

Prevention and Control of Tropical Diseases in the 21<sup>st</sup> Century: Back to the  
Field

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## Introduction

First let me say what a great honor it is for me to be the President of the American Society of Tropical Medicine and Hygiene. This represents the pinnacle of my career, and I want to thank all of my colleagues and collaborators who, over the past 35 years, have provided me the many opportunities to work in this field. Their constant encouragement and support allowed me to develop and grow.

Most important, I want to thank my wife, Bobbie, for the support and encouragement she has given me over the years; she must share equally in any success I have had. She was always supportive and encouraged me to go where the action was even though it meant my being away in the field for weeks at a time without her knowing where I was or what I was doing; remember the days before satellite and cell telephones? But it was her support and encouragement that allowed me to live and work in the field, which is so important to tropical medicine research. And, I want her to know how much I appreciate her dedication to my career.

The understanding and support I received from my immediate family allowed me to spend most of my career in the field. Of the 31 years since I received my degree from the Johns Hopkins School of Hygiene and Public Health, 20 were spent living and working in tropical countries in Asia, the Pacific and the Caribbean. Those 20 years in the field shaped my life and my career. This morning I want to talk about the need to provide attractive programs and more opportunities for young scientists to obtain in-depth field experience. I am not talking about 1 to 3 week epidemic investigations. These are certainly important, but if we ever hope to reverse the trend of emergent/resurgent tropical diseases in the 21<sup>st</sup> century, we must have a better understanding of the changing ecology/epidemiology of those diseases. The only way we can obtain that kind of detailed information is to study the diseases over time in areas where they are endemic/enzootic.

## History

With that introduction, let me back up and talk briefly about the history of tropical medicine. An understanding of what happened in the past, what was done right and what was done wrong, helps put the present situation into perspective.

The last century was one of triumphs and failures. The triumphs came mostly in the first 70 years of the 20<sup>th</sup> century, and resulted primarily from understanding the ecology of the diseases through field and laboratory research and using that knowledge to develop and implement prevention and control programs aimed at breaking the transmission cycles at their weakest points. The failures occurred when we became complacent after successes were achieved, and from relying too much on the “quick fixes” or the “magic bullet” approach to disease control.

Consider the vector-borne diseases, which are my specialty. Sir Patrick Manson was the first to discover that blood sucking arthropods could transmit disease pathogens to humans.<sup>(1)</sup> Working in China, he showed that the filarial worm, *Wuchereria bancrofti*, the causative agent of lymphatic filariasis or elephantiasis, was transmitted to humans by *Culex* mosquitoes in 1877. Within a few years, Smith & Kilbourne in 1891 showed that Texas cattle fever was transmitted by hard ticks, Ross, working in Calcutta, showed that anopheline mosquitoes were the vectors of malaria in 1897, and Reed and his coworkers showed that yellow fever in Cuba was transmitted by *Aedes aegypti* in 1900.<sup>(2-4)</sup>

By the end of the first decade of the 20<sup>th</sup> century, the transmission cycles of most of the major arthropod-borne diseases had been worked out: dengue in

1902, African sleeping sickness in 1903, plague in 1905, Rocky Mountain spotted fever in 1906 and typhus in 1909, just to name a few of the more important epidemic vector-borne diseases that plagued mankind at the beginning of the 20<sup>th</sup> century. <sup>(5)</sup>

These early pioneers of tropical medicine were naturalists and excellent observers, and they proposed control programs based primarily on controlling the arthropod vector. The first dramatic demonstration of the success of this approach was the control of yellow fever in Cuba by General William Gorgas in 1900; he organized the control of *Ae. aegypti* by the systematic elimination and control of the mosquito larval habitats in Havana. <sup>(6)</sup> The process was repeated in Panama in 1904, thus allowing the construction of the Panama Canal to be completed in 1912. <sup>(7)</sup> Prevention and control programs for most of the major vector-borne diseases were developed in the next few decades. By the 1960s, many of these diseases that had been the major public health problems of humans for centuries, were effectively controlled. <sup>(5)</sup> These programs were aided by the development and use of residual insecticides, the first magic bullets, after World War II, but the approach was still the same, break the transmission cycle at its weakest link by controlling the arthropod vector. Unfortunately, we became complacent and with the advent of quick fix

approaches to control diseases using new insecticides and antibiotics we entered what I call the age of “magic bullets.”

By the time I arrived at the Johns Hopkins University School of Hygiene and Public Health in 1965 to work on my doctorate, I was told that I was in a dying field, that vector-borne diseases were a thing of the past, and especially that I should not specialize in malaria, the favorite disease of my major professor, Lloyd Rozeboom.

The 1970s ushered in an era of complacency that continued through the waning years of the 20<sup>th</sup> century. By 1970, malaria had been eliminated from North America and Europe, effectively controlled in Asia, the Pacific, Central and South America, and progress had been made in Africa.<sup>(8)</sup> Urban yellow fever had been effectively controlled in both Africa and the Americas, as had dengue in the Americas and the Pacific.<sup>(9,10)</sup> Plague was no longer a major public health problem, and most of the important infectious diseases were effectively controlled by antibiotics and other new wonder drugs.

These triumphs, and the policy decisions that followed, resulted in a 30 year drought for funding field research in tropical medicine; policy makers could

see no reason to continue to fund research and control programs for diseases that were no longer public health problems. During this period, we saw the training opportunities in tropical medicine decrease dramatically, both at home and abroad. Universities redirected their programs to emphasize community medicine and chronic diseases, and parasitology and arbovirus programs were de-emphasized or eliminated completely. International training opportunities disappeared as funding was terminated for programs such as the highly successful National Institutes of Health (NIH) sponsored International Centers for Medical Research and Training (ICMRT). It was these programs which had a university base, the overseas Department of Defense laboratories and the Rockefeller network of arbovirus laboratories that provided the field training for many of the current American leaders in tropical medicine.

At about this same time, a revolution was occurring in biomedical research as major advances were made in molecular biology. It was an exciting period as we learned more about the immunology, pathogenesis, cell biology and host-parasite interactions of many diseases which led to many breakthroughs that have a direct impact on our current ability to diagnose, treat, prevent and control tropical diseases. By 1970, both Sir MacFarlane Burnett in Australia and Surgeon General Stewart of the United States had declared the war on

infectious diseases won!<sup>(11,12)</sup> Some experts proclaimed that this new technology was the solution to most of our health problems, especially infectious diseases. The persons who made those claims, however, had most likely never worked in the field, and certainly didn't understand the complexities of the transmission cycles of many tropical diseases.

Unfortunately, the 1970s and 1980s were also a time of limited resources. The emphasis placed on high technology research and "quick fix" solutions left few research dollars available for basic disease ecology/epidemiology and control studies. And with decreased funding for field research, it became more difficult to attract bright young scientists into fields such as vector biology, which plays such an important role in tropical medicine.<sup>(13)</sup> In the year 2000, there are many countries where diseases like malaria and dengue hemorrhagic fever are among the most important public health problems, that do not have a single, properly trained vector biologist on their ministry of health staff.

In this country, many scientists became accustomed to the comforts of their modern laboratories and do not want to put up with the trials and tribulations of field work. Moreover, traditional microbiological methods such as



isolation/culture of the organism and serology, are being de-emphasized as more and more reliance is placed on “high tech” methods to detect organisms, primarily using sequence technology. There is no doubt that these latter methods have revolutionized diagnostics and are an essential part of our ability to deal effectively with infectious diseases now and in the future. Unfortunately, however, many molecular biologists have not been trained in basic parasitology, microbiology or virology. This trend is seen more frequently in laboratories in tropical developing countries, where it is not uncommon to find persons with no microbiology training running diagnostic laboratories without the quality control provided by traditional methods. Modern technology is critical to improving diagnostics, but equally critical is training in traditional microbiology/virology. Without isolates of the pathogens we are studying, the sequence data collected by so many, will be worthless.

Another casualty of this “age of magic bullets” was the concept of preventive medicine. Many medical schools revised their curriculum to place emphasis on curative medicine and de-emphasized preventive medicine. This change, over time, has resulted in a whole generation of people who have no

concept of prevention; many primary schools no longer even teach basic hygiene.

Concurrent to these scientific changes over the past 30 years were global demographic and societal changes that combined with the decaying public health infrastructure and de-emphasis of disease prevention, opened the door to the dramatic global resurgence of infectious diseases in the waning years of the 20<sup>th</sup> century. The unprecedented population growth since World War II, the unplanned and uncontrolled urbanization, the changing land use and agricultural practices, and the rapid movement of people, animals and commodities via modern transportation, have all been major contributors to the recent dramatic resurgence of many diseases that were effectively controlled in the 1950s and 1960s, e. g. , malaria, dengue and cholera, and the emergence of newly recognized diseases such as Lyme disease, and ehrlichiosis. <sup>(14, 15)</sup>

Some scientists saw this trend coming and predicted a resurgence of epidemic vector-borne diseases as early as 1970; Drs. Hernando Groot and Bill Reeves in a Pan American Health Organization meeting in 1970, sounded the first alarm that the resurgence of vector-borne diseases was a real threat. <sup>(16)</sup> Bill Reeves, in his 1971 Presidential address to this society warned us that the

war on infectious diseases can be lost.<sup>(17)</sup> A decade later in 1980, I gave the Highlights of Medical Entomology talk at the Entomological Society of America meeting, entitled, “The Resurgence of Vector-Borne Diseases,” and predicted at that time that dengue hemorrhagic fever would emerge as a major public health problem in the American tropics much as it had in southeast Asia 20 years earlier.<sup>(18)</sup> There were others, but few listened to these early predictions, and it was not until the Institute of Medicine Report on Emerging Infections was published in 1992 that public health officials, policy makers, and the general public began to recognize the importance of the dramatic resurgence of diseases that were conquered in the earlier part of the century, and the emergence of newly recognized infectious diseases;<sup>(19)</sup> infectious pathogens were rising from apparent defeat to wage a new war on mankind.

### Lessons Learned

I have provided this rather lengthy historical review because I think there are some important lessons to be learned from our previous triumphs and failures. A main take-home message from this review is that despite the recent popularity of the word “eradication,” most infectious disease agents and their hosts or vectors are here to stay; it is unlikely that we will eradicate many of them. To paraphrase Dr. Joshua Lederberg, “Our microbial

enemies are so adaptable that they will take advantage of the smallest opportunity as soon as we stand down our guard.” <sup>(20)</sup>

The second lesson learned from this brief historical review is that in the 21<sup>st</sup> century, we must not become complacent after achieving a few successes, but rather we must maintain constant vigilance and emphasize sustainability in our prevention and control programs if we are to be successful in the war against infectious disease microbes.

A third lesson is that effective prevention and control programs of most tropical infectious diseases require an intimate knowledge of their biology, behavior and transmission dynamics, or put more simply, the disease ecology of the pathogens we are fighting. Major breakthroughs in our ability to control some of these diseases have in the past, and will in the future, only come through gaining an intimate knowledge of the disease in its natural setting through longitudinal studies. An exciting current example of the value of this approach is the discovery by Bill Petri and his group working in Bangladesh that host immunity does indeed play a major role in the transmission dynamics of *Entamoeba histolytica*. <sup>(21)</sup> Bill and his group, using modern diagnostic tools such as antigen detection and PCR in the field

setting, have dispelled the long held view that there is no amebiasis in preschool children in developing countries. They followed 289 2- to 5- year-old children in Dhaka for 1 year and found 39% had at least one new *Entamoeba histolytica* infection. They also found that the long-held view that there is no immunity to amebic colonization was wrong by showing that children who had stool IgA lectin-specific antibodies at the beginning of the study had 64% fewer new *Entamoeba histolytica* infections. This is a classic example of how new technology, combined with longitudinal field studies, can shed new light on old disease problems.

A final lesson is that “success often breeds failure.” In the past, once a disease was successfully controlled, the resources devoted to that program were redirected to other competing priorities. Barring eradication of the pathogen, the past 30 years have taught us that if we stand down our guard, many of these diseases will return with a vengeance. Let me emphasize again that we must build sustainability into prevention and control programs of the 21<sup>st</sup> century. <sup>(22)</sup>

Let me also make it clear, however, that I am an enthusiastic supporter of research to develop new technology. The wonders of this technological

revolution will continue to unfold as we sequence more organisms and learn the functions of the genes and the proteins that are encoded in the genome. We can expect new, more sensitive and specific diagnostic tests, new drugs for use in fighting parasitic, bacterial and viral diseases, new vaccines that will be safe, economical and effective, and new ways to manipulate the genome of organisms, both large and small, to interrupt the transmission cycles of disease pathogens. In the next few decades there will be advances in biomedical research that will make those of the past 30 years seem ancient. It will indeed be an exciting period, but if we are to be successful using this new technology effectively to prevent human disease, we must have tropical medicine experts who understand the disease ecology, as so aptly illustrated by Bill Petri and his group.

The temptation will be to get caught up in this excitement, and focus only on developing magic bullets for the disease pathogens we are fighting, while ignoring disease prevention programs. This is exactly what we did in the 1970s and 1980s. Let me remind you that there are many tropical diseases for which there are no quick fixes or magic bullets on the horizon, but for which there are effective strategies for prevention and control. Malaria, dengue, yellow fever, African trypanosomiasis, Chagas' disease, plague, West Nile virus,

epidemic polyarthrititis and Japanese encephalitis are just a few of the major vector-borne diseases that are preventable by using interventions currently available.

Even if we have a magic bullet for a particular disease, we may not use it effectively. Yellow fever vaccine is about as close to a magic bullet as we have in tropical medicine. It is a live attenuated vaccine that is economical, safe, and effective, providing life-long immunity with a single dose.<sup>(22)</sup> It was used in the 1940s, 1950s and 1960s to effectively control urban yellow fever in west Africa, at the same time that this disease was controlled in the Americas by eliminating the urban vector mosquito, *Aedes aegypti*, from most tropical American countries. Because yellow fever and dengue have the same urban mosquito vector, this latter program also effectively controlled dengue in the Americas. International health officials discontinued both programs in the early 1970s because yellow fever was no longer a public health problem. In the place of these programs, it was recommended that yellow fever vaccine be used as an emergency response tool for epidemic yellow fever.<sup>(ref.)</sup> This policy has been a total disaster because the response was always too late and too little. If, on the other hand, yellow fever vaccine was incorporated into the World Health Organization

Expanded Program of Immunization (EPI) in the countries in Africa and the Americas that are at risk for outbreaks, this disease would no longer be a resurgent threat. Barring the EPI approach, the only other way to prevent urban epidemics of yellow fever is to control the vector mosquito *Aedes aegypti*. This latter approach would kill two birds with one stone because dengue/dengue hemorrhagic fever would also be controlled. If we do not do this, urban yellow fever will likely become the next global public health emergency.

The point here is that we should not make the same mistake that we did in the 1970s and put all of our resources into the development of those elusive magic bullets that may or may not work. We should learn from our experience of the past 30 years that while an occasional magic bullet may be developed, they are slow in coming. And when we do have them available, they may not be used effectively to prevent the disease. In the meantime, we must develop, implement and maintain sustainable disease prevention programs for those major tropical diseases for which strategies are available.

This will not be an easy task. First, most funding agencies prefer to fund the “high tech,” “quick fix” approaches to disease control because it



gives them more visibility, even though it may not be the best public health policy. We as public health officials must bear some of the responsibility because we have supported this approach, and further, we have propagated the philosophy that surveillance and emergency response, as opposed to disease prevention programs, is a sound public health policy. We need to change these policies! Second, the many demographic and societal changes that have occurred in the past 50 years have changed the transmission dynamics and ecology of many of the resurgent tropical diseases. To effectively prevent and control the pathogens that cause these diseases, we must study them in their new geographic settings. This will require field work by trained scientists who understand the complexities of the biology and behavior of the reservoir hosts, the arthropod vectors, the pathogen, and the interactions between all three populations. It is this kind of knowledge that will also allow development and more effective use of the “magic bullets” that will surely be developed. It is critical that we strike a balance in funding between research to develop new technology and field research on disease ecology.

### Tropical Medicine Training in the 21<sup>st</sup> Century

So what is it that we need? I would argue that we need a new cadre of young scientists who have a sound background in new molecular technology and epidemiology to be trained in tropical medicine. These scientists must be given the opportunity to gain hands-on experience with the diseases they are studying in the field. We must make field work more attractive by developing and supporting field research programs that attract young scientists. We must provide opportunities for them to apply new technology in the field and to experience first hand the joys and challenges of field work. It is difficult to do this from the comfort of the modern laboratory or by making short trips of a few weeks to a field site. To fully benefit from a field experience, one must live and work in the endemic/enzootic site, side by side with colleagues from these areas.

My first real field experience and my first job was at the School of Tropical Medicine in Calcutta, India, as part of the Johns Hopkins University ICMRT. Bobbie and I, with two small children, arrived there in July of 1969 to a terrible culture shock. It was also a time of turmoil in West Bengal and East Pakistan, (Bangladesh), and it was before television in that part of the world so we missed the moon landing. All that aside, however, it was a fantastic experience and these two years made me realize the importance of field work

and field stations if you are working on tropical diseases. It influenced the rest of my career.

In those days I was a parasitologist, and Fred Bang had sent me to India to work on a mathematical model for lymphatic filariasis. I won't go into the details, but it didn't take me long to realize that there were major holes in our knowledge of the transmission dynamics of *W. bancrofti*. So I wrote to Fred and told him I was going to change my research project. Fred was upset but there was not much he could do; I was already there and he was back in Baltimore. Moreover, I had the support of people like Brad Sack, Jerry Schad and Tom Simpson.

So I set up a longitudinal study of the host-parasite-vector interactions in my study area across the Hooghly river in Howrah.<sup>(24)</sup> I wanted to know everything that happened to the human, parasite and mosquito populations in that 1 kilometer square area over a period of 2 years. We conducted annual census and blood surveys of the human population and Tim Dondero came over from Malaysia and conducted a clinical survey. We collected resting mosquitoes from 6 indoor stations, 6 days a week for 2 years. These were dissected, thousands of them, to determine stages of parasite present and the

infection rate of each stage. We did all night landing/biting collections for mosquitoes indoors and outdoors once every month, and 4 hour landing/biting collections between 10pm and 2am in the same houses bi-weekly for a full year.

With the help and consultation of Fred Dunn, we tried to identify human behavior characteristics that influenced the transmission of *W. bancrofti* in the area.

Surprisingly, the results reveals a stable host parasite relationship.<sup>(24)</sup>

Persons living in the study area were bitten by an estimated 116,000 mosquitoes per year and exposed to large numbers of infective larvae, 4,000 to 6,000, per year depending on whether you were sleeping outdoors or indoors.

Yet there was little severe filarial disease in long-term residents, and the microfilaremia rate was stable at 10%. The average mosquito was carrying only 2.5 stage 3 larvae, so people were constantly exposed to sub-optimal doses of infective larvae, providing constant stimulation to the immune system. We concluded that most likely, immune tolerance prevented most larvae from completing their migration to the deep lymphatics, thus preventing patent infections and disease. The paper describing this study was used for a number of years by Eli Chernin at Harvard in his parasite epidemiology course. And Fred Bang finally forgave me and offered me a permanent position. This field

experience in Calcutta drove home to me the value of observing diseases in their natural settings, and the importance of the influence of human behavior on disease transmission dynamics.

After India, I joined Scott Halstead and Leon Rosen at the University of Hawaii to begin my dengue career, and was lucky enough to spend a good share of the next 4 years studying the re-emergence of epidemic dengue in the South Pacific Islands. We had developed the mosquito inoculation technique as a quantitative assay for dengue viruses and had great success in the Pacific. <sup>(25)</sup>

At that time, the mosquito inoculation technique and fluorescent antibody tests were considered new technology, and we were anxious to test them in Southeast Asia.

I took leave of absence from the University, joined the US Navy and went to work at NAMRU-2 in Jakarta, Indonesia, where with the support of Kurt Sorensen and David Dennis, I started the Virology Department at NAMRU-2. We developed the first effective virologic surveillance system for dengue/dengue hemorrhagic fever, better defined the spectrum of clinical illness associated

with dengue infection, and identified virus strain and serotype as being important risk factors in the pathogenesis of dengue hemorrhagic fever.<sup>(26, 29, 30)</sup>

I joined CDC in 1980 and convinced Tom Monath to send me to Puerto Rico to develop the dengue laboratory there. It was there that I was able to bring all of my field experience together and develop a laboratory-based surveillance system that really worked. It was also there that I was forced to begin to think like a real public health professional when I was asked by Walter Dowdle to develop a prevention and control program for dengue/DHF. The approach to surveillance, prevention and control that we developed in Puerto Rico in the 1980s,<sup>(31)</sup> is now the basis for the WHO Global Strategy for prevention and control of DHF.<sup>(32)</sup>

In 1989, they made me come home and I have been in Fort Collins since. I go into this brief review of my field experiences to illustrate that working in the field can be very rewarding scientifically as well as fun and exciting.

These are the experiences that allow one to understand the complexities of the diseases you are studying, and how human culture and behavior affect disease transmission. When you leave to go home, it is important to leave a

functional program that will continue in your absence. This approach builds capacity and partnerships that will pass the test of time.

Field work has many challenges. You learn many lessons that guide your research and your life. You learn early to not believe everything you see. An example of this was illustrated when John Cross was working out the natural history of *Capillaria philippinensis*, a new parasite he discovered that caused high morbidity and mortality in certain areas of the Philippines.<sup>(ref.)</sup> He and his team had been working in Northern Luzon and had surveyed a village. In examining the stools from a particular family, they found all seven to be positive for *C. philippinensis*. John was very concerned and returned immediately to the village, recommending hospitalization and treatment for the entire family. There was reluctance by the family, and after some persistent questioning by John, the father finally admitted that there had only been one stool, taken from his youngest daughter. It was a lot easier to divide the single stool and place a portion in the stool cartons for the other family members than to collect an individual stool from each. The take-home lesson here is that you always double check your results and follow up on any unusual findings. It is not uncommon for field workers to produce the results you want or expect.

Field work is certainly rewarding; it broadens your insight into the complexities of the disease you happen to be studying at the time. Professor Wally Peters who had 50 years' experience in the field in Africa, Asia and the Americas, told me, "the greatest fun is to be had by going into the field." He told me that he rather naively went off to Africa in the early 1950's "with a bucket of DDT in one hand and a bottle of chloroquine in the other to eradicate malaria." A few years later after living and working there, he was the first to tell WHO in Geneva "that it was not possible to eradicate malaria in holoendemic Africa with the means at our disposal."

Things haven't changed much in the 45 years since then, and I would urge the "Roll Back Malaria" program to learn from this lesson and to begin now to support research to develop alternative approaches to replace those methods that they are currently relying on. In other words, do not place all of your eggs in one basket. Professor Peters told me recently, "Duane, do your best to persuade the new generation of young men and women to go and learn about people and parasites in the tropics. That is where the action is."

There are those who argue that we already have programs in place to provide adequate field training for young scientists. The NIH has several programs



that provide support for short-term training in tropical countries. The International Collaboration in Infectious Disease Research (ICIDR) program is the best known, and currently, there are 18 grants awarded to investigators in 13 US universities working on a wide variety of tropical disease agents.<sup>(34)</sup> These grants are awarded for 5 years, but do not provide enough funds to develop and maintain a field station presence in the collaborating country. Training of American scientists, therefore, is usually based on short-term visits to the host country.

In addition to NIH, the Department of Defense (DOD) (both Army and Navy) have overseas research units in various parts of the world that may be, but are rarely used for long-term training of young civilian scientists. Finally, the Centers for Disease Control and Prevention (CDC) has a number of field stations that have been used for training. Internationally, the Wellcome Trust supports a number of field stations in tropical developing countries specifically to do research and train young scientists in tropical medicine. And France supports a number of overseas laboratories. The bottom line is that in the year 2001, it is difficult for a young American scientist to find an opportunity to have long-term training in a tropical field setting. The

American Society of Tropical Medicine and Hygiene should work hard to improve those opportunities.

I personally like the old ICMRT approach of establishing four or five field stations around the world. This program, through which I received my first real field experience at the Calcutta School of Tropical Medicine in India under the Johns Hopkins University grant, provided practical hands on field training in tropical medicine for many young scientists who went out on tours of 2 years or longer, to places like India, Pakistan, Colombia and Malaysia. These ICMRTs or something similar should be reactivated and funded by grants that would allow support of a field presence by a number of senior and junior staff members.

Other options include developing collaborative programs that would allow students and university staff to utilize the DOD and CDC overseas facilities to conduct research with government and local scientists in the countries where the field stations are located. I have had the privilege of working in all three of these institutions over the years, and learned a great deal from each.

Another option might be for this society to play a more active role in tropical medicine training; who knows better than the members of the American Society of Tropical Medicine and Hygiene where training priorities should be placed? With proper support, we could expand the Ben Kean and Centennial funds into programs that would support both short-term and long-term training.

Ideally, we should develop all of these programs; collectively they could provide opportunities for the training that will be required if we are to be successful in prevention and control of tropical diseases in the 21<sup>st</sup> century.

Programs such as these will also be critical in our efforts to guide the development, evaluate the efficacy and determine the most effective use of the new technology that will surely be developed.

There is currently a window of opportunity to support overseas training in tropical medicine that we haven't seen in over 40 years. The dramatic emergence/resurgence of tropical infectious diseases in the past 30 years underscores the ease with which pathogens can move between cities, states, countries and continents via today's modern transportation, and reinforces the urgent need to develop and implement new, sustainable prevention

strategies. At the beginning of the 21<sup>st</sup> century, infectious diseases, many of which were considered conquered 30 years ago, are responsible for approximately one third of global deaths each year.<sup>(35)</sup> In addition, these diseases inflict a tremendous economic burden on communities.<sup>(36, 37)</sup>

Paradoxically, this is occurring at a time when funding opportunities for tropical medicine and infectious diseases are at an all time high.

Governments, international funding agencies and private foundations are looking for good programs to fund.

We, as a society, must take advantage of this opportunity and develop programs that will insure adequate training for the next generation of tropical medicine specialists. Only with this kind of expertise, will we be able to develop the prevention programs that can reverse the trend of emergent/resurgent tropical infectious diseases in the 21<sup>st</sup> century.