Emerging Microbial Threats: Issues, Challenges, and Opportunities at the Human-Animal-Ecosystem Interface

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Disclosure

No conflicts with this presentation
Identify factors contributing to infectious disease emergence and spread

Discuss recent examples of disease emergence from animal reservoirs

Describe challenges in zoonotic disease detection and response

Review current efforts to strengthen global capacity for early detection, response, and control of emerging diseases
Crude Death Rate* for Infectious Diseases
United States, 1900-1996

*Per 100,000 population per year.

MMWR 1999;48:621–48
“...One can think of the middle of the twentieth century as the end of one of the most important social revolutions in history, the virtual elimination of the infectious disease as a significant factor in social life.”

Burnet, 1962
IOM Definition of Emerging Infections

New, reemerging or drug–resistant infections whose incidence in humans has increased within the past two decades or whose incidence threatens to increase in the near future.
## Factors Contributing to the Emergence of Infectious Diseases

### 1992
- Human demographics and behavior
- Technology and industry
- Economic development and land use
- International travel and commerce
- Microbial adaptation and change
- Breakdown of public health measures

### 2003
- Human susceptibility to infection
- Climate and weather
- Changing ecosystems
- Poverty and social inequality
- War and famine
- Lack of political will
- Intent to harm

*Institute of Medicine*
Human Demographics and Behavior
## Number and Location of Megacities* by Setting and Year, 1950–2025

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
<th>Number (%) in developing world</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>2</td>
<td>0(0)</td>
</tr>
<tr>
<td>1975</td>
<td>3</td>
<td>1(33)</td>
</tr>
<tr>
<td>2007</td>
<td>19</td>
<td>14(74)</td>
</tr>
<tr>
<td>2025</td>
<td>27</td>
<td>21(78)</td>
</tr>
</tbody>
</table>

*≥10 million people

Source: UN Dept of Economic and Social Affairs, World Urbanization Prospects: 2007 Revision
International Travel and Commerce
Global Aviation Network

PNAS 2004;101:15124–29
Microbial Adaptation and Change

RUNNING OUT OF WONDER DRUGS
50 YEARS AFTER THE ADVENT OF PENICILLIN, DOCTORS FEAR ANTIBIOTICS ARE LOSING THEIR PUNCH
BY SANDRA G. BOODMAN

BAD BUGS, NO DRUGS
As Antibiotic Discovery Stagnates ...
A Public Health Crisis Brews

IDSA
Infectious Diseases Society of America
July 2004

"Don't forget to take a handful of our complimentary antibiotics on your way out."

THE NEW YORKER, January 12, 1998
COMBAT DRUG RESISTANCE

No action today, no cure tomorrow

7 APRIL 2011 WORLD HEALTH DAY
Poverty and Social Inequality

NEJM 2004; 350:1483

Lancet 2005;365:901–3
Fierce Quake Devastates Haiti; Worst Is Feared

By SIMON ROMERO
and MARC LACEY
SANTO DOMINGO, Dominican Republic — A fierce earthquake struck Haiti Tuesday, causing widespread destruction and fear. The death toll in the Caribbean nation jumped to 900, and the number of missing people was revised down to 2,000 from the original estimate of 30,000.

A magnitude 7.0 earthquake hit Haiti on Tuesday, causing widespread destruction and fear throughout the Caribbean nation. The death toll in the capital, Port-au-Prince, has risen to 900, and the number of missing people was revised down to 2,000 from the original estimate of 30,000.

The strong quake rocks Haitian capital

A magnitude 7.0 earthquake hit Haiti on Tuesday, causing widespread destruction and fear. The death toll in the capital, Port-au-Prince, has risen to 900, and the number of missing people was revised down to 2,000 from the original estimate of 30,000.

The Washington Post
“What hasn’t happened is worth noting,” said Nigel Fisher, deputy special representative of the United Nations secretary general in Haiti. “We haven’t had a major outbreak of disease. We haven’t had a major breakdown in security.”

New York Times, 7-10-10
Lack of Political Will – Human Disease

Polio: Obstacles keep eradication out of reach

Polio spreading from Kano has reinfected >20 countries from West Africa to Indonesia
Lack of Political Will – Zoonotic Disease

Early Cases of SARS: Guangdong Province, China

Nov 16, 2002: first known cases of atypical pneumonia in Foshan

Feb 11-12, 2003: China reports 305 cases of acute respiratory syndrome in Guangdong Province
Carlo Urbani
President of the Italian Chapter of Doctors without Borders

- French Hospital in Hanoi, Vietnam, early March 2003: Dr. Urbani called to evaluate American businessman who had fallen ill with “bad case of influenza”

- The patient had been in “Hotel M” in Hong Kong

- Dr Urbani realized that the patient did not have flu, but probably a new highly contagious disease; he notified WHO, and an investigation began

- Bangkok, Thailand, late March: Dr Urbani presented with dyspnea, fever, myalgias, thrombocytopenia, leukopenia
Chain of transmission among guests at Hotel M—Hong Kong, 2003

* Health-care workers; † All guests except G and K stayed on the 9th floor of the hotel. Guest G stayed on the 14th floor, and Guest K stayed on the 11th floor; § Guests L and M (spouses) were not at Hotel M during the same time as index Guest A but were at the hotel during the same times as Guests G, H, and I, who were ill during this period.
Himalayan palm civet
*Paguma larvata*

Chinese Ferret-Badger
*Melogale moschata*

Raccoon-dog
*Nyctereutes procyonoides*

Animal photos courtesy of Dr. Yi Guan
Hong Kong University, and badgers.org.uk

Science; July 18, 2003
Severe acute respiratory syndrome coronavirus-like virus in Chinese horseshoe bats


*Department of Microbiology, †Research Centre of Infection and Immunology, ‡State Key Laboratory of Emerging Infectious Diseases, and §Department of Pathology, University of Hong Kong, Queen Mary Hospital, Pokfulam, Hong Kong Special Administrative Region, China

Communicated by Lap-Chee Tsui, University of Hong Kong, Hong Kong Special Administrative Region, China, August 8, 2005 (received for review June 22, 2005)

Although the finding of severe acute respiratory syndrome coronavirus (SARS-CoV) in caged palm civets from live animal markets in China has provided evidence for interspecies transmission in the genesis of the SARS epidemic, subsequent studies suggested that the civet may have served only as an amplification host for SARS-CoV. In a surveillance study for CoV in noncaged animals from the wild areas of the Hong Kong Special Administrative Region, we identified a CoV closely related to SARS-CoV (bat-SARS-CoV) from 23 (39%) of 59 anal swabs of wild Chinese horseshoe bats (Rhinolophus sinicus) by using RT-PCR. Sequencing analysis of three bat-SARS-CoV genomes from samples collected on different dates showed that bat-SARS-CoV is closely related to SARS-CoV from humans and civets. Phylogenetic analysis showed that bat-SARS-CoV formed a distinct cluster with SARS-CoV group 2b CoV, distantly related to known group 2 CoV. Differences between the bat-SARS-CoV and SARS-CoV genomes were observed in the spike genes, ORF 3 and ORF 8, which regions where most variations also were observed between the human and civet SARS-CoV genomes. In addition, the presence of a 29-bp insertion in ORF 8 of bat-SARS-CoV genome, not in human SARS-CoV genomes, suggests that it has a common ancestor with civet SARS-CoV. Antibody against recombinant bat-SARS-CoV nucleocapsid protein was detected in 84% of Chinese horseshoe bats by using an enzyme immunoassay. Neutralizing antibodies against bat-SARS-CoV also was detected in bats with low viral loads. Precautions should be exercised in the handling of these animals.

Methods

Wild Animal Surveillance and Sample Collection. The study was approved by the HKSAR's Department of Agriculture, Fisheries, and Lands.
Table. Factors contributing to the emergence of infectious diseases according to IOM reports, 1992 and 2003

<table>
<thead>
<tr>
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<td>Human demographics and behavior</td>
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<td>Breakdown of public health measures</td>
<td>Lack of political will</td>
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<tr>
<td></td>
<td>Intent to harm</td>
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*Boldface* indicates factors that contributed to the emergence and spread of severe acute respiratory syndrome. IOM, Institute of Medicine.
“The SARS experience ... made one lesson clear early in its course: inadequate surveillance and response capacity in a single country can endanger national populations and the public health security of the entire world.”

Heymann D, Rodier G. Emerg Infect Dis 2003
Another strange illness rears its ugly head on U.S. soil...

HELP.

Symptoms:
Odd behavior, confusion, belief that prairie dogs are pets.
Monkeypox

- Orthopox virus
- First identified in non-human primates, but reservoir is rodents
- 1\textsuperscript{st} human illness seen in 1970 in Congo during smallpox eradication era
- Clinical features similar to smallpox
- Lower mortality (<10%); less efficient person-to-person transmission
- All previous disease in West and Central Africa
- Understudied; smallpox vaccine appears cross-protective
Case

- A 30-year-old woman developed sore throat, headache, fever, malaise and a small painless papule on her left cheek

- Within 48 hours, throat soreness and malaise worsened and additional lesions developed
Primary inoculation lesion at site of prairie dog bite

Secondary lesions
Officials Scramble to Contain Monkeypox

Outbreak of Virus in Midwest Is the First Reported in Western Hemisphere

By-Teo Strick
Washington Post Staff Writer

Tammy Kautzer’s 3-year-old daughter had never been so sick. Her fever spiked above 105. Her glands were so swollen they looked like they were popping out of her neck. And then small, tender red welts began erupting all over her body.

“She kept getting worse. All she did was cry,” Kautzer said yesterday. “I don’t know what the doctors were thinking, but I really didn’t know if she was going to make it.”

Kautzer’s daughter, Schyan, did recover, but only after a harrowing week in the hospital, during which time Kautzer and her husband also got milder versions of the same sickness.

The illness of the family in Decoster, Wis., were the start of the first outbreak reported in the Western Hemisphere of monkeypox, a sometimes-life-threatening disease related to smallpox.

At least 20 people in three Midwestern states have been stricken in the outbreak, which state and federal health officials are urgently working to contain.

“We’re doing everything possible to contain it,” said Jeffrey P. Davis, Wisconsin’s chief medical officer.

Eighteen of the cases have been reported in Wisconsin, with one additional case in Illinois and one in Indiana. More potential cases were being investigated, officials said.

State and federal authorities are tracing about 200 animals that were distributed in 13 states by an exotic pet dealer in Illinois. The dealer sold rodents known as prairie dogs, which are believed to be the source of the outbreak.

“There’s the potential of transmission from animal to human, so certainly we are concerned,” said Jeff Squibb of the Illinois Department of Agriculture.

In addition to trying to prevent more infections, officials are worried that the animals could spread the disease to wild rabbits and other indigenous creatures, allowing the virus to become entrenched in the United States. The last time a new disease became established in this country was in 1999 when the West Nile virus entered. It has subsequently spread nationwide.

“That’s probably the biggest concern we have other than the immediate concern of trying to get the message out as quickly as possible to try to identify people who might have been exposed,” said Stephen Ostroff, deputy director of the National Center for Infectious Diseases in Atlanta.

The monkeypox outbreak came just as concerns were mounting over severe acute respiratory syndrome (SARS), a deadly permutation of potential transmissions.

One of the Wisconsin cases involved a rabbit owner who was infected by his pet, which apparently became infected during a visit to the same veterinarians who treated a sick prairie dog, Davis said.

Although no cases of the disease apparently have spread directly from person to person in the United States, that has been known to occur with monkeypox in Africa.

At the same time, investigators are tracking the disease backward to try to determine how it first arrived in the Western Hemisphere.

Monkeypox is usually found only in central and western Africa. It is caused by a virus in the same family as the smallpox virus. It triggers similar symptoms—fever, cough and a rash of small red blistering spots that eventually break open and scar over, sometimes leaving scars.

Monkeypox is believed to be much less deadly than smallpox, with a mortality rate of 1 percent, but about 30 percent of people who have been diagnosed have died, according to the Centers for Disease Control.

The exotic animal pet dealer will not be sold to Minnesota.
Movement of Imported African Rodents to Animal Distributors and Distribution of Prairie Dogs from an Animal Distributor Associated with Human Cases of Monkeypox*

**Rodent Shipment from Accra, Ghana**

**TX-1**
- 50 Gambian giant rats (GR)
- 53 rope squirrels (RS)
- 2 brushtail porcupines (BP)
- 47 tree squirrels (TS)
- 100 striped mice (SM)
- ~510 dormice (DM)

- 4/9/03
- NJ
- RS, BP, TS, SM

- 4/9/03
- TX-2
- GR

- 4/11/03
- TX-3
- RS, SM, DM

- 4/17/03
- TX-4
- DM

- 4/17/03
- TX-5
- DM

- 4/16/03
- TX-6
- TS, SM, DM

- 4/21/03
- IL-1
- GR, DM

- 4/26/03
- TX-7
- DM

- 4/28/03
- TX-8
- DM

- 4/29/03
- TX-9
- DM

- 5/12/03
- IL-2
- DM

- 5/18/03
- TX-10
- DM

- 6/1/03
- IL-2
- DM

- 6/5/03
- MN
- DM

- Japan
- DM

- 4/28/03
- TX-9
- DM

- 4/28/03
- TX-9
- DM

- 4/29/03
- TX-10
- DM

- 6/1/03
- IL-2
- DM

- 6/5/03
- WI
- DM

- WI
- Human cases: 17 confirmed, 22 probable/suspect
- 42 PDs traced
- 14 PDs traced
- 24 PDs traced

- IL-1
- Human cases: 8 confirmed, 4 probable/suspect
- 11 PDs traced
- 1 PD traced

- IN
- Human cases: 7 confirmed, 9 probable/suspect
- 1 PD traced

- MO
- Human cases: 2 confirmed

- SC
- No human cases

- MI
- No human cases

- KS
- Human cases: 1 confirmed

- MO
- Human cases: 2 confirmed

- SC
- No human cases

- MI
- No human cases

- KS
- Human cases: 1 confirmed

*As of July 8, 2003. Does not include one probable human case from Ohio; investigation ongoing.

**Identified as distributor C in MMWR 2003;52:561-4.

†Identified as distributor D in MMWR 2003;52:561-4.


‡Includes 2 persons who were employees at IL-1

? - date of shipment unknown
Annual Global Trade in Exotic Animals

- 4 million birds
- 640,000 reptiles
- 40,000 primates
- Illegal trade unknown – estimate $4-6 billion
Vigilance

- The “Alert” Physician
- The “Alert” Veterinarian
- The “Alert” Pathologist / Laboratorian
- The “Alert” Research Scientist
- The “Alert” Public Health Official

Transplants led to rabies deaths

3 cases traced to lone donor could prompt new screening

By DAVID WYNBERG

Three people died from rabies after receiving organs from a donor later found to have had the disease — the first reported cases of rabies spread through organ transplants, health officials said Thursday.

Federal officials say they will review whether more screening is necessary. Transplant agencies currently test organs for HIV, hepatitis and other viruses, but not for rabies, though some agencies ask if potential donors were exposed to possibly rabid animals.

“We are learning as we go,” said Dr. Mitchell Cohen, an infectious disease expert with the Centers for Disease Control and Prevention. “This has never happened before.”

The organ recipients, from Texas and Oklahoma, received a liver and two kidneys on May 4 at Baylor University Medical Center in Dallas. The donor, a 28-year-old Arkansas man, had died the previous day at CentraCare Health System in Tuscaloosa, Texas, hospital spokesperson Frances Francis said.

The donor had gone to the Tuscaloosa hospital April 28 for treatment of nausea and vomiting. Francis said.

He developed “severe mental status changes” and was diagnosed with a brain hemorrhage, Cohen said.

The transplant patients died from rabies June 7-21, Cohen said. A fourth patient, who received two lungs from the donor, died from complications during the transplant at the University of Alabama, Birmingham.

The CDC and health officials from Alabama, Arkansas, Oklahoma and Texas are checking whether health care workers, family members or friends who had close contact with the donor or four recipients should get rabies treatment — a dose of immune globulin followed by five doses of rabies vaccine over 28 days.

Babies may be transmitted between people through saliva, though Cohen said only two such cases have been reported, both in Ethiopia. They were not confirmed by lab tests.

It usually takes one to three weeks before people infected with rabies show symptoms, but it can take years, the CDC said. It is not known how the organ donor from Arkansas contacted the virus, but the strain found in all of the patients suggests it came from a bat, Cohen said.

People with rabies generally develop fever and headaches, followed by confusion, hallucinations and incoherence.

The disease is nearly always fatal. The United States saw one to three human cases a year, usually caused by bites or scratches from bats.

Though rabies has never been known to be passed through organ transplants before, at least eight people have contracted the virus worldwide through organ transplants, the CDC says.

Organics in America are tested for HIV, hepatitis B and C, syphilis and two other viruses, cytomegalovirus (CMV) and human T-lymphotropic virus (HTLV), said Virginia McBride, an organ donation specialist with the U.S. Health Resources and Services Administration.

Organs from an HIV-positive donor were never tested for HTLV in case an organ recipient contracted the virus.

“’I don’t think we want that scenario or kind of widespread panic or news on a dime,” she said.
“Tracing the origin of HIV has confirmed that viruses can jump from one species to another after a very long period of no transmission and adapt rapidly.”
Stages of Cross Species Transmission

<table>
<thead>
<tr>
<th>Stage</th>
<th>Transmission to humans</th>
</tr>
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<tbody>
<tr>
<td>Stage 5: exclusive human agent</td>
<td>Only from humans</td>
</tr>
<tr>
<td>Stage 4: long outbreak</td>
<td>From animals or (many cycles) humans</td>
</tr>
<tr>
<td>Stage 3: limited outbreak</td>
<td>From animals or (few cycles) humans</td>
</tr>
<tr>
<td>Stage 2: primary infection</td>
<td>Only from animals</td>
</tr>
<tr>
<td>Stage 1: agent only in animals</td>
<td>None</td>
</tr>
</tbody>
</table>

**Rabies**

**Ebola**

**Dengue**

**HIV-1 M**

Ecological Origins of Novel Human Pathogens

Mark Woolhouse and Eleanor Gaunt
Centre for Infectious Diseases, University of Edinburgh, Edinburgh, United Kingdom

A systematic literature survey suggests that there are 1,399 species of human pathogens. Of these, 87 were first reported in humans in the years since 1980. The new species are disproportionately viruses, have a global distribution, and are mostly associated with animal reservoirs. Their emergence is often driven by ecological changes, especially with how human populations interact with animal reservoirs. Here, we review the process of pathogen emergence over both ecological and evolutionary time scales by reference to the “pathogen pyramid.” We also consider the public health implications of the continuing emergence of new pathogens, focusing on the importance of international surveillance.

Keywords: Animal Reservoirs; Emerging Infectious Diseases; Surveillance; Zoonoses

Systematic literature review: 1,399 human pathogens
87 (6%) first reported since 1980; 58 (67%) viruses, mostly RNA
Global distribution
Majority from animal reservoirs
Global trends in emerging infectious diseases

Kate E. Jones¹, Nikkita G. Patel², Marc A. Levy³, Adam Storeygard³, Deborah Balk³, John L. Gittleman⁴ & Peter Daszak²

Emerging infectious diseases (EIDs) are a significant burden on global economies and public health¹-³. Their emergence is thought to be driven largely by socio-economic, environmental and ecological factors¹-⁹, but no comparative study has explicitly analysed these linkages to understand global temporal and spatial patterns of EIDs. Here we analyse a database of 335 EID ‘events’ (origins of EIDs) between 1940 and 2004, and demonstrate non-random global patterns. EID events have risen significantly over time after controlling for reporting bias, with their peak incidence (in the 1980s) concomitant with the HIV pandemic. EID events are dominated by zoonoses (60.3% of EIDs); the majority of these (71.8%) originate in wildlife (for example, severe acute respiratory virus, Ebola virus), and are increasing significantly over time. We find prion pathogens constitute only 25.4% of EID events, in contrast to previous analyses which suggest that 37–44% of emerging pathogens are viruses or prions and 10–30% bacteria or rickettsia⁸,¹⁰,¹¹. This follows our classification of each individual drug-resistant microbial strain as a separate pathogen in our database, and reflects more accurately the true significance of antimicrobial drug resistance for global health, in which different pathogen strains can cause separate significant outbreaks⁴,¹². In broad concurrence with previous studies on the characteristics of emerging human pathogens⁵,⁶,¹¹, we find the percentages of EID events caused by other pathogen types to be 10.7% for protozoa, 6.3% for fungi and 3.3% for helminths (see Supplementary Data and Supplementary Table 2 for a detailed comparison to previous studies).

Nature 2008;451:990–93

- Review of 335 emerging disease events, 1940-2004
- Non-random global distribution
- 60% from animal reservoirs; 72% of those from wildlife
- Identification of geographic hot spots
Economic Impact of Recent Zoonotic Epidemics

Infectious Disease Movement in a Borderless World. IOM Forum on Microbial Threats Workshop Summary, 2010

Figures are estimates and are presented as relative size.
"Human and animal health are inextricably linked. They always have been. They always will be.”

James H. Steele
1913 – 2013
Chief, Veterinary Public Health Division, CDC
Assistant Surgeon General for Veterinary Affairs, USPHS

Calvin Schwabe
1927 – 2006
Professor of Veterinary Medicine
“Endemic and enzootic zoonoses cause about a billion cases of illness in people and millions of deaths every year, and emerging zoonoses are a rising threat to global health.”

See Series page 1936

December 1, 2012
“One Health”

Humans

Domestic Animals

Wildlife

Ecosystems

http://www.onehealthcommission.org/
Spillover Events

Prediction Considerations

- **Hot spots**
  - e.g., rainforests, megacities
- **Hot reservoirs**
  - e.g., bats, pigs, prairie dogs
- **Hot settings**
  - e.g., wet markets
- **Hot vectors**
  - e.g., *Aedes albopictus*
- **Hot vehicles**
  - e.g., bush meat
Swine Flu Names Evolving Faster Than Swine Flu Itself
Emerging Pandemic Threats Program

UC Davis-Led Team Selected to Implement USAID Wildlife Surveillance Project to Detect and PREDICT Emerging Infectious Diseases

- 5-year, $400 million effort
- Launched in FY10
- Focus on early identification of and response to dangerous pathogens in animals (especially wildlife) before transmission to humans
Opportunities to Prevent, Detect, and Respond to the Emergence and Transmission of Zoonotic Diseases

Sustaining Global Surveillance and Response to Emerging Zoonotic Diseases. IOM Forum on Microbial Threats Workshop Summary, 2009
Common Ground for Medical and Veterinary Communities

- Avian, animal, and pandemic influenza
- Other zoonotic diseases including those associated with exotic pet and wildlife trade
- Foodborne disease
- Healthcare-associated infections
- Antimicrobial resistance
- Blood, organ, tissue safety
- Neglected tropical diseases
- Pathogen discovery / new diagnostics
- Disease eradication
- Biosafety / Biosecurity
- Bioterrorism / Biodefense
Future Challenges

The Next Generation of Diseases Are in Hiding, Somewhere

By DONALD G. McNEIL JR.

In 2004, the world will be on the lookout for the re-emergence of SARS, monkeypox, new forms of flu and the unexpected. We have been warned. But must epidemics always catch humanity by surprise?

They kill far more people than war does, world constantly testing for new strains.

Other killers are held in check by alert public health officials: measles with vaccine, cholera with water trucks, chlorine and well-borers.

But for many diseases, the world does not put the clues together in time. It was two years after rare sarcomas were noticed in California men in 1981 before the world real-

- Another Influenza Pandemic
- Antimicrobial Resistance
- International Foodborne Disease Outbreaks
- Urban Yellow Fever in Latin America or Asia
- Microbial Etiologies of Chronic Diseases
- The Unexpected
BIRD FLU
Is Asia hatching the next human pandemic?
“At the same time, I am somewhat bemused by the number of ‘experts’ who appear regularly in the public media and predict—with virtual certainty—that H5N1 will be the next pandemic strain—and soon! Lifelong students of this disease are much more humble about their predictions!”

Theodore C. Eickhoff, M.D.
Chief Medical Editor
Infectious Disease News
December 2005;18:4
“A robust public health system— in its science, capacity, practice, and through its collaborations with clinical and veterinary medicine, academia, industry and other public and private partners—is the best defense against any microbial threat.”
Opportunities

International Health Regulations (2005)

www.who.int/csr/ihr/en/

- Timely reporting
- Information sharing
- Laboratory capacity
IHR 2005: “Faster, Stronger, Broader”

- Goal: prevent international spread of disease
- Not a surrogate for national surveillance and response systems
- But all Member States must be able – in a timely way – to detect, assess, report, and respond to public health risks / emergencies of international concern
Public Health Emergency of International Concern (PHEIC)

- Decision instrument
- Immediate notification of even one case:
  - Smallpox
  - Poliomyelitis
  - SARS
  - Influenza caused by new subtypes
- Notification determined by assessment:
  - Cholera
  - Pneumonic plague
  - Yellow fever
  - Viral hemorrhagic fever (Ebola, Marburg, Lassa)
  - West Nile fever
  - Others of national/regional concern (e.g., dengue, Rift Valley fever)

IHR 2005
Lessons Learned and Future Needs

- Vigilance
- Strengthened surveillance and public health laboratory capacity
- Better predictive capability
- Multidisciplinary partnerships
- Improved coordination, proactive communication, and avoidance of stigmatization
- Transparency and sustained political will (locally, nationally, regionally and globally)
- Address research, training, and education priorities
• Focus on threats or disease activity affecting humans, animal, or plants to achieve early detection and situational awareness and enable better decision making

• All hazards approach

• Guiding Principles
  • Leverage existing capabilities
  • Embrace all-of-nation approach
  • Add value for all participants
  • Maintain global health perspective
Conclusions

- Trends in factors favor microbes
- New threats will emerge; many will be zoonotic
- Vigilant frontline healthcare workers will continue to have a critically important role in recognition of emerging diseases
- History: travel, work, hobbies, animal contact
- Surveillance is critical to achieving public health security; improving national and international surveillance capabilities should be priorities for national health and security policy
- Helping individual countries improve their surveillance capacities will benefit all countries
Recent Examples – VBDs/Zoonoses

- West Nile - 2012
- H3N2 influenza variant
- Hantavirus pulmonary syndrome
- Heartland virus
- MERS-CoV
- H7N9 influenza

www.promedmail.org
Expect the Unexpected

Complacency
Game Changers

- Pathogen Discovery
- Human Microbiome Project
- Whole Genome Sequencing
- Culture Independent Diagnostic Testing
- Bioinformatics
- Synthetic and Systems Biology
- Healthcare Reform
- Electronic Health Records
- Social Media
- One Health
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- Robin Moseley

**Emory**
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- Jeannette Guarner
- Dianne Miller
Emergence of Zoonoses

- West Nile virus: >15,000 deaths in the United States
- Ebola virus: >1,553 deaths
- HIV: >30 million deaths
- Hendra virus: Four deaths
- Nipah virus: >250 deaths
- 2012–2013 MERS coronavirus: 54 deaths

- 'Spanish flu': H1N1 influenza: ~50 million deaths
- 'Hong Kong flu': H3N2 influenza: ~700,000 deaths
- 'Russian flu': H1N1 influenza
- 'Avian flu': H5N1 influenza: >371 deaths
- 'Swine flu': H1N1 influenza: >15,000 deaths
- 'Asian flu': H2N2 influenza: ~100,000 deaths
- 1999–2002 H9N2 and H7N7 influenza: One death
- 'Avian flu': H7N9 influenza: 44 deaths

Figure 1: Confirmed Cases of MERS-CoV by Month
(n=178)

WHO Status Report, 1/20/14
CONFIRMED CASES OF MIDDLE EAST RESPIRATORY SYNDROME - CORONAVIRUS 2012 - 2013

WHO Status Report, 1/20/14
FIGURE E.1: Early Control of Zoonotic Disease Is Both Cost-effective and Prevents Human Disease

Source: Adapted from IOM (2009).

World Bank Report Number 69145-GLB, 2012