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The Forum on Emerging Infections comprises representatives from academia, industry, professional and interest groups, and government agencies. Through public workshops and private meetings, the activities of the Forum seek to facilitate discussion and inquiry into the most challenging and crosscutting set of issues. Sessions of the Forum are designed to examine emerging as well as long-standing problems in light of the most recent or groundbreaking advances that may lead to further innovation or solutions. Summary reports based on the proceedings of the workshops are prepared and published by the National Academy Press. Dissemination of the report targets audiences of the Forum's activities including decisionmakers within the government agencies of the Departments of Defense, State, Agriculture, Veterans Affairs, and Health and Human Services; state, tribal, and local government agencies in all domains of public health; schools of public health; the academic and industry research communities; international health experts; and, the legislative and policy communities.

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## INTRODUCTION

The Forum on Emerging Infections comprises representatives from academia, industry, professional and interest groups, and government agencies. Through public workshops and private meetings, the activities of the Forum seek to facilitate discussion and inquiry into the most challenging and crosscutting set of issues. Sessions of the Forum are designed to examine emerging as well as long-standing problems in light of the most recent or groundbreaking advances that may lead to further innovation or solutions. Summary reports based on the proceedings of the workshops are prepared and published by the National Academy Press. Dissemination of the report targets audiences of the Forum's activities including decisionmakers within the government agencies of the Departments of Defense, State, Agriculture, Veterans Affairs, and Health and Human Services; state, tribal, and local government agencies in all domains of public health; schools of public health; the academic and industry research communities; international health experts; and, the legislative and policy communities.

## BODY

The Institute of Medicine (IOM) is a private, non-profit organization that provides health policy advice under a congressional charter granted to the National Academy of Sciences. The Forum on Emerging Infections, part of the Board on Global Health at the IOM was created in 1996 in response to a request from the Centers for Disease Control and Prevention and the National Institutes of Health. The goal of the Forum is to provide structured opportunities for representatives from academia, industry, professional and interest groups, and government agencies to examine and discuss scientific and policy issues that are of shared interest regarding research, management, and policy issues related to infectious diseases. In accomplishing this task, the Forum provides the opportunity to foster the exchange of information and ideas, identify areas in need of greater attention, clarify policy issues by enhancing knowledge and identifying points of agreement, and inform decision makers about science and policy issues. The Forum on Emerging Infections is intended to illuminate issues, and not to provide formal consensus recommendations on any policy that may be pending before any organization or federal agency. Its strengths are the diversity of its membership and the contributions of individual members expressed throughout the activities of the Forum.

In all its activities, the Forum seeks to strengthen and forge links among the public health, medical care, and government, academic, and industry scientific communities. To accomplish this, the Forum meets twice a year to discuss topics of particular interest and urgency to U.S. government agencies, public health specialists, and U.S.-based funders and implementers of infectious disease research and control activities. In addition, the Forum convenes at least two major workshops annually. The Forum members determine the subject area and scope of the workshops. The state of urgently needed medical products that are in an orphaned condition demanding special attention, the crisis of antimicrobial resistance, the impacts of managed care, the capacity of the public health system, the emergence of zoonotic diseases, the consequences of viral disease eradication, and biological threats and terrorism are among the topics that have been addressed through workshops (workshop agendas appear in Appendix B). The next workshop (April 2002) will examine the effects of globalization on the emergence of infectious diseases. We anticipate many of the common themes that have emerged during previous workshops—such as research challenges; education and training needs for the medical and public health communi-

ties and the public; and, opportunities for strengthening private-public sector partnerships—will likely focus our discussions on the actions needed and taken across the public and private sectors.

After each workshop, a report summarizing the proceedings of the workshop is prepared, reviewed according to National Research Council report review procedures, and published by the National Academy Press. The workshop summary presents lessons learned from described experiences, delineates a range of pivotal issues and their respective problems, and puts forth some potential responses as described by the workshop participants. (Workshop reports published during the period of this award are included with this report.)

Dissemination of the report targets audiences of the Forum's activities including decision-makers within the government agencies of the Departments of Defense, State, Agriculture, Veterans Affairs, and Health and Human Services; state, tribal, and local government agencies in all domains of public health; schools of public health; the academic and industry research communities; international health experts; and, the legislative and policy communities. Sufficient copies of the workshop summaries are produced for distribution to the sponsor(s), the Forum members and workshop attendees, and other major stakeholders. Copies of the workshop summaries are produced for broader distribution, and made available on the Internet through the National Academy Press ([www.nap.edu](http://www.nap.edu)).

Elements of report dissemination include briefings, press conferences and announcements, public release meetings, conference sessions (e.g., at professional society meetings), and website distribution. In addition, the IOM collaborates with the associations representing the major scientific and public health interests to disseminate the workshop summary widely to their members, and to reach out to state, local, and international constituencies.

## **KEY RESEARCH ACCOMPLISHMENTS**

### **February 6–7, 2002 Workshop**

#### **Issues of Resistance: Microbes, Vectors, and the Host**

Resistance in microbes—bacterial, viral, or protozoan—to therapeutics is not surprising or new. It is, however, an increasing challenge as drug resistance accumulates and accelerates, even as the drugs for combating infections are reduced in power and number. Today some strains of bacterial and viral infections are treatable with only a single drug, some no longer have effective treatments. The disease burden from multi-drug resistant strains of tuberculosis, malaria, hepatitis, and HIV is growing in both developed and developing countries.

Through invited presentations and participant discussion, a workshop held on February 6–7, 2002 explored the causes and consequences of the resistance phenomenon. The Forum discussion also examined the scientific evidence supporting current and potential strategies for containment of resistance in microbes, vectors, and animal and human hosts. The methods and measures of a response for industry, federal regulation, domestic and international public health, federal and academic research, and the private healthcare sector were addressed. Issues considered in defining the challenges included the following:

- Existing disincentives for new research and production of antibacterials and antivirals
- Biological and chemical pesticide resistance in vectors for infectious diseases
- Nosocomial infections and the role of hospital prescribing in spreading resistance

- Transfer of resistance in animal microbes to human pathogens and the resulting risk of human disease
    - Vaccine-resistant microbes
    - The contribution of behavioral factors and therapeutic compliance to the emergence of resistance
      - The cost of resistance (disease burden from human and vector resistance)
- Response measures and options for the future were examined and included the following:
- Globally-integrated surveillance of resistant pathogens and vectors coupled with prediction tools for resistance pharmacodynamics
    - The application of genomics research in the detection of genes associated with the development of resistance
      - Regulating the rational use of antibiotics, antibacterials, and antivirals in humans and animals (role of physicians, public health, veterinary public health, animal husbandry/food production industry, federal agencies)
      - Novel and emerging technologies to combat resistance (feasibility and access for laboratories and developing countries)
      - Education and risk communication regarding the imprudent use of drugs

### **November 27–29, 2001 Workshop**

#### **Biological Threats and Terrorism: How Prepared Are We?**

##### **Assessing the Science and Response Capabilities**

In the wake of the events of September 11, already mounting concerns about bioterrorism became imminent priorities for policymakers, researchers, public health officials, and private industry. These communities grappled with ways to better understand the potential threats and ensure the country's ability to preempt an attack or respond to the consequences.

The Forum on Emerging Infections was uniquely positioned through its representation of multi-sector science and policy expertise to convene a working group discussion on the next steps for responding to bioterrorism.

The November 27–29, 2001 workshop of the Forum explored the current scientific understanding of threatening pathogens and what measures have been put in place to better monitor, prevent, and respond to their emergence. To determine where progress has been made and where gaps remain, Forum presentations and discussions reviewed existing policies, infrastructure, and research and scientific tools.

Additionally, Forum presentations and discussions sought to identify the obstacles to preparing an optimal response, particularly as it relates to the complexities of interaction among private industry, research and public health agencies, regulatory agencies, policymakers, academic researchers, and the public. During the three-day workshop, Forum members and invited guests explored the issues surrounding emerging opportunities for more effective collaboration as well as the scientific and programmatic needs for responding to bioterrorism.

## September 19-20, 2001 Workshop\*

### Linking Infectious Agents and Chronic Conditions

The belief that many long-recognized chronic diseases are infectious in origin goes back to the mid-nineteenth century, when cancer was studied as a possible infectious disease. In the 1950s and 1960s, much biomedical research was directed, unsuccessfully, at the identification of microorganisms purportedly causing a variety of chronic diseases. In recent years the picture has begun to change. One chronic disease after another has been linked, in some cases definitively, to an infectious etiology (e.g., peptic ulcer disease with *Helicobacter pylori*, cervical cancer with several human papillomaviruses, Whipple's disease with *Tropheryma whippeli*, Lyme arthritis and neuroborreliosis with *Borrelia burgdorferi*, AIDS with HIV). Evidence implicating microorganisms as etiologic agents of chronic diseases with substantial mortality and morbidity impact, including atherosclerosis and cardiovascular disease, diabetes mellitus, inflammatory bowel disease, and a variety of neurological and neuropsychiatric diseases, continues to mount.

In an effort to identify cross-disciplinary aspects of the challenge of infectious etiologies of chronic diseases, a workshop was planned to explore the factors that drive infectious etiologies of chronic diseases to prominence and seek to identify more broad-based strategies and research programs that need to be developed. The goals of the workshop included the following:

- Review the range of pathogenic mechanisms and diversity of etiologic microbes and chronic diseases, including inflammatory syndromes and cancer;
- Explore trends, advances, and gaps in collaborative research on diagnostic technologies, and their integration into epidemiologic studies and surveillance;
- Identify chronic conditions and syndromes that warrant further investigation;
- Identify research needed to clarify the etiologic agents and pathogenic mechanisms involved in chronic conditions, screening for multiple potential agents of the same outcome, and considering that one microbe might induce multiple syndromes;
- Identify the principal bottlenecks and opportunities to detect, prevent, and mitigate the impact of chronic conditions on human health against the overall backdrop of emerging infections;
- Consider the benefits and risks of early detection and prevention of chronic diseases caused by infectious agents.

## February 1-2, 2001 Workshop

### The Consequences of Viral Disease Eradication

The legacy of smallpox eradication has removed the worldwide suffering caused by this disease, has resulted in yearly savings of substantial financial resources that are no longer needed for its treatment and prevention, and has helped build consensus and confidence to expand eradication programs to other diseases. Since smallpox eradication, the science of eradication has changed and with it, our definitions of what diseases are possible to eradicate. For example, many diseases, such as polio, measles, onchocerciasis, dracunculiasis, lymphatic filariasis, leprosy, and Chagas diseases, once thought not to be eradicable, are now targeted for elimination and subsequent eradication. These and other disease control experiences provide strong evidence

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\* Due to the events of September 11, 2001, the workshop was postponed, but will be rescheduled in 2002/2003.

that with full implementation of an appropriate control strategy, disease transmission can be effectively interrupted, if not eliminated regionally and possibly eradicated globally.

Among the vaccine-preventable diseases, concerted efforts are underway to eliminate or eradicate several viral diseases. The global effort to eradicate polio has nearly eliminated the disease from the Western Hemisphere. By 2002, it is anticipated that wild type poliovirus transmission will be interrupted worldwide. The Pan American Health Organization (PAHO) in 1994 developed an enhanced measles vaccination strategy with the goal of measles eradication from the Western Hemisphere by 2000. While measles cases are still reported, PAHO's measles eradication strategy has been very effective in interrupting transmission and maintaining the absence of measles virus in >99% of the 12,000 reporting municipalities in the Americas. The interruption of indigenous measles transmission in the Americas by the end of the year 2000 remains an attainable goal.

The criteria for assessing eradicability of polio, measles, and other viral infections have been debated extensively. What is specifically not addressed are the relative desirability and feasibility, and the time required, to stop immunizations. With the elimination and eradication of several viral diseases on the horizon, issues surrounding the cessation of immunization activities become exceedingly important. Resolution of the issues affecting when and how immunization and other prevention activities can be stopped in conjunction with disease eradication are paramount to domestic and international public health agencies, pharmaceutical and vaccine manufacturers, and international security analysts.

The workshop was held in an effort to better understand the dynamics of disease eradication and post-immunization policies. Through invited presentations, panel discussion, and open dialogue with workshop participants, the principles underlying the biological challenges, medical interventions, and operational considerations for post-immunization strategies for vaccine-preventable viral diseases were explored and important efforts to facilitate wise decision making were highlighted.

### **June 7-8, 2000 Workshop**

#### **The Emergence of Zoonotic Diseases**

As defined by the World Health Organization, zoonoses are "those diseases and infections which are naturally transmitted between vertebrate animals and man, with or without an arthropod intermediate." Outbreaks of zoonotic diseases emerge either by apparently new agents, or by known microorganisms that appear in areas or species in which the disease was previously unknown. New animal diseases with an unknown host spectrum are also included in this definition. The specific causes of such diseases are varied and include complex interactions at the molecular level as well as more large-scale social and ecological dynamics affecting the growth and movement of populations and changes in the environment. Additional factors such as climate, technology, land-use, and human behavior can converge in a manner favorable to the emergence of zoonotic diseases.

Zoonotic diseases represent one of the leading causes of illness and death from infectious disease. Worldwide, zoonotic diseases have a negative impact on commerce, travel, and economies. In most developing countries, zoonotic diseases are of major public health significance and contribute to an already overly burdened public health system. In industrialized nations, zoonotic diseases are of particular concern for at-risk groups such as the elderly, children, pregnant

women, and immunocompromised individuals. The potential use of zoonotic pathogens as bioterrorism agents also remains a concern of scientists and policymakers.

The workshop's goal was to increase knowledge and understanding of zoonotic diseases with current and probable future public health significance. The workshops explored the forces that drive zoonotic diseases to prominence, and sought to identify more broad-based strategies and research programs that are needed to respond to these diseases. The goals of the workshop were to evaluate (1) the relative importance of zoonotic diseases against the overall backdrop of emerging infections, (2) the state of our understanding of zoonotic diseases, and (3) surveillance and response strategies to detect, prevent, and mitigate the impact of zoonotic diseases on human health. Issues pertaining to these three thematic areas were addressed through invited presentations and subsequent discussions, which highlighted the ongoing programs and actions being taken, and identified the most important needs in this vital area.

### **REPORTABLE OUTCOMES** (*Published Reports*)

*Biological Threats and Terrorism: Assessing the Science and Response Capabilities.* Workshop Summary. Washington, DC: National Academy Press. 2002.

*Considerations for Viral Disease Eradication: Lessons Learned and Future Strategies.* Workshop Summary. Washington, DC: National Academy Press. *In press* (2002).

*The Emergence of Zoonotic Diseases: Understanding the Impact on Animal and Human Health.* Workshop Summary. Washington, DC: National Academy Press. 2002.

*Emerging Infectious Diseases from the Global to the Local Perspective.* Workshop Summary. Washington, DC: National Academy Press. 2001.