CONTROL AND PREVENTION OF EMERGING ZOONOSES.

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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.
Emerging and Re-emerging Zoonoses

• Zoonoses: “The diseases and infections which are naturally transmitted between vertebrate animals and man.” (WHO, 1959)

• Emerging and re-emerging zoonoses: “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.” (Meslin, WHO, 1992)

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>
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<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.
ZOONOSES and the RISK of DISEASE EMERGENCE
Int. Conf. Emerging Infectious Diseases, Atlanta, GA, July 16-19, 2000

- 49% (832) of the 1,709 human pathogens are zoonotic and 9% (156) are emerging pathogens, but 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.
- All but one of classified category A biological agents for bioterrorism and most of category B are zoonoses.

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 Disease)
- 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 (Rhabdovirus)
- 1997 Menangle virus (Paramyxovirus)
- 1997 Influenza virus H5N1 (Hong Kong)
- 1998 Nipah virus (Paramyxovirus)
- 1999 Influenza virus H9N2 (Hong Kong)

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
- Bioterrorism
Speed of Global Travel in Relation to World Population Growth


Population Density, United States, 1790-2000

Source: F.A. Murphy, UCD
Emerging Zoonoses

- Estimated Global Mobile Population
  - International Travelers: 698 million (WTO, 2000)
  - Migrant Workers: 70-80 million (ILO, 2001)
  - Refugees/Uprooted People: 22 million (UNHCR, 2002)
  - 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
• Ethnic preferences
• “High-risk” populations, especially increase of immuno-compromised individuals (up to 20%)
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

Fig. 1. First occurrence of indigenous BSE cases.
Emerging Infections: Economic Development and Land Use

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 and Nipah viruses.

(Source: F.A. Murphy, UCD)

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Nipah virus, Malaysia, 1998

Deforestation, urbanization, increased pig production....
EMERGING, RE-EMERGING ZOONOSES

Leptospirosis

In the past: mainly serovars: L. canicola, L. icterohaemorrhagiae

Increased cases in dogs in USA in recent years, in California: L. pomona, L. bratislava
In Massachusetts, New Jersey, New York, Michigan:
L. grippothyphosa, L. pomona, L. autumnalis

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

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, African pygmy hedgehogs
  - Egyptian bats and rabies
Emerging Zoonoses

Emerging Bacterial Zoonoses and the Immunocompromised Individuals.

- Salmonellosis, Campylobacteriosis
- *Rhodococcus equi, Bordetella bronchiseptica*
- Bacillary angiomatosis (*Bartonella henselae, B. quintana*)
- Fish tank Granuloma (*Mycobacterium marinum*)
- Dog bites (*Capnocytophaga canimorsus*)
Emerging Zoonoses: Why Now?

• Better tools for diagnosis of fastidious organisms: The Molecular Microbiology Revolution: Hantavirus, Bartonella, etc…
• Epidemiological studies, outbreak investigation
• 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 i.e., tick-borne infections: Ehrlichioses, Lyme, etc.

Emerging Zoonoses

• Knowing is not enough; we must apply.
• Willing is not enough; we must do.

(Goethe)
Emerging Zoonoses: Control and Prevention

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

Emerging Zoonoses: Control and Prevention

- 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 spp. in marine mammals.
Emerging Zoonoses: Control and Prevention

• Investigation
  Collaborative field work of multidisciplinary teams with the support of expert staff scientists and advanced laboratories with molecular biological and immunological 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 reservoirs of Rickettsia felis, murine typhus, Sarcocystis neurona.

Emerging Zoonoses: Control and Prevention

• 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: Control and Prevention

• 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 multitests

Emerging Zoonoses: Control and Prevention

• 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)
Control and Prevention 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), readiness, establishing surveillance systems, collaboration and technology transfer.

• **What should be next?** Increased awareness and improved curriculum in VPH/ Zoonoses for DVM students. Develop a group of field-trained specialists.

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Strategies in Prevention and Control: 
**What we need** *(G.A. Gellert, Nature, 1994;370:409)*

- 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.