New and Emerging Infections: Catalysts for Change in Public Health

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From the mid-point of the 20th century, the focus of interest in public health progressively shifted from concerns about the infectious diseases and sanitation to chronic diseases – primarily cancer and heart disease – and the exploration of alternative systems for health care. The reasons for this are understandable. During the 1950s to 1970s, many infectious diseases, at least in the industrialized world, declined sharply or even disappeared. The causes were several – new vaccines and antibiotics, improved nutrition and housing, better sanitation and health care. Optimism, at least in some quarters, was unbridled. In fact, Sir Macfarlane Burnet, the Australian Nobel Laureate stated: *"One can think of the middle of the 20th century as the end of one of the most important social revolutions in history, the virtual elimination of the infectious diseases as a significant factor in social life."* Although we knew that progress in the developing countries was modest, at best, resources for research and education in the infectious diseases steadily eroded.

In 1981, however, a small dark cloud appeared on the horizon in the form of the first cases of AIDS and by April 1984, the responsible virus was identified. The U.S. Secretary of Health and Human Services proclaimed this to have been "the triumph of science over a dread disease" and predicted confidently that a vaccine would be available in two years. Time passed and the unwarranted hubris among researchers and politicians began to ebb. Now, some 20 years later, a world-wide pandemic is in progress; AIDS is the fourth leading cause of death world-wide; there is no vaccine in sight and the quest for a curative drug still continues.

Other microbial agents have appeared: SARS from Asia; transmissable spongioform encephalitis ("mad cow disease") from England; H5N1 influenza from Asia; monkeypox from Africa. Indeed some 30 new or emergent agents have been identified during the past 25 years. Increasingly, we are coming to appreciate that there are countless microbial agents, known and unknown, constantly evolving and adapting themselves to new hosts and, more readily than ever, being transmitted across the world. At the same time, it has been recognized that there is a markedly increased risk of microbial agents being used as weapons of terrorism. The microbial threat was aptly characterized by Dr. Joshua Lederberg, formerly President of Rockefeller University and a Nobel Laureate, in solemnly pointing out that man's only competitors for the dominion of the planet are the viruses and that the ultimate outcome of that competition is not foreordained.

Why is the threat becoming apparent at this time? Few, today, appreciate the profound and increasingly rapid societal changes that are taking place across the world. Four are of particular significance. The growth in urban populations is staggering. Fifty

years ago, there were only two cities with a population greater than 5 million persons – New York and London. Today, there are 20 with populations larger than 10 million and 6 that have more than 15 million. Many of these cities are in tropical and subtropical regions where crowding is most severe, malnutrition is common and sanitation is minimal – a fertile soil for a mutant organism to gain a foothold and to be transmitted. Second is the logarithmic growth in international travel – 18 million commercial flights each year carrying 1,600 million passengers, some coming from the most remote parts of the world. No town on earth is more than 36 hours from any other town, well less than the incubation period of most infectious diseases. Third is the fact that we are witnessing an unprecedented growth in hospitals and health care facilities everywhere. Although this could bode well for better health, many of these facilities have limited equipment and trained personnel; provisions for sterilization are often limited; and cross-contamination is not uncommon. Thus, many, unfortunately, serve as a focal point for transmission of blood-borne disease and antibiotic resistant organisms. Finally, foods of all types are moving across the globe in unprecedented quantities, sometimes carrying with them, microbes of many types. An internationalized food supply is not an unmitigated advantage. At the same time, food production and processing has been moved from small farms and animal herds to enormous farms, large herds of animals and food processed in factories of a size, hitherto unknown. With these developments has come the possibility of contamination and spread of disease across large areas and to large populations.

A further threat has emerged over the past decade – the possible use of microbes as biological weapons. This was a threat that was essentially ignored until the mid 1990s in the belief by many that it was so difficult to grow and disseminate highly virulent organisms that none would try to do so and, in any case, biological organisms had seldom been used by nation states in warfare. However, as rapid advances began to be made in biotechnology, the capacity and expertise for producing potential weapons became ever more widely available and potentially possible in laboratories around the world. A watershed event was the discovery in 1995 that a little-known religious cult in Japan had produced and endeavored to disseminate both anthrax organisms and botulinum toxin throughout Tokyo and were planning to acquire Ebola virus so as to be able to disseminate it in an aerosol spray. Meanwhile, the cult released sarin gas in the Tokyo subway inflicting many casualties.

An equally disturbing revelation was made in the 1990s by the former Deputy Director of a hitherto unknown USSR bioweapons program after he had defected. Prior to his revelations, it had been thought that, since 1973, as a result of the Biological Weapons Convention, all countries had ceased research and production of biological weapons. He brought the alarming news that the Soviet Union had had a biological weapons program, that employed some 60,000 persons at 50 laboratories. It was, in fact, as large as the Soviet nuclear weapons program. The weaponization and production of large quantities of smallpox virus were an important part of this effort. Subsequent to the Russian economic crisis, support to the laboratories sharply diminished and many scientists left to take positions elsewhere in Russia and the rest of the world, bearing with them, knowledge of biological weapons.

In our own country a 2000 review of programs needed to deal with disease outbreaks of any substantial size, especially those involving large numbers of patients, revealed that few municipalities, states or countries were at all well-prepared. The potential release of biological weapons was a real concern but the SARS outbreaks served to illustrate the fact that Mother Nature herself could potentially precipitate no less a major human infectious disease catastrophe even in this present era. If complacency prevailed briefly as the SARS threat receded, we now have the even more ominous challenge posed by H5N1 influenza and its potential for pandemic spread and casualties that could rival or exceed in number the 1918 outbreaks when tens of millions died world-wide.

Given the diverse possible array of agents that could conceivably result in large enough numbers of cases to threaten civil integrity, it is impossible to be fully prepared to deal with each. However, there are basic preparations that can be made that would be relevant to threats, whatever their origin. Of principal importance is the need to greatly heighten the level of public health and emergency preparedness and a special program with this in mind was initiated in the United States four years ago. This is a complex and long-term task and, as evidenced this month in New Orleans, it is clear that our own country has a very great deal yet to be done. The essence of such a program is based on the development of mechanisms for rapid detection of a problem and its immediate investigation and characterization by public health teams, diagnosis by experts and requisite laboratories, plans to respond with large scale deployment of vaccines or antibiotics and well-defined plans to provide medical care for much larger numbers of patients than are normally accommodated.

To effect an operable plan requires participation of a diverse array of different groups including health care workers, hospitals, voluntary organizations such as the Red Cross and Red Crescent, law enforcement to assure order, methods of transportation for patients and refugees, methods for essential communication among the principal participants and with the general public. Who should lead such an effort whose principal objective is the prevention and alleviation of human suffering? In an earlier era, the public health department was usually expected to take a predominant role in orchestrating the diverse organizations and talents necessary to meet the challenge. However, in our own country and I know in many others, public health departments have diminished in size and expertise; many now lack skills in epidemiology and management; and surveillance systems that might detect problems have languished.

Change is needed in the perception of and respect for public health. Today, an important opportunity is offered for public health to reaffirm its role and to take a lead in fostering the needed community and national programs for emergency preparedness measures for public health and medicine. Regrettably, Schools of Public Health, as a whole, have not been distinguished for their leadership in policy development, in research and in needed public advocacy. And this, I would note, is from the perspective of one who has spent 14 years as a Dean of a School of Public Health and, who, more recently, has been involved at the highest level of government in endeavoring to initiate national

and local programs of public health preparedness. It seems to me that there is not only a need but an important opportunity for a fuller mature development of Schools of Public Health that are professional schools; that work closely with those who are dealing with real world problems; that are truly dedicated to educating tomorrow's professional leaders in public health; that undertake research to bridge the now cavernous gaps between basic research and its application; and that define and actively advocate for needed public policy. The need is international.

A final caution is in order and, for this, I quote from a statement published two years ago by the U.S. Institute of Medicine – as you know, one of our National Academies of Science:.

> *"Today's world is truly a global village, characterized by growing concentrations of people in huge cities, increasing global commerce and travel...One can safely predict that infectious diseases will continue to emerge...Depending on present policies and actions, this situation could lead to a catastrophic storm of microbial threats."*

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1984 confluence

- *Man's only competitors for the dominion of the planet are the viruses – and the ultimate outcome is not foreordained.*

Joshua Lederberg
Nobel Laureate, USA

The competitors are increasing

- New and emerging infections have been increasing in number
- The sources of the threat:
  - Natural mutation of microbes
  - Emergence of organisms from remote areas
  - Biological terrorism
- The threats are international

"Conquest" of the infectious diseases 1950s-70s

- Dramatic changes: 1950-1970
  - Vaccines
  - Antibiotics
  - Nutrition
  - Housing
  - Sanitation
- Decline or elimination of many diseases in the industrialized world
  - Smallpox, diphtheria, whooping cough, tetanus, polio, measles, *et alia*

- *"One can think of the middle of the 20th century as the end of one of the most important social revolutions in history, the virtual elimination of the infectious diseases as a significant factor in social life"*

Sir Macfarland Burnet
Nobel Laureate, Australia

A cloud on the horizon

- June, 1981 – first cases of AIDS diagnosed
- April, 1984 – HIV is identified
  "the triumph of science over a dread disease"
  "a vaccine will be available in 2 years"
- 2005 -a world-wide pandemic in progress
  - 4th leading cause of death world-wide
  - No vaccine
  - No curative drug

HIV is not the only surprise

- 1989 Conference on Emerging Infections
- An illustrative additional inventory
  - SARS – from Asia
  - Monkeypox – from Africa
  - TSE – "mad cow" disease – from UK
  - *H5N1 influenza* – from Asia
- More than 30 new agents in 25 years

Why now?

- Growth in urban populations
  - Population of cities
    - 1975 – 5 with more than 10,000,000
    - 2005 – 20 with more than 10,000,000
      6 with more than 15,000,000
  - By 2015
    - 5 cities with more than 20,000,000 persons
    - 55% of world's population in urban areas

Why now?

- Growth in urban populations
- International travel
  - Volume
    - 18 million commercial air flights yearly
    - 1.6 billion air passengers per year
  - Remote area destinations
  - All cities less than 36 hours from others

Why now?

- Growth in urban populations
- Travel
- Growth of hospitals in endemic areas
  - Major sites for disease distribution
  - Problem of blood borne diseases
  - Development of antibiotic resistance

Why now?

- Growth in urban populations
- Travel
- Growth of hospitals in endemic areas
- Food supply
  - Internationalized
  - Industrialized
    - Animal husbandry
    - Food processors

Intentional release of biological agents

- A threat, largely ignored until 1995
  - Too difficult to grow organisms
  - Technologically difficult to disseminate
  - Not used because of a moral barrier

What has changed?

- Advances in biotechnology
  - Numbers and sophistication of laboratories
  - Information access – internet
  - Trained microbiologists
  - Aerosolization devices
- Growth of independent terrorist groups

Watershed events
Aum Shinrikyo -- Japan

- Religious cult released Sarin gas in Tokyo subway (1995)
  - Cult - previously unknown to intelligence
  - Thousands of members, well-funded
  - Tried to aerosolize anthrax and botulinum toxin throughout Tokyo at least 8 times
- *Concern – unknown, non-state sponsored organization, acting without concern for moral deterrents*

Watershed events
USSR Bioweapons Program

- A secret program – unknown until 1989
- 1992 – Ken Alibek, Deputy Director of bioweapons program, deserts
- 1995 – Full scope of program apparent
  - 60,000+ persons in 50 different labs
- *Concern – Expertise and possibly specimens now dispersed world-wide. Still a secret program*

"On May 8, 1980, WHO announced that smallpox had been eradicated..Soon after, smallpox was included in a list of biological weapons targeted for improvement in the 1981-85 Five -Year Plan...

Where other governments saw a medical victory, the Kremlin perceived a military opportunity...the military command issued an order to maintain an annual stockpile of 20 tons (of smallpox virus)."

Alibek, 1998

A recurrent menace -- influenza

- Influenza – 1918 – H1N1
  - Case-fatality rate - about 2 %
  - Deaths -- U.S. 675,000
    World >40,000,000
- Influenza – 2004/2005 – H5N1
  - ~100 cases/ 53 deaths

Responses to the threat

- Detection
  - Mechanisms for reporting "24/7"
  - Team for emergency investigation
- Diagnosis
  - Known and identified experts
  - Laboratory capability
- Response
  - Vaccines, antibiotics
  - Isolation and quarantine
  - Provision of medical care

Coping with the New Threats--
public health leadership is key

- Planning and preparation
  - Collaborative participation of many groups needed
    - Health care staff and hospitals
    - Voluntary organizations such as Red Cross/Red Crescent
    - Pharmaceutical and medical supply providers
    - Law enforcement agencies
    - Education and transportation departments
- Execution and the role of a command center
- Communication
  - Public
  - Local, national, international – political and professional

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Special needs for the future

- Greatly strengthened network of international cooperation and communication
  - Cooperative international centers for epidemiology and laboratory diagnosis in all countries
  - A far more generously supported WHO effort to orchestrate the many national initiatives
- A focused research and development program

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- "Today's world is truly a global village, characterized by growing concentrations of people in huge cities, increasing global commerce and travel...One can safely predict that infectious diseases will continue to emerge...Depending on present policies and actions, this situation could lead to a catastrophic storm of microbial threats."

Institute of Medicine/ National Academy of Sciences
Microbial Threats to Health, 2003

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- *International collaboration and cooperation is not an option for dealing with infectious diseases. It is a necessity if mankind is to survive.*

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