth noting. First, as noted earlier, guinea worm disease becomes particularly

[128] "Guinea Worm Fact Sheet"
[129] "Dracunculiasis"
[130] Zimmer 2000: 205

problematic in areas where drinking water is scarce. As such, dedicated monitoring programs must undertake efforts to map out common water sources—especially in drought ridden areas where reports from local populations may be unreliable or unavailable because they are highly mobile. Highly mobile populations, such as modern day cattle herders in much of Eastern Africa can prove near impossible for world health authorities to accurately monitor with the constant, close attention to detail required of a campaign such as this. Unlike the smallpox campaign, the guinea worm eradicators cannot mass vaccinate their way out of this problem. Instead, each guinea worm needs to be painstakingly pulled from its unwilling host. And as such, eradicators will need to build up community trust and involvement in order to get local peoples to work with them in order to stamp out this parasite. As one journalist even noted, "If the campaign succeeds, it will be the first time a disease has been wiped out through education - rather than the use of a vaccine or medicine."[131]

Second, monitoring programs must also take care to watch for suspected or potential cases of guinea worm within individuals or communities. An organization like the Carter Center, which employs both full time staff members and legions of local volunteers trains such workers to travel from village to village carefully taking watching the walking patterns of each person they come across to spot any abnormalities.[132] If, for example, a local person is found limping along a roadside, he or she will be politely questioned as to how long the limp has persisted, what other symptoms have manifested and similar questions in an attempt to gain more diagnostic clues.[133] If the case seems suspicious, the suspect will be asked to visit a special isolation camp run by the aforementioned center, where they can be treated while preventing the further spread of infectious

[131] "Fresh Push to Rid the World of Guinea Worm by 2015"
[132] "How to Slay a Dragon"
[133] Ibid.

larvae into other sources of drinking water.[134] The work is undoubtedly exhausting, but unquestionably necessary if the campaign is to succeed.

Political Will

As with all eradication efforts, the campaign against the guinea worm remains a fundamentally risky endeavor and therefore, leaders of states are unwilling to invest in programs which appear to have little chance of success. Instead, state leaders are shrewd observers and contribute to such efforts when they judge that these campaigns are likely to succeed. The case of the United Kingdom's recent support for the program illustrates this phenomenon.

To this end, the United Kingdom's international development minister, Stephen O'Brien spoke highly of the Carter Center efforts, noting, "'President Carter's commitment has brought guinea worm to the brink of eradication...It has never been a question of if we can rid the world of this ancient disease - but when.'"[135] O'Brien's praise came shortly after the announcement of a donation of £20 million by the Department for International Development (DfID) for the campaign, which will fill about one third of the funding gap.[136] The quote is particularly significant.

By the time the announcement was made in 2011, well over 99% of the world's disease burden of guinea worm had been eliminated, relative to the caseload at the time the campaign began in 1986.[137] It seems patently clear then, that any nation which joined the effort or significantly increased publicity of previous involvement in this campaign beginning in 2011 chose to do so for little more than reputational reasons. To be fair, the United Kingdom is hardly

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[134] Ibid.
[135] "Fresh Push to Rid the World of Guinea Worm by 2015"
[136] Ibid.
[137] "Guinea Worm Fact Sheet"

alone in assuming this position and even the cynic would be hard pressed to argue that the nation should not have become involved at all because it lacked purely altruistic motivations. What seems clear in any case, however, is that like many nations, the United Kingdom wishes to be part of the winning coalition not if—but when, dracunculiasis is eradicated. It is important to note that the example of the United Kingdom is not intended to criticize that nation's actions or intentions with regard to the eradication of the guinea worm. Instead, the example is simply intended to demonstrate that even political actors like states which were previously disinterested in the effort because it did not factor into their calculations of rational self-interest can become motivated when factors like reputations and the interplay non-state actors changes political will. In turn, sufficient political will can act as a powerful force that spurs eradication.

Agencies

These simplified two-step process described earlier has, in turn, been managed by a number of different, specialized organizations all spearheaded by the efforts of a single group which has largely led the charge since joining the eradication fight in 1986: The Carter Center. Before delving into how The Carter Center and its affiliated groups were able to effectively bring Guinea worm under control, however, it is necessary to first explore how these private organizations rose to the forefront of an enterprise that has historically been the restricted to the purview of states alone.

Five years before the Carter Center was even involved, the United Nations marked the beginning of the International Drinking Water Supply and Sanitation Decade (IDWSSD), in 1981.[138] The effort, organized at the United Nation's conference at the Argentine city of Mar del Plata in 1977 aimed to provide those in developing nations with access to clean, potable water and

[138] "WHA 34.25: International Drinking Water Supply and Sanitation Decade"

proper sanitation by the end of the decade in 1990.[139] Since Dracunculiasis is a disease spread exclusively through the consumption of contaminated drinking water sources, this goal presented an ideal opportunity to launch a campaign against the parasite which caused it. The fortuitous timing did not escape the sights of that most vaunted UN-agency—the WHO. Just a few short years later, the World Health Assembly issued Resolution 39.21 in which it formally declared its intention to eradicate Dracunculiasis.[140]

This resolution is particularly important because in it, the WHO calls upon not only the member states as observers have no doubt come to expect, but also other non-traditional groups. Consider, for example the following passage, which comes directly after the call to all affected member-states.

> "The Thirty-Ninth World Health Assembly…INVITES bilateral and international development agencies, private voluntary organizations, foundations, and appropriate regional organizations:
>
> (1) to assist countries.' efforts to add, within the context of primary health care, a dracunculiasis control component to ongoing or new water supply, rural development, health education and agricultural programmes in endemic areas by providing required support
>
> (2) to provide extrabudgetary funds for this effort;"[141]

[139] Ibid.
[140] "WHA 39.21: Elimination of Dracunculiasis"
[141] "WHA 39.21: Elimination of Dracunculiasis"

This explicit invitation is to international development agencies and most notably to private voluntary organizations is worth mentioning for at least two reasons. First, it marks a departure from previous eradication efforts which rested largely on the shoulders of states. The second, and more surprising reason is that the World Health Organization called upon groups that are undoubtedly smaller and resource-poor in comparison to states to make available extra budgetary sources of funding to propel this effort. In retrospect, this call is particularly curious when we consider that some of the best endowed philanthropic organizations the world would ever see, like the aforementioned Bill and Melinda Gates Foundation, would not exist for decades to come.

It would be unfair to discount the role of governments in the effort to eradicate the Guinea Worm. Even after the Carter Center began to lead the campaign in 1986, they partnered closely with a number of governmental and intergovernmental organizations like the CDC, USAID, the Peace Corps, UNICEF and the governments of guinea worm endemic countries. Still, the role of this singular actor should not be undervalued here. A few brief examples prove instructive.

Keeping in mind that the first step to breaking the cycle of guinea worm transmission consists of providing clean sources of drinking water, the Carter Center's efforts were aimed at addressing this problem in a number of ways. The offending copepods can be killed by boiling the water, applying safe larvicides, or filtering it through fine mesh cloths or even simple cotton ones that have been folded over a few times.[142] The Carter Center's innovation, then, was to facilitate partnerships with other organizations—notably, large corporate donors—and thereby to make these options far more cost effective for those individuals and communities affected by the Guinea Worm.

[142] "How to Slay a Dragon"

With regard to the desperately needed filtering cloth, partner organizations like E. I. du Pont de Nemours & Company and Precision Fabrics Group had donated 1 million square yards of nylon filter material by 1994 alone.[143] Corporations like American Cyanamid, American Home Products and BASF have donated the larvicide ABATE®, which kills off the parasites but proves safe for human consumption.[144] Johnson & Johnson has donated medical supplies to provide for the needs of more than 3,000 villages, including Tylenol®, gauze for wounds, and forceps.[145] The Carter Center's website lists dozens of partner organizations, ranging from private voluntary organizations to governments as diverse as that of Finland and Saudi Arabia. It is perhaps the support of this latter group--the governments themselves—which proves most striking. A number of these governments and their affiliated international development agencies have donated in no small measure to the Carter Center itself.

With the continued efforts of the Carter Center and cooperation of corporations and governments, it is unlikely that guinea worm will persist for long.

[143] "Guinea Worm: Countdown to Zero Timeline"
[144] Ibid.
[145] "Carter Center Releases Action Plan for Guinea Worm Eradication, Targets Ghana, Nigeria, and Sudan"

Chapter V: Conclusion

The conceptual puzzle I proposed to begin this theoretical discussion was two-fold. The first challenge dealt primarily with addressing the question of why states would cooperate to eradicate infectious diseases given structural and situational incentives not to do so.

While the answer is complex, it can fundamentally be answered with three related components: reputational benefits that states gain from participation, rational self-interest behind participation and finally, the interplay of state and non-state actors. As we have seen, these factors have played different roles in each campaign to eradicate disease. In some cases, like that of the smallpox effort, factors like rational self-interest have remained powerful explanations for why both the United States and the Soviet Union chose to pursue the strategy of eradication rather than merely vaccinating their own populations every year. In other cases like that of dracunculiasis, though rational self-interest may not account for state's direct involvement, it still helps to explain the presence of the enabling environment which did allow for non-state actors to successfully launch eradication efforts.

Undoubtedly, it should be clear by now that eradication schemes are, by their nature, cooperative endeavors. As such, the second part of the puzzle dealt with resolving the question of what makes these cooperative schemes successful. To tackle this question, I generated a five-point rubric which sought to capture critical components of the eradication campaigns. They were: ways to cure, treat or manage the disease and its spread; monitoring programs; political will; community engagement; and agencies tasked, and adequately equipped to deal with the disease. I applied these components to the eradication campaigns to evaluate likelihood for success and reasons for failure. While some efforts like the first malaria campaign failed precisely because it did not meet these

necessary conditions, others like the subsequent malaria effort and the smallpox effort built upon them.

As a final note here, I have endeavored to demonstrate the steady shift between state and non-state actors. As the latter group has grown in number and institutional capacity, it has shown an increasing ability and willingness to shoulder the burden for eradicating infectious diseases when states are unwilling or unable to do so themselves. This has been visible such that while the WHO was responsible for the eradication of smallpox, the close observer will have noticed a gradual increase over time in the number of non-state actors involved to the extreme case of guinea worm disease today where a non-state actor—The Carter Center, leads the effort now. To be sure, states and interstate bodies like the WHO remain vital to any eradication campaign; even in the guinea worm case they offer support, for example. But the shift is notable and has important implications for the future of eradication.

The Difficulty of Eradication

As mentioned earlier, any states choosing to participate in eradication were knowingly taking on an enormous risk. The smallpox campaign, after all, was hardly the first attempt at the eradication of a disease. Instead, it was simply the latest in what had been until then a series of overly-ambitious projects that some of the most-well respected scientific experts criticized as foolhardy endeavors. Rene Dubos, for example, a prominent and well respected medical scientist who wrote a book called *Man Adapting*, in which he argued that far from feasible, the idea of eradicating a disease would instead become a historical curiosity that later generations confined to library shelves.[146] The reader may look upon the success of the smallpox campaign and read

[146] Dubos 1965: 379

Dubos' words today with some relish, but given the enormous difficulties that remain in stamping out any disease even in modern time—let alone at the time when Dubos published *Man Adapting*, his skepticism is not unwarranted. Eradication, after all is possible only for the smallest subset of diseases for which a constellation of factors align—only some of which this thesis has had the scope to fully tackle—in the most fortuitous ways. Still, however, upon closer inspection we find that the seemingly insignificant distinction between difficult and impossible has made all the difference—certainly when we consider the 500 million humans who needlessly perished in the last century, especially when we keep in mind the incomparably greater billions in all future generations who will never know the scourge of Variola thanks to the efforts of eradication.[147]

Tackling Misconceptions

There persists a popular misconception that the diseases that will be eradicated are those which inflame crises and dominate news headlines. At the time of this publication, there is perhaps no better example than the ongoing crisis of Ebola Virus Disease in West Africa which has left nearly 7,000 dead, many families further impoverished and remained a major topic in news headlines across the world.[148] A viral hemorrhagic fever, its high case fatality rate, gruesome symptoms, lack of vaccines and medicines all make for a nightmarish scenario for the poorly-equipped health infrastructure of nations like Liberia and Sierra Leone which remain among the hardest hit. In recent months, many media figures have asked whether such a deplorable pathogen which has taken so many lives in the developing world and frightened citizens and leaders alike living in the comparative safety of the wealthiest and most industrialized nations, ought not be slated for eradication. The sad truth remains, however, that eradication is not primarily determined

[147] Koplow 2003: 1
[148] "Ebola Outbreak: West Africa Death Toll Nears 7,000"

by how abhorrent the global community finds a particular pathogen, but by how feasible its destruction might be. Ebola is a disease of recent zoonotic origin, one of whose possible host species is bats.[149] Since no vaccine currently exists against the virus which cause Ebola, every bat and other potential animal which acts as a carrier would need to be sought out, long before humans enter the calculus. Intuitively, we realize that such a scheme cannot succeed. Ebola is unlike smallpox which persisted in only humans, such that the vaccination of the last human meant the end of the virus' reign. It is also unlike the guinea worm whose ease of elimination from a common resource—drinking water—meant that it could be coupled with other development projects. Finally, ebola is also unlike malaria in that its near-global ubiquity among human populations and strides against it meant that the disease had secure its place on the eradication slate.

Lessons for Future Eradication Campaigns

In this section I wish to offer the reader two parting lessons for future eradication campaigns gleaned from successes and failures of the eradicators of decades past. These are by no means exhaustive, but are instead only intended to serve as a starting place for eradicators bravely facing the unknown pathogens of the future. For these daunting endeavors and the stalwart men and women who will face them, there is perhaps no better field manual than past experience.

First, for practitioners on the ground, it is important to note that the reality of day to day eradication against any pathogen will be markedly different from much of the highly theoretical political calculus occurring at the state level which has been described here in detail. As such, eradicators should be forewarned against trying to apply the logic of, say, game theoretic modeling used to describe why participation makes institutions great facilitators of cooperation directly to

[149] Calisher et. al. 2006

their daily affairs of individuals without any qualifications. Instead, these lessons will need to be adapted. Consider a clarifying example: the case of cognitive biases which inhibited honest reporting of smallpox cases in endemic countries such as India and Somalia during the eradication efforts. Though smallpox is long dead, this tendency to hide cases will undoubtedly resurface with the next eradication campaign. At first, such an action will certainly seem curious as suppressing the actual number of cases can only prove counterproductive to any serious effort. But when we consider the reasons behind suppression, the rationale becomes clearer. On the individual level, reporting was often relegated to mid-level officials who were chastised rather than rewarded for their candor[150]. As a result, the incentive structure of reporting in these countries was naturally set up such that officials had little reason to report accurate figures for fear that they might suffer rebuke or even lose their post in favor of someone who might simply underreport statistics anyway. From the macroscopic perspective, countries might choose to underreport figures because of the perception of shame that came with harboring smallpox. The lesson for future eradicators then, is that rather than rebuking officials in these positions which may only lead to cognitive dissonance and a doubled down position, it is instead better to work with them when possible. If officials prove to be unwilling or unable to help, then replacement with more competent and willing persons will be necessary. This argument is one steeped at least as much in improving efficiency as much as it is in demonstrating compassion to those in difficult positions. It is also more likely to gain the support of local workers than efforts that simply write off whole communities as ineffectual or unwilling to help.

A second related lesson relates brings the discussion of eradication back to the macroscopic level of nations. The feelings of fear and shame discussed above, are not limited to the realm of

[150] Henderson 2009: 169

individuals. Instead, close observers will see states exhibit similar kinds of behaviors. There is perhaps no better example which illustrates this than state competition. State competition proved to be a double edged sword in regions in which old rivalries became intertwined with the campaign. The desire to beat a regional competitor to the finish-line of eradication did, in some cases, encourage a healthy sense of competition. In other cases, however, the shame of being the last country in a region to have eradicated smallpox led authorities to hide cases, as with the case of Somalia.[151] What is needed is an understanding by eradicators, that the reasons behind underreporting are often complex and may be rooted in individual motivations like shame or fear of reprisals or much larger-scale ones like national competition. Only by understanding these motivations can future campaigns take steps to preemptively address them.

[151] Henderson 2009: 236

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