OUTBREAK:

The Shifting Ecology of Infectious Disease

A PBS Documentary

&

Public Education Campaign

A Production of

After Image Media Productions

Michael Penland | Executive Producer | After Image Media Productions

162 Prospect Place, Brooklyn, NY 11238 • 718-230-4715/v 718-622-2509/f • mpenland.aimp@earthlink.net

"This current emerging threat is a wake-up call… [SARS] appears to be contagious with a high degree of efficiency in at least close quarters. It's emerging in a part of the world where there are great conditions of crowding and a great deal of international travel. And certainly it reminds us that we really do live in a global village and that an emerging problem in one corner of the world will soon be an emerging problem for all of us."

Julie Gerberding
Director of CDC
Press Briefing, March 27, 2003

"Most of the diseases that are in the book have either a vaccine or a drug, so we recommend a vaccine or a drug. This is the first time that we have recommended people avoid an area and this is of course because we do not understand the disease completely, because there's no vaccine and there's no drug."

David Heymann
Director of Communicable Diseases, WHO
Press Briefing, April 4, 2003

“While dramatic advances in science and medicine have enabled us to make great strides in our struggle to prevent and control infectious disease, we cannot fall prey to an illusory complacency. We must understand that pathogens - old and new - have ingenious ways of adapting to and breaching our armamentarium of defenses.

We have not done enough… we must recognize the need for a new level of attention, dedication, and sustained resources to ensure the health and safety of this nation - and of the world."

Microbial Threats to Health: Emergence Detection, and Response
Institute of Medicine Report, March 15, 2003

O U T B R E A K

The Shifting Ecology of Infectious Disease

Table of Contents

Project Description

OUTBREAK: The Shifting Ecology of Infectious Disease is a two-hour PBS science documentary special and broad public education campaign, which explores one of the greatest challenges we face as a species — the ongoing battle against infectious disease. SARS is a vivid example of how new ecological interactions can threaten global health. But it isn't the only example. Many other diseases have appeared or resurged in the last few decades, illustrating the complex relationships between global environmental conditions, human behavior, and pathogen evolution. *OUTBREAK* will demonstrate that our individual health is inextricably tied to the health of our communities, and that our communities are interlinked in a global ecosystem of disease.

Ecology will be the unifying concept that guides our storytelling because it offers a deep understanding of infectious disease. An ecological perspective helps to explain why epidemics rise and fall, why endemic diseases remain endemic, and why new diseases appear and old diseases resurge. It shows the importance of environmental stewardship, and what happens when it fails. Ecology also highlights important connections, such as the link between poverty and disease, the natural emergence of antibiotic and pesticide resistance, the critical role played by human behaviors in spreading infections, and why some of our public health efforts have succeeded while others have failed.

In an age of globalization, no place on the planet is remote, and no outbreak of infectious disease is truly isolated. The next epidemic could start with a virus carried by a passenger on an international flight, a fungus on an imported fruit, or a mosquito species expanding its habitat. We will likely have little warning, and may not even know when a new pathogen has arrived in our midst. HIV had been circulating in the human population, most likely for decades, before it was recognized as a pathogen, and by then AIDS was well on its way to becoming a global pandemic.

SARS as Prologue

A public health crisis is unfolding before our eyes.

The first reports last November were unremarkable. The scientists and doctors huddled together in the World Health Organization's war room on emerging infectious disease heard of an unexplained pneumonia that had struck a handful of people in Southern China. It appeared similar to many other unexplained disease they reviewed over the years, which after further investigation turned out to have unremarkable explanations – an alarming fever killing children in rural India is now thought to have been caused by pesticide poisoning; a mysteriously illness with high fatality striking the highlands of Madagasacar was later attributed to a common strain of influenza afflicting a malnourished population.

Reports continued to trickle in about the new pneumonia, but accurate information was lost in the fog of slow communications from a rural province, a poor public health infrastructure, and a central government reluctant to publicize a threatening new disease that could damage tourism and trade. It would be months before the world's top disease experts truly understood the threat that was emerging.

That all changed when a Chinese doctor -- who had been treating the sick in Guangdong and unknowingly contracted the disease -- traveled to Hong Kong. He inadvertently turned the 9th floor of the Metropole Hotel into a SARS hot zone, spreading it to at least 12 other guests. An American businessman then took it to Vietnam. A group of returning tourists spread the outbreak to Singapore. Others diffused it throughout Hong Kong. It took root in several hospitals, and local schools closed down indefinitely when a number of children became sick. The Amoy Gardens housing complex became a particularly ferocious epicenter where 268 residents contracted the disease.

On March 15th, the World Health Organization issued an international health alert, the first time in a decade; followed two weeks later by an unprecedented advisory against travel to the most heavily affected regions. Just days after SARS left China, it began to circle the globe via air travel, in one of the fastest disease spreads in history. It has now infected over 3,000 people, been responsible for 144 deaths, and has spread to 21 countries on five continents. "Since the discovery of the SARS cases, I feel very

worried,"said Chinese president Hu Jintao on April 14, commenting publicly for the first time. "I feel anxious for the masses."

No one can predict how high the count will go — will this outbreak be contained and retreat, or will it become the next global pandemic? That is the question on everyone's mind, as scientists scramble to unravel the mysteries surrounding SARS.

The international alarm over SARS derives from how little we know about the disease, and how quickly it has spread. It now appears to be caused by a coronavirus (a highly contagious virus family that produces the common cold in humans), but we know very little about this never-before–seen strain. Nothing in our drug armament has proven effective in helping the sick. It does not appear to be evolving away from virulence as it moves through the human population, as might be the case. And, most significantly, it is highly contagious in ways we do not fully understand. Some people appear to act as so called "super-spreaders," — in Singapore, one hospital patient is believed to have infected 100 people. Furthermore, some scientists speculate that there may also be some unknown environmental component which helps to amplify the disease, helping to explain its spectacular spread at the Amoy Gardens complex, and its rapid colonization of hospital wards.

The biggest and most enduring questions, however, are ecological. Where did this virus come from? Has it always existed, hidden in some remote ecosystem niche or did it newly mutate or jump from animals into humans for the first time? And why did it enter the human population now? Was there a shift in China's natural or manmade landscape exposing the first person — the index case that started the outbreak — to its natural habitat? If the current outbreak dies down, what are the chances that it will simply happen again, perhaps in the fall when most respiratory infections resurge?

When the natural history the SARS is finally unraveled, we will have a fascinating understanding of this unique ecological event. But SARS already confirms what we know: we ignore the threat posed by emerging disease, and the global changes that aid them, at our peril. SARS also reminds us, in the words of CDC director Dr. Gerberding, "that we really do live in a global village and that an emerging problem in one corner of the world will soon be an emerging problem for all of us."

The Ecology of Infectious Disease

From an ecological perspective, SARS is not a unique event. It is only the most recent in a long series of infectious diseases to enter the human population in the last few decades. Experts have long warned that a new influenza pandemic could appear and sweep across the globe — we would have no immune defense against such a strain, nor stockpiled vaccines. But influenza, with its roughly 30-year cycle between pandemic strains, is one of the only events we can anticipate. Most diseases have taken us by surprise.

World population growth, urbanization, and deteriorating environmental conditions have encouraged a host of pathogens to jump the species barrier from animals into humans. AIDS, Ebola, Nipah virus, Hantavirus in the Americas, and Lyme disease are all relatively new to the human population; SARS may turn out to be the latest to have made this leap. Other well-established pathogens are constantly mutating under ecological pressure, gaining or losing virulence along the way. Cholera, malaria, and tuberculosis are all resurging around the globe, dodging our defenses, and infecting new populations.

Our documentary will reveal that placing any disease in an ecological context provides a valuable framework for understanding why it erupts in a particular place at a specific moment in time. Nipah, for example, emerged recently in Malaysia when deforestation forced bats out of their natural habitat and into closer proximity with farm animals; pigs then contracted the virus and spread it to humans. Dengue, and the more deadly dengue hemorrhagic fever, have become global public health crises because the mosquito that transmits them (*Aedes aegypti)* is perfectly adapted to exploit the overcrowded and helter skelter growth of many urban centers in the developing world. And the origin of AIDS is most likely attributable to a deadly combination of hunting monkeys for "bush meat," a changing human sexual ecology, and unsafe medical practices.

But what escalates any one outbreak into a global pandemic? Historically, disease pathogens have expanded their geographic range until they have colonized to the environmental limits of their survival, aided largely by human travel and trade. Bubonic plague flowed out of Asia during the Middle Ages over new silk-trade routes to ravage an unprotected Europe. Cholera spanned out from the lower Ganges River where it was

endemic, first along Hindu pilgrimage highways throughout India, and later on newly introduced British trade and military networks, to make its way around the globe. European explorers brought smallpox to the Americas, decimating the Amerindian population. Yellow fever came to the Caribbean from Africa aboard slave ships.

In the modern era, pathogens are able to exploit a much more efficient mode of transportation: fast, inexpensive air travel. With thousands of flights taking off each day, in and out of even the most remote locales, it has become all too easy for a pathogen to hitch a ride, as West Nile most likely did en route to New York City, and as SARS did when it fanned out from Hong Kong.

An ecological view also reminds us that evolution is the driving force behind a shifting disease ecology. In the competition between pathogens and humans, we are at a distinct disadvantage. Pathogens propagate and mutate at an exponentially faster rate, often allowing them to outmaneuver modern medicine. The tuberculosis bacteria is just one of many pathogens that have evolved resistance to all of our first-line treatment drugs — the cheapest and most readily available — causing great unease in the medical community. Joshua Lederberg, the Nobel Laureate geneticist and microbiologist, has long warned that the biological "arms race" between humans and evolving microbes is the most significant threat we face.

The ecology of infectious disease has gained increased attention in the last two decades, because scientists better appreciate the threats posed by constantly evolving infectious pathogens across many different ecosystems: the global AIDS pandemic, recently complicated by anti-retroviral resistance and recombinant forms of HIV; the geographic expansion of mosquito-borne diseases like West Nile and dengue fever; the persistence of water and food-borne diseases; and the discovery of a growing number of infectious causes for chronic diseases. At the same time, we face the uncertain future of SARS, the likelihood of another global influenza pandemic, and the deeply unsettling prospect of bioterrorism.

In 1992, the Institute of Medicine issued their groundbreaking report, *Emerging Infections: Microbial Threats to Health in the United States*, written by Nobel Laureate microbiologist Joshua Lederberg and 19 of the nation's most prominent scientists and physicians. The report was a wake-up call to many in the scientific and public health communities because it offered the first comprehensive view of the threats posed by emerging and resurging infectious diseases. The Central Intelligence Agency introduced

a national security perspective in their January 2000 report, *The Global Infectious Disease Threat and Its Implications for the United States.* And the foreign policy implications were highlighted last year by *Why Health Is Important to U.S. Foreign Policy,* published by the Council on Foreign Relations and the Milbank Memorial Fund. In March 2003, the Institute of Medicine released an update of its original report, calling for enhanced global surveillance and faster international response capacity. Also in 2003, the Rand Corporation issued *The Global Threat of New and Reemerging Infectious Diseases: Reconciling U.S. National Security and Public Health Policy.* ‡

OUTBREAK will build on these reports by offering in-depth, scientifically rigorous, character-driven stories told through the voices of contemporary scientists working on the frontlines of public health worldwide. Our audience will be guided through both historical and contemporary disease investigations, the natural history of microbial pathogens, our versatile and vulnerable immune system, and the public health technologies we have employed to understand and curb infectious disease.

A hallmark of this series will be case studies, each an intriguing scientific detective story, with SARS as the lead mystery. The cast of characters will include stealthy microscopic villains (infiltrating the human population and dodging our immune systems); innocent victims (often infected through some unknown route of exposure); and intrepid scientist-sleuths (employing high-tech, microbial crime labs to investigate the mysterious and invisible world that causes human illness and death).

OUTBREAK will be an unprecedented television event of great consequence. It will illuminate the science behind the headlines, helping our viewers understand human health in a larger, ecological context. This literacy will result in a broad and well-informed public discourse on scientific and health-related policy issues. *OUTBREAK* will bring the intrigue of scientific inquiry into the living rooms and classrooms of millions of people, engaging viewers in an epic biological story that is compelling, exciting and unforgettable.

** Statistics in this treatment are accurate as of its writing, but they are in constant flux.

‡
The Global Infectious Disease Threat and Its Implications for the United States
Central Intelligence Agency, January 2000.
http://www.cia.gov/cia/publications/nie/report/nie99-17d.html

Why Health Is Important to U.S. Foreign Policy
Council on Foreign Relations and the Milbank Memorial Fund, May 2001.
http://www.milbank.org/reports/Foreignpolicy.html

Microbial Threats to Health: Emergence, Detection, and Response
Institute of Medicine, March 2003.
http://www.nap.edu/books/030908864X/html/

The Global Threat of New and Reemerging Infectious Diseases: Reconciling U.S. National Security and Public Health Policy
Rand, 2003.
http://www.rand.org/publications/MR/MR1602/index.html

Public Health and Science Themes

OUTBREAK: The Shifting Ecology of Infectious Disease will offer an in-depth exploration of a number of broad public health and science themes that will shape both the television program and its educational outreach components. These themes will emerge naturally from the case studies we present, highlighting the complex, overlapping factors that produce infectious disease, and help to make connections for our non-scientific audience that will resonate long after the series has aired. These public health and science themes will be articulate with the help of both our formal and informal advisors, providing important roadmaps to an understanding of the ecology of infectious disease.

The *OUTBREAK* themes might include:

An Ecological Perspective

Biological Evolution

A Global Perspective

Environmental Change

Antibiotic Resistance

Human Immune System

Poverty as an Amplifier of Disease

Bioterrorism

An Ecological Perspective

Ecology is a powerful idea, a unifying concept that helps clarify the organization of natural systems and the interdependence of organisms. The history of infectious disease research over the last 150 years, discovery upon discovery, has brought a growing awareness of how ecological interactions dictate the rise and fall of disease in human populations. It has highlighted the central roles played by evolution, change and

equilibrium, and diversity and biocomplexity in shaping human infectious disease. Ecology helps to explain why a pathogen inactive in humans for many years may suddenly cause an epidemic; why some microbes evolve increased or decreased virulence; how viruses and bacteria share genetic factors for antibiotic resistance; and why some viruses respond to vaccines while others do not. Our greatest public health successes, as well as our most tragic failures, have hinged on an understanding of ecology and our ability to alter it.

The natural history of any infectious disease can only be understood by examining the ecosystems in which it thrives. These ecosystems are complex and frequently overlapping. They can range as broadly as from a suburban backyard in Connecticut to a tropical jungle along the Ebola River in Zaire, to a fast food restaurant in Washington State, and to a chicken farm in China. Each of these habitats combines natural and built elements working in intricate relationships with human behavior. And these ecosystems are far from static: rather, they are dynamically changing, presenting an evolving set of natural history mysteries to be solved in order to advance public health. The forthcoming Institute of Medicine report will highlight how changing ecological conditions have caused the emergence and resurgence of infectious disease.

Deciphering disease ecosystems has required scientists to adopt investigative approaches utilizing varying perspectives and scales. Thus, a global view must encompass factors such as ever-increasing travel and trade, deteriorating ocean quality, and changing climate patterns. A regional perspective must consider population growth and urbanization, sanitation and clean water, mega-agribusiness, and war and natural disasters. And a microscopic scale must be used to comprehend pathogen evolution, vector ecology, and the human immune system. Our audience will come to appreciate that infectious disease can only be understood by considering interactions within, and between, these various perspectives.

Biological Evolution

Evolution is the driving force in the ecology of infectious disease. Pathogens and their hosts follow the rules for adaptation and survival first observed by Charles Darwin. Thus, viruses and bacteria will evolve to reduce environmental stress caused by our control measures, exploit new biological opportunities presented by human behaviors, and develop toxins that make them stronger microbial competitors. Humans

are also evolving and adapting, and this history is written in our genomes and the memories of our immune systems. But microbes have a distinct advantage: these simple, parasitic organisms reproduce at an exponentially faster rate than their human hosts.

The remarkable resilience of these pathogens has meant that human disease is a constantly shifting adversary. These microbes have acquired ingenious ways of infecting the human body, sometimes jumping a species barrier to get there. They have evolved new strategies to spread from human to human, and new capabilities to dodge our immune defenses. Pathogens have adapted to survive in a wide range of climatic conditions, found new ways of traveling around the globe, and gained greater virulence when it is beneficial to their propagation. Some pathogens, like the influenza and AIDS viruses, have made an evolutionary specialty of rapid evolution. We are often caught in a desperate game of catch up, blindly ignorant in the face of new disease outbreaks. Joshua Lederberg, the Nobel Laureate geneticist and microbiologist, has long warned that the biological "arms race" posed by microbial evolution is the most significant threat that we face as a species.

A Global Perspective

OUTBREAK will emphasize the global ecology of infectious disease, and thus underscore the need for a truly global public health response. Historically, disease pathogens have expanded their geographic range until they have colonized to their environmental limits of survival, thanks largely to human travel and trade. Bubonic plague flowed out of Asia during the Middle Ages over new silk-trade routes to ravage an unprotected Europe. Cholera spanned out from the lower Ganges River where it was endemic, first along Hindu pilgrimage highways throughout India, and later on newly introduced British trade and military networks, to make its way around the globe. European explorers brought smallpox to the Americas, decimating the Amerindian population. Yellow fever came to the Caribbean from Africa aboard slave ships.

The seventh global cholera pandemic began when the newly mutated El Tor strain emerged in Indonesia in 1961. This strain is uniquely well adapted for ocean survival, and it completed its circumnavigation of the globe when a ship took on ballast water in Asia and then discharged it off the coast of Peru in 1991. Latin America had not seen cholera for a century, but the disease quickly spread to 16 countries, causing millions of infections and hundreds of thousands of deaths. Public health officials are

concerned because El Tor has not receded, as in past pandemics, but has remained endemic in many countries. Now, a mutation of the El Tor strain has produced the even more virulent Bengal strain (prior cholera exposure provides no immunity), which has appeared in 11 south Asian countries. It is not yet clear whether this strain will produce the next global pandemic.

Today, the globalization of disease is accelerated by jet travel and an ever-expanding volume of international trade. SARS is a perfect example. What started as a small outbreak in the Guangdong Province of southern China exploded when world travelers shared a Hong Kong hotel with an infected man and then returned to their respective countries. AIDS spread in a similar manner, appearing simultaneously in the U.S. and Europe after probably decades of sporadic and unrecognized transmissions in Africa. Drug resistant strains of staphylococcus bacteria have now circled the globe, sometimes picking up greater resistance at each stop.

Like airplanes, mosquitoes and other vectors help pathogens exploit new ground. Asian Tiger mosquitoes, carriers of dengue fever and other diseases, invaded Texas in a shipment of used tires and have now spread to 26 states. A simian strain of Ebola arrived in the Washington, D.C. area in a shipment of research monkeys from Asia. Over the last decade, malaria has been spread by local mosquitoes in the U.S. 17 times, most recently in Virginia and on Long Island. West Nile encephalitis appeared sporadically throughout the world before arriving in New York City in 1999. It has now reached 39 states and Canada, infecting numerous animals, including more than 100 species of birds; as well as horses, dogs, cats, and, most recently, alligators.

Biotechnology advances in the last decade, particularly the ability to track pathogens as they mutate and adapt, have allowed scientists a sobering glimpse of these global trends. The implications for public health have been wide-ranging, as we better understand the ecology of infectious disease.

Environmental Change

OUTBREAK will examine the extraordinary environmental upheaval we are experiencing at the dawn of the 21st century and consider how it may be altering disease patterns. Disease ecosystems are so complex that it would be surprising if they were *not* disrupted by environmental shifts. Recent scientific evidence suggests that a number of

environmental factors cause infectious diseases to emerge, resurge, and be redistributed worldwide.

It is believed that malaria-carrying mosquitoes could increase their range from 45% coverage of the planet to 60% if global temperatures rise by three degrees. In 1993, a heavy El Niño rain in the American Southwest produced a bumper yield of piñon nuts, and the disease-carrying rodents that feed on them, leading to a deadly outbreak of Hantavirus. The regrowth of forests in suburban Connecticut allowed deer populations to explode, and offered a foothold to the ticks that spread Lyme disease. Large hydroelectric dams have altered local environments in some developing countries to give rise to both schistosomiasis and Rift Valley fever.

In 1970s and 80s, researchers began to change their thinking about the world's oceans, and now better appreciate how deteriorating conditions may spread human disease. This new view posits that warming and increasingly polluted oceans act as reservoirs and transporters of infectious bacteria and viruses, and may play a critical role in their genetic swapping and mutation. For example, evidence now suggests that pollution gave rise to increased algae blooms, which were exploited by the El Tor strain of cholera, hastening its spread.

Even war and natural disasters can amplify infectious disease. The plague outbreak following the 1906 San Francisco earthquake is an often-cited historical example. More recently, when Hurricane Mitch ravaged Central America in 1998, fatal outbreaks of cholera and dengue fever spread in its wake, as did respiratory and intestinal ailments. On the African continent, war and famine have greatly accelerated the spread of disease. During the Rwandan civil war, tens of thousands of children died of Shigella dysentery, and 250 people a day died in refugee camps in the worst outbreak of cholera in recent memory. The AIDS virus found the perfect ecosystem in which to propagate when guerilla warfare, tribal conflicts and social strife battered East and Central Africa in the early 1970s.

Antibiotic Resistance

The development of antibiotics was one of the greatest revolutions in public health, and *OUTBREAK* will recount this scientific milestone. Few people remember a time when a child could die from a cut finger, or the terrible toll that infections took during war. Modern surgery and many other medical procedures would be

unimaginable without antibiotics. However, from an ecological perspective, it was inevitable that the "magic bullets" of the antibiotic revolution would gain only a short-term advantage.

Antibiotic resistance exemplifies the evolutionary challenges facing public health today. The ecology of infectious disease is a biological competition between pathogens and their hosts, the outcome of which is far from certain. The relatively recent discovery that bacteria can share antibiotic resistance and pathogenic traits through the transfer of plasmids and "jumping genes" alarmed many in the biomedical community. Bacteria have done this with remarkable efficiency, producing a global pool of virtually unstoppable pathogens. In 1952, for example, 100% of staphylococcus bacteria were vulnerable to penicillin. By 1982, 90% of clinical staph infections were penicillin-resistant. Some staph strains have emerged with multiple resistance; one found in Australia was unchallenged by 31 different drugs. These lethal "super bugs" were once limited to the closed ecosystems of hospitals and their often immune-suppressed patients, but they are now spreading to the general population. Increasingly, our last defensive line in terms of effective antibiotic drugs is being threatened by pathogen evolution.

This pattern of adaptation is being replicated across many diverse ecosystems of disease. Multiple-drug resistant TB is now an alarming global concern. Malaria was once easily treatable, but resistance to anti-malarials has reversed that. Mosquitoes have also developed resistance to once-lethal pesticides, eroding the enormous gains previously made against not only malaria, but also yellow fever and dengue fever. In the relatively brief span of the AIDS epidemic, HIV has already developed resistance to some of the most effective anti-retroviral drugs.

As recently as the 1970s, the public health and medical communities professed confidence in having largely won the battle against infectious disease. A deeper scientific understanding now prevails, acknowledging that human infectious disease is a constantly changing and extremely challenging landscape. To defend the public's health, new technologies must continuously be developed to overcome the evolutionary hurdles posed by the microbes with which we share the planet.

Human Immune System

The human immune system, of course, is also an ecology. *OUTBREAK* will use elegant computer animation to bring it to life, explaining how it has been shaped over

evolutionary time through constant assaults by pathogens. This cellular battle has produced the enormous versatility of the immune system, making it the second-most complex system in the human body (after the nervous system). It can detect and destroy millions of foreign pathogens, many of which it has never before encountered. At the same time, immune response varies greatly from person to person – in fact, this is one measure of our genetic strength as a species.

The immune system, as our primary defense against pathogenic microbes, is under attack as never before. HIV/AIDS is a unique assault in the history of the human species. Each emerging disease presents a new battleground on which the immune system must fight. At the same time, many factors can suppress immune response, including malnutrition, pregnancy, anti-cancer and transplant drugs, and the burden of multiple infections. For decades, antibiotic drugs have been our strongest ally against disease, and now even that is threatened.

Poverty as an Amplifier of Disease

Wealth does not assure good health, but poverty almost always brings disease. New evidence suggests just how devastating an endemic disease like malaria can be on national development. There is probably no factor that correlates more closely with good health than does economic development, and this is as true in the United States as it is in Ethiopia, China, or Russia. This fundamental relationship will be explored throughout *OUTBREAK*, and it will be put in sharp relief by case studies from around the globe. The American public often takes our own tremendous advances in public health for granted – whether sanitation infrastructure, childhood immunizations, or simply mosquito-proof window screens. A global perspective on infectious disease is not complete without appreciating the economic basis of the developed world's public health achievements.

OUTBREAK will examine poverty as an amplifier of disease because it has a multidimensional impact on the ecological interaction of humans and their pathogens. Inadequate sanitation is the single biggest cause of poor health: fully one fifth of the world's population lacks clean water. But there are many other contributing factors, including deficient nutrition, population overcrowding, an overexploited environment, and the compounding effect of carrying many pathogens simultaneously. Basic infrastructure failings also play an important role, such as poorly trained medical

personnel, unsafe blood supplies, lack of sanitary hypodermic syringes; and even poor transportation, communication, and education can erode public health.

Bioterrorism

The anthrax attacks of 2001 revealed that Americans are relatively unaware of the true risks of bioterrorism. An environment of sensational headlines and heightened fears undercuts the effectiveness of the public health defenses we have in place. However, that experience also demonstrated that our scientific understanding of infectious pathogens needs to continually evolve. One of the most disturbing aspects of bioterrorism is that we may not know when we are under attack. Biological agents can easily slip under our public health radar. How can we detect the spread of an infectious agent when it is dispersed through a municipal water supply, the plume of crop duster, or even along the route of a letter dropped in the mail? By the time we do recognize an attack, the pathogen may be ecologically entrenched and difficult, if not impossible, to eradicate.

Despite the inherent unpredictability of bioterrorism, and the potential for broad exposure, the basis for detection and control remain the same as in any other outbreak – good science. Preparedness is grounded in an ecological understanding of infectious pathogens, and a public health infrastructure with adequate resources to meet any potential threat. *OUTBREAK* will examine the threat of bioterrorism within the larger ecology of infectious disease. By doing so, our audience will be better able to understand the real risks of bioterrorism, and how to combat them.

Program Rationale

There is a critical need for *OUTBREAK* today as SARS has terrified many around the globe. We now know that an airplane with a single infected passenger can spark a public health emergency. Newspaper headlines count the sick and dying. Panic and backlash could be just around the corner, threatening both public health and economic stability. Against this backdrop of public alarm, *OUTBREAK* will offer an important antidote: a thoughtful, scientific understanding that will lay the groundwork for public discourse about the real risks of infectious disease and the most prudent responses.

An informed public has always been one of the most powerful weapons in the public health arsenal. This is particularly true when a controversial disease prevention program must overcome moral, cultural, and political obstacles. Ignorance and fear played critical roles in amplifying the early AIDS epidemic in this country, and this pattern is being repeated around the world, with India and China now sitting on the precipice. Our leaders need broad public support when making tough public health decisions that require the expenditure of economic and political capital. Without this support, health initiatives wane, creating an ever-worsening cycle of disease.

The United States currently spends over 14 percent of its total national budget on medicine, but only one to two percent of that on public health. A recent poll found that only 10% of Americans understood the concept of public health. Yet the need for greater vigilance is high. Prior to the 1999 outbreak of West Nile virus in New York, the city had let both its disease surveillance and mosquito control programs lapse. In 1989, Ebola arrived in Reston, Virginia in a shipment of research monkeys — this particular strain turned out not to cause illness in those humans who were exposed, but it could easily have been different. And bioterrorism presents an ecological wildcard of unimaginable consequence.

Many scientists and public health officials have sounded an alarm over the hazard of newly emerging diseases, and the need for a robust international early warning and response system. The Federation of American Scientists, World Health Organization, World Bank, Centers for Disease Control and Prevention, National Institutes of Health, and Institute of Medicine have all called for greatly increased vigilance against emerging and resurging

diseases. *OUTBREAK* will support this effort by driving home the global interconnectedness of public health, and encouraging a long-range, ecological perspective. SARS demonstrates how far we have come — quickly instituting health and travel advisories, and apparently containing the disease in a number of cities — but it also shows how far we have to go.

The mainstream media generally does a superficial job of covering human disease, and rarely examines the underlying science. The popular science media does better, but generally focuses on the latest medical advances or on new epidemics. *OUTBREAK* offers a rare opportunity to present the scientific foundation of public health, and the natural history of infectious disease. By placing human disease within the broader biological context of evolution, viewers will be left with a deep understanding of our role in the natural world, a world we forever share with pathogens.

From a historical perspective, SARS could not have arrived at a better time. The international scientific community has launched an unprecedented collaborative effort to investigate this disease, and they are using tools on the cutting edge of the biotechnology revolution. Astonishing progress has already been made. A suspect pathogen has been identified, and is now being confirmed. Its genome has been sequenced in record time, which will provide many answers, and has already raised more questions. Field diagnostic kits are being developed. And plans are now being laid for a fast track vaccine development program. Our cameras will record this urgent scientific endeavor, and it will make an exciting story. But it will also provide an invaluable scientific education, preparing our audience to be informed participants in the many policy debates we will face as we enter the "biological century."

Public health is one of the most important issues of our time, because it determines the quality of our lives and the strength of our civilization — yet it is little understood by the general public. *OUTBREAK* will correct this shortcoming by bringing the science and practice of public health to life for viewers across the nation.

Project Status

After Image Media Productions is uniquely positioned to move on this story immediately. For the past year we've been developing and researching *OUTBREAK: The Shifting Ecology of Infections Disease*, a PBS science documentary, with a $94,000 development grant from the Rockefeller Foundation. We have now turned our attention to the SARS outbreak because it so dramatically illustrates the kinds of ecological interactions that affect all diseases, and the unique threats posed by newly emerging pathogens.

Our long list of formal and informal scientific advisors, and our extensive contacts in the international public health community, allow us to bring unique insight to this breaking story. We have a working relationship with infectious disease scientists around the globe, including the CDC, NIH, and WHO, and many of the research centers now investigating the SARS outbreak. David Heymann, director of communicable diseases at WHO, is an observer to our board of science advisors, and we are working closely with his staff.

Given the urgency of the SARS story, and that many scientists believe it may resurge in the fall (as do most respiratory diseases), there is great urgency to shoot this unfolding science mystery story. Filming will begin as soon as initial funds are received, and we will take our viewers straight to the frontlines: to the hospitals now caring for SARS patients, to the labs where scientists are racing to find drugs and a vaccine, and into the field with epidemiologists as they explore the now infamous Metropole Hotel or Amoy Gardens apartment complex. This SARS drama will then be placed within a more expansive view of the ecology of infectious disease.

Project Personnel

Michael Penland — Executive Producer
After Image Media Productions

Michael Penland brings 20 years of documentary production experience to leading the *SARS: The Next Global Pandemic?* team. He has nurtured a long-standing interest in public health and infectious disease into a insightful ecological story that will appeal to a broad audience. All of his projects are grounded in dramatic storytelling, compelling interviews, and a vivid visual language. He is also dedicated to extending the reach of his documentaries through diverse educational materials.

Michael has produced, directed, and written a wide range of award-winning programming for network, PBS, and cable television. He has made innovative documentaries on scientific, health, social, cultural, and political topics, commended for bringing a fresh perspective to national issues. His recent credits include: *A World of Their Own: The Teenage Brain,* from PBS's *The Secret Life of the Brain* series, which explored recent advances of our understanding of the human brain; *Consuming Passions,* a one-hour show in a PBS series on the social history of the automobile; *Heaven and Earth,* part of Peter Jennings' *The Century series,* which told the heroic story of the Apollo moonmission; *American Dreaming,* a prize-winning documentary on the rebirth of Atlantic City and the social costs of casino gambling. Michael helped shape *Edgewise,* John Hockenberry's weekly political and cultural program on MSNBC, and he was a staff producer and director for many years at *Day1One,* the ABC News magazine show. He also produced for *The AIDS Quarterly and Health Quarterly* programs for WGBH in Boston.

Terry Rockefeller — Consulting Executive Producer

Terry Rockefeller has a long history of public television producing, series management, and fund raising. She began her producing career at NOVA, PBS's preeminent science series. She then moved onto a number of high-profile, special-event science series, including *The Strangeness of Nature* with Lewis Thomas, *The Ring of Truth* with physicist Philip Morrison, and the acclaimed anthropology series, *Odyssey*. More

recently, Terry has been both a producer and executive producer at the award-winning production company, Blackside, where she developed PBS science, history, and religion series. While at Blackside, Terry was one of the producers on *Eyes on the Prize*, the landmark series on the Civil Rights movement.

Terry has also been working with John Marshall, one of the founding fathers of ethnographic documentary filmmaking, to bring his life's work with the !Kung San hunter-gatherers of the African Kalahari to PBS as a new series.

- **Cassi Feldman Researcher and writer**

Cassi Feldman is an experienced reporter and editor, for both print and the Web. At the *San Francisco Bay Guardian,* she covered a wide range of issues, including housing, homelessness, and welfare. She brought new insight and clarity to these contentious topics, making them accessible to a broad readership. In 2001, she won top honors from the prestigious Peninsula Press Club for her investigative report on tenant empowerment in public housing. Prior to her work at the *Bay Guardian,* Cassi served as managing editor of *SF Station*, a cutting-edge Web site that helped create an online identity for San Francisco, and worked as a freelancer for a variety of publications. As a longtime volunteer with Birch Services and Sunburst Projects, she has provided support and counseling to families living with HIV / AIDS.

Cassi eagerly joined the *OUTBREAK* project as researcher and writer to apply her journalistic skills and creative vision to the complex, multifaceted issues surrounding the ecology of infectious disease.

Science Advisory Board

- **Dr. Barry Bloom**
  Dean, Harvard School of Public Health
  Co-chair, Institute of Medicine's Board on International Health
  Co-chair, International Vaccine Institute's board of trustees
  Chair, Immunology of Tuberculosis Steering Committee, WHO

- **Dr. Ruth Berkelman**
  Professor, Dept. of Epidemiology, Rollins School of Public Health, Emory University
  Former Senior Advisor to the director of the CDC
  Former Deputy Director, National Center for Infectious Diseases, CDC
  Former Director of the Division of Surveillance and Epidemiologic Studies, CDC
  Retired Assistant Surgeon General, U.S. Public Health Service

- **Dr. Rob DeSalle**
  Associate Curator, American Museum of Natural History
  Curator of the *Epidemic*! exhibit, and editor of the companion book
  Co-director, Molecular Laboratories, American Museum of Natural History

- **Dr. Andrew Dobson**
  Professor, Department of Ecology and Evolutionary Biology, Princeton Univ.
  Adjunct Professor, Woodrow Wilson School of Public Policy, Princeton Univ.
  Aldo Leopold Leadership Fellow
  Author, *Infectious Diseases in Natural Populations* (with Bryan Grenfell)
  Past Editor, *Biological Conservation*
  Editorial Board, *Trends in Ecology and Evolution, Natural Resource Management* and *Journal of Helminthology*

- **Dr. Margaret Hamburg**
  Vice President for Biological Weapons, Nuclear Threat initiative
  Former Assistant Secretary for Planning and Evaluation,
  U.S. Department of Health and Human Services
  Former Commissioner of Health, City of New York
  Former Assistant Director, NIAID, National Institutes of Health
  Member of the Institute of Medicine, the NY Academy of Medicine, the Council on Foreign Relations, and a fellow for the Amer. Assoc. of the Advancement of Science

- **Dr. D.A. Henderson**
  Principal Science Advisor, Office of Public Health Emergency Preparedness,
  U.S. Department of Health and Human Services
  Former Dean, Johns Hopkins School of Public Health
  Former Associate Director, White House Office of Science & Tech. Policy
  Former Director, WHO Smallpox Eradication Campaign

- **Dr. David Rosner**
  Professor of History and Public Health, Columbia University
  Director, Center for the History and Ethics of Public Health and Medicine,
  Mailman School of Public Health, Columbia University

- **Dr. Andrew Spielman**
  Director, Laboratory of Public Health Entomology, Harvard School of Public Health
  Director, Malaria and Human Affairs Program, Center for International Development,
  Harvard University
  Author, *Mosquito: A Natural History of Our Most Persistent and Deadly Foe*
  (with Michael D'Antonio)

- **Dr. Jack Woodall**
  Director, Nucleus for Investigating Emerging Infectious Diseases,
  Dept. of Medical Biochemistry, Institute of Biomedical Sciences,
  Federal University of Rio de Janeiro, Brazil
  Founder and Member, Policy Committee of ProMED-mail
  Former Director, New York State Health Department's Arbovirus Laboratory

Advisory Board Observers

- **Dr. David Heymann**
  Executive Director, Communicable Diseases,
  World Health Organization
  Former Chief of Research Activities, WHO Global Programme on AIDS
  Former Medical Epidemiologist, U.S. Centers for Disease Control and Prevention
  Former Medical Officer, WHO Smallpox Eradication Campaign