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."

Emerging Infections: Microbial Threats to Health in the United States. Institute of Medicine, 1992.
“As we face the new millennium, we must renew our commitment to the prevention and control of infectious diseases, recognizing that the competition between humans and microbes will continue long past our lifetimes and those of our children.”

Jeffrey P. Koplan, Director, CDC

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**Emerging and Re-emerging Zoonoses**

- Zoonoses **have been defined** (WHO, 1959) as:
  “The diseases and infections which are naturally transmitted between vertebrate animals and man”.

- Emerging and re-emerging zoonoses **were defined** (Meslin, WHO, 1992) as:
  ”Zoonotic diseases caused either by totally new or partially new agents, or by micro-organisms previously known, but now occurring in places or in species where the disease was previously unknown.”
ZOONOSES and the RISK of DISEASE EMERGENCE

<table>
<thead>
<tr>
<th>Infectious Organisms</th>
<th>Human Pathogens (N=1709)</th>
<th>Zoonoses (N=832)</th>
<th>Emerging Pathogens (N=156)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viruses/Prions</td>
<td>507 (30%)</td>
<td>183 (22%)</td>
<td>64 (41%)</td>
</tr>
<tr>
<td>Bacteria/Rickettsia</td>
<td>541 (32%)</td>
<td>250 (30%)</td>
<td>48 (31%)</td>
</tr>
<tr>
<td>Fungi</td>
<td>309 (18%)</td>
<td>83 (10%)</td>
<td>16 (10%)</td>
</tr>
<tr>
<td>Helminths</td>
<td>286 (17%)</td>
<td>275 (33%)</td>
<td>9 (6%)</td>
</tr>
<tr>
<td>Protozoa</td>
<td>66 (3%)</td>
<td>41 (5%)</td>
<td>19 (12%)</td>
</tr>
</tbody>
</table>

49% of the human pathogens are zoonotic and 9% are emerging pathogens. 73% (114/156) of the emerging pathogens are zoonotic. Overall, zoonotic pathogens are more than 3 times more likely to be associated with emerging diseases than non-zoonotic pathogens.

Emerging Zoonoses

- Some Major Bacterial Etiologic Agents of New Zoonoses Identified Since 1976
  - 1976 *Capnocytophaga canimorsus*
  - 1977 *Campylobacter* spp.
  - 1982 *E. coli* O157:H7
  - 1982 *Borrelia burgdorferi* (Lyme disease)
  - 1983 *Helicobacter pylori* and other spp.
  - 1986 *Ehrlichia chaffeensis* (HME)
  - 1992 *Bartonella henselae* (Cat scratch Dis.)
  - 1994 *Rickettsia felis* (Murine typhus like)
  - 1994 *E. Equi/A. phagocytophila* (HGE)
Emerging Zoonoses

- Some Major Viral Etiologic Agents of New Zoonoses Identified Since 1990
  - 1991: Guanarito virus (Venezuelan hemorrhagic fever)
  - 1993: Sin nombre virus (Hantavirus pulmonary Syndrome)
  - 1994: Sabia virus (Brazilian hemorrhagic fever)
  - 1994: Hendra virus (Equine morbillivirus)
  - 1996: Australian bat Lyssavirus
  - 1997: Menangle virus (pigs, humans)
  - 1997: Hong Kong influenza virus H5N1
  - 1998: Nipah virus
  - 1999: Hong Kong influenza virus H9N2

Emerging Infectious Diseases

- Major Factors Contributing to the Emergence of Infectious Diseases
  - 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

Institute of Medicine Report, 1992
Population density, United States, 1790-2000

Source: F.A. Murphy, UCD

Speed of Global Travel in Relation to World Population Growth

Emerging zoonoses

• Estimated Global Mobile Population

  • Refugees/Uprooted People  22 million  (UNHCR, 2002)
  • Undocumented Migrants   10-15 million (ILO, 2000)
  • International Travelers    698 million (WTO, 2000)
  • Migrant Workers          70-80 million (ILO, 2001)
  • Migrant Victims of Trafficking  0.7 million (IOM, 2001)

Emerging Infections: Technology and Industry
Emerging zoonoses

Food-related illness and death in the United States
(Mead et al., EID, 1999)

It is estimated that annually food borne diseases cause approximately:

• 76 million illnesses
• 325,000 hospitalizations
• 5,000 deaths.

Emerging zoonoses

Changes in the factors that contribute to the epidemiology of food-borne diseases.
(Osterholm, 2002)

• Diet
• Commercial food service
• New methods of food production
• New or re-emerging infectious agents
• “High-risk” populations
Emerging zoonoses

Factors associated with the “globalization” of food borne diseases.
(Osterholm, 2002)

- Water
- Animal feeds and manures
- Workers
- Transportation
- Rodents, other wildlife, insects
- Food processing
Emerging Infections: Economic Development and Land Use

In 1983 avian influenza (H5N2) appeared in Pennsylvania, killing 17 million chickens, and costing more than $60M. (Source: F. A. Murphy, UCD)
Raccoon rabies,  
United States,  
1977-1999  
(Source: F.A. Murphy, UCD)

Black flying fox  
Fruit bat (*Pteropus alecto*)  

Range: North to Papua New Guinea and eastern islands of Indonesia, south to New South Wales  

In 1996, this species and another, the little red flying fox (*P. scapulatus*), were shown to carry a virus very closely related to rabies virus.  

Since then, flying foxes were also shown to carry the newly discovered Hendra virus and Nipah virus.  

(Source: F.A. Murphy, UCD)
Nipah virus, Malaysia, 1998
Deforestation, urbanization, increased pig production….

Emerging zoonoses

New and exotic pets, hunting pens and game translocation.

• Translocation of infected animals: bats and rabies, brucellosis and reindeer, echinococcosis and foxes.
• Translocation of susceptible animals: ostriches and emus and Western Equine Encephalitis.
• Hunting pens: rabies and raccoons
• New and exotic pets: salmonellosis and iguanas, Egyptian bats and rabies, African pygmy hedgehogs…
Number of Salmonella Marina Isolates Reported Annually and Number of Iguanas Imported Annually

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of S. Marina isolates</th>
<th>No. of iguanas imported</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1983</td>
<td>0</td>
<td>0</td>
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<tr>
<td>1984</td>
<td>200000</td>
<td>200000</td>
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<td>1985</td>
<td>400000</td>
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<td>1993</td>
<td>1000000</td>
<td>1000000</td>
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<tr>
<td>1994</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Pediatrics 1997;99:399-402
EMERGING, RE-EMERGING ZOONOSES

Leptospirosis

In the past: mainly serovars: \textit{L. canicola}, \textit{L. icterohaemorrhagiae}

Increased cases in dogs in USA in recent years, in California: \textit{L. pomona}, \textit{L. bratislava}

In Massachusetts, New Jersey, New York, Michigan: \textit{L. grippothyphosa}, \textit{L. pomona}, \textit{L autuminalis}

Clinical changes: acute renal failure rather than hepatic insufficiency or coagulation abnormalities.

Emerging Zoonoses: Why Now?

- Better tools for diagnosis of fastidious organisms: The Molecular Microbiology Revolution: Hantavirus, \textit{Bartonella}, etc…
- Epidemiological studies, outbreak investigations, Surveillance systems: Hantavirus, influenza, leptospirosis, Hendra and Nipah viruses.
- Wildlife studies have revealed new pathogens; new studies done on interaction between wildlife reservoir and domestic animals/humans.
- Increased interest in vector borne diseases, especially tick-borne infections: Ehrlichioses, Lyme disease, etc.
Emerging Zoonoses

- Knowing is not enough; we must apply.
- Willing is not enough; we must do.
  (Goethe)

Emerging Zoonoses: Strategies for Prevention and Control

- Recognition
- Investigation
- Collaboration: Interagency structures
- Advanced structures for diagnosis and surveillance, International and interdisciplinary interventions
- Applied epidemiological and ecological research: Field-trained specialists: Epidemic Intelligence Veterinary Public Health Officers?
- Education: Training, technology transfer.
- Information/Communication
Emerging Zoonoses: Strategies for Prevention and Control

• Recognition:

Emerging zoonotic infections first need to be identified.

Traditional approach: identification of a human health problem leading to identification of problems in domestic or wild animal populations (i.e. Rift Valley fever, Q fever, chlamydiosis).

New approaches: identification of a health problem in animals that could be associated with human disease (West Nile virus, USA, 1999).

investigation of potential pathogens in wildlife leading to identification of new reservoirs: Lyssavirus in bats, Australia, brucella sp. in marine mammals…

Emerging Zoonoses: Strategies for Prevention and Control

• Investigation

Collaborative field work of multidisciplinary teams with the support of expert staff scientists and advanced laboratories with molecular biologic and immunologic technologies.

“Shoe-leather” epidemiology initially to determine main risk factors and potential reservoirs, leading to preventive measures: Hantavirus, Americas, Nipah virus, Malaysia.

New approach: Inventory of pathogens carried by various wildlife species, especially when encroached with human habitat: opossums and Rickettsia felis, murine typhus, sarcocystis neurona.
Emerging Zoonoses: Strategies for Prevention and Control

- Collaboration: Interagency structures
- Need for a scientific bridge between various disciplines: zoology, ecology, ornithology, geography, veterinary and human medicines…as illustrated by the early “West Nile fiasco” bird disease or human disease?…Which agency is in charge?
- Interface between Public Health and Veterinary Public Health at local, national and international levels.

Emerging Zoonoses: Strategies for Prevention and Control

- Advanced structures for diagnosis and surveillance, international and interdisciplinary interventions: Know-How, availability and flexibility
- Applied epidemiological and ecological research: Field-trained specialists: Epidemic Intelligence Veterinary Public Health Officers? Fellowships, training grants, PhDs…
- Develop training in molecular epidemiology: The microchip revolution: on site instantaneous multitest
Emerging Zoonoses: Strategies for Prevention and Control

- Education: Training, technology transfer.
- Information/Communication
  - Enhance communication of information
  - Use diverse communications methods
  - Establish partnerships to ensure rapid implementation of prevention measures
  - An on-line journal for new and emerging disease information

(Source: F.A. Murphy, UCD)


- A rapid communication system
- A wide-ranging legal authority
- A way to get full participation of everyone involved and to deal with “turf battles” (who gets the credit?)
- A coordinated response to the media and a professional response to public misperceptions
- A progressively redefined case definition (for clinical and epidemiological purposes)
- A locally updated clinical management guidelines
- A locally updated biosafety management guidelines
- Reagents and diagnostic technology transfer to local sites
- A way to shift from emergency to regular response mode.
**CDC Emerging Infections Priority Issues, 1999-2000**

(in yellow those applying to emerging zoonoses)

- Antimicrobial resistance
- Food and water safety
- Vectors and animal health
- Blood safety
- Infections that cause chronic diseases
- Opportunistic infections
- Maternal and child health
- Health of travelers and refugees
- Vaccines

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**Strategies for Prevention and Control of Emerging Zoonoses: CONCLUSIONS**

- **Discovery-to-control continuum:** discovery, recognition, epidemiologic field investigation, etiologic investigation, diagnostics development, focused research, technology transfer, training and outreach, prevention, control and elimination, if possible.
- **What made it possible?** Better diagnosis tools, Awareness (especially of the wide wildlife reservoir) and Readiness, Collaboration and technology transfer, establishing surveillance systems.
- **What should be next?** Field-trained specialists: Epidemic Intelligence Veterinary Public Health Officers?
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August 14, 1953 – May 10, 2002