Emergence of new pathogens
‘Viruses’

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Outline

• Emerging pathogens -trends
• Emerging & re-emerging diseases
• Factors contributing to emergence
• Examples/ Case studies
• Public health response
• Control and prevention
Emerging pathogens-trends

• Changes in environment - ecological changes provide new opportunities for pathogens to emerge and gain access to human populations

• Ease of world travel (trade and tourism) and increased global interdependence – transmission of infectious agents, disease reservoirs/vectors
Emerging pathogens-trends

- A pathogen may emerge as an important public health problem because of changes in itself or its transmission pathways.
  - **The viruses** with the greatest potential for emergence in the near future include: hantavirus, dengue, influenza, and HIV etc

- Since last quarter of 20\textsuperscript{th} century - New & Reemerging infectious diseases

- Unusually large number - Rotavirus, HIV/AIDS, Hantavirus, Hepatitis E, Hepatitis C, ............
• **MERS (Middle East Respiratory Syndrome)** similar to SARS caused by *coronavirus* which appeared in Saudi Arabia in late 2012, caused 52 deaths (van Boheemen *et al.*, 2012).

• India (**Bangalore**) - a Haj returnee was diagnosed with MERS this week (**Deccan Herald**- Nov, 11, 2013).

  *WHO* - November, 4, 2013 – 149 affected, 64 deaths (53 in Middle East)

• ‘**Severe fever with thrombocytopenia syndrome**’ (**SFTS**) in China in 2010. – *bunyavirus*, (Dexin Li, 2013). **Ticks** are suspected to be the vector that transmits the virus to human.

• China, May, 2013- new H6N1 avian influenza virus (Nov, 15, 2013, **Deccan Herald**)
Emerging infections

• “New, emerging infections whose incidence in humans has increased within the past two decades or whose incidence threatens to increase in the near future.”
Emerging Viral Infections in the World and US since 1973

<table>
<thead>
<tr>
<th>Year</th>
<th>Virus/Agent</th>
<th>Disease/Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>Rotavirus</td>
<td>Enteritis/Diarrhea</td>
</tr>
<tr>
<td>1977</td>
<td>Ebola virus</td>
<td>VHF</td>
</tr>
<tr>
<td>1977</td>
<td>Hanta virus</td>
<td>VHF / renal failure</td>
</tr>
<tr>
<td>1983</td>
<td>HIV</td>
<td>AIDS</td>
</tr>
<tr>
<td>1988</td>
<td>Hepatitis E</td>
<td>Hepatitis</td>
</tr>
<tr>
<td>1989</td>
<td>Hepatitis C</td>
<td>Hepatitis</td>
</tr>
<tr>
<td>1990</td>
<td>Guanarito virus</td>
<td>VHF(Venezuela)</td>
</tr>
</tbody>
</table>
# Emerging Viral Infections in the World and US

<table>
<thead>
<tr>
<th>Year</th>
<th>Virus Name</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>Sabia virus</td>
<td>VHF (Brazil)</td>
</tr>
<tr>
<td>1994</td>
<td>Hendra virus</td>
<td>Respiratory dz</td>
</tr>
<tr>
<td>1995</td>
<td>Hepatitis G</td>
<td>Hepatitis</td>
</tr>
<tr>
<td>1995</td>
<td>H Herpesvirus-8</td>
<td>Kaposi sarcoma</td>
</tr>
<tr>
<td>1997</td>
<td>Avian influenza (H5N1)</td>
<td>Influenza</td>
</tr>
<tr>
<td>1999</td>
<td>Nipah virus</td>
<td>Encephalitis</td>
</tr>
<tr>
<td>1999</td>
<td>West Nile virus</td>
<td>Encephalitis</td>
</tr>
<tr>
<td>2003</td>
<td>Monkey pox</td>
<td>Pox</td>
</tr>
<tr>
<td>2003</td>
<td>SARS-CoV</td>
<td>SARS</td>
</tr>
</tbody>
</table>
### Major Factors Contributing to Emergence of New Pathogens

<table>
<thead>
<tr>
<th>Microbial agent</th>
<th>Human Host</th>
<th>Human Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic adaptation &amp; change</td>
<td>Human susceptibility to infection</td>
<td>Climate and weather</td>
</tr>
<tr>
<td>Dev. of resistance to drugs</td>
<td>Human demographic and behaviors</td>
<td>Changing ecosystems</td>
</tr>
<tr>
<td></td>
<td>International trade and travel</td>
<td>Economic development and land use</td>
</tr>
<tr>
<td>Intent to harm (bioterrorism)</td>
<td>Occupational exposures</td>
<td>Technology and industry</td>
</tr>
<tr>
<td>Occupational exposures</td>
<td>Inappropriate use of antibiotics</td>
<td>Poverty and social inequality</td>
</tr>
<tr>
<td>Inappropriate use of antibiotics</td>
<td>Lack of public Health measures</td>
<td>Animal populations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>War and famine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of political will</td>
</tr>
</tbody>
</table>
HUMAN

ENVIRONMENT
- Mega-cities
- Migration
- Climate change
- Pollution
- Exploitation

ANIMALS
- Antibiotics
- Zoonosis
- Food production
- Intensive farming

VECTORS
- Vector proliferation
- Vector resistance

Transmission
Emerging viral Infections: Climate & environmental change

- **Deforestation** forces animals into closer human contact- increased possibility for agents to breach species barrier between animals & humans
- **El Nino**- Triggers natural disasters & related outbreaks of infectious diseases, altered vector range, vectorborne diseases, Hantavirus pulmonary syndrome (HPS),
- **Global warming** - spread of Dengue, Malaria, Leishmaniasis, Filariasis
Emerging viral Infections: Economic Development, Land Use, Changing Ecosystems

- Changing ecology influencing *waterborne*, vector borne disease transmission
  Dams, Changes in water ecosystem - RVF
  Deforestation/ reforestation : Kyasanur Forest dis, Lyme disease)
- More exposure to wild animals and vectors *(RVF, Lassa fever)*
- Agricultural activities - Hanta, Argentine hemorrhagic fever, Nipah, West Nile
- Contamination of watershed areas by animals
# Waterborne viral infections

Feces Contaminated drinking water and improperly treated water

<table>
<thead>
<tr>
<th>Disease</th>
<th>Virus</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatitis A disease</td>
<td>Hepatitis A virus</td>
<td>Fever, jaundice, vomition, diarrhea, severe abd. pain</td>
</tr>
<tr>
<td>Poliomyelitis/Polio</td>
<td>Poliovirus</td>
<td>90-95% no symptoms, physical abnormalities in later stages</td>
</tr>
<tr>
<td>Hepatitis E</td>
<td>Hepatitis E virus</td>
<td>Fever, jaundice, vomition, diarrhea severe abd. pain</td>
</tr>
<tr>
<td>SARS</td>
<td>Corona virus</td>
<td>Fever, myalgia, cough, sore throat</td>
</tr>
<tr>
<td>Adenovirus infection</td>
<td>Adenovirus</td>
<td>Pharyngitis, pneumonia</td>
</tr>
<tr>
<td>Calicivirus</td>
<td>Viral gastroenteritis</td>
<td>Severe diarrhea</td>
</tr>
<tr>
<td>Rotaviral diarrhea</td>
<td>Rotavirus</td>
<td>Severe diarrhea in children</td>
</tr>
<tr>
<td>Rift valley fever</td>
<td>A bunyavirus</td>
<td>Fever, severe myalgia, diarrhea</td>
</tr>
<tr>
<td>West Nile fever</td>
<td>WNV- a Flavi virus</td>
<td>encephalitis</td>
</tr>
</tbody>
</table>
Emerging viral Infections: Technology and Industry

- Food-handling practices - SARS, H5N1 influenza,
- More organ transplants and blood transfusions (Hepatitis C, HIV, Kaposis Sarcoma)
- New drugs for humans (prolonging immunosuppression)
- **Animal husbandry practices** - (H1N1, H5N1, Nipah etc. 60 to 80% new human infections likely originated in animals, rodents and bats, (hantavirus pulmonary syndrome, Lassa fever, and Nipah virus encephalitis)
Emerging viral Infections:
Human Demographics, Behavior, Vulnerability

- Uncontrolled urbanization - more people, more crowding, unsafe water, poor sanitation
- Changing sexual mores (HIV, STDs)
- Injections (HIV, Hepatitis C)
- Changing eating habits: out more, more produce (food borne infections)
- More populations with weakened immune system: elderly, HIV/AIDS, cancer patients and survivors, persons taking antibiotics and other drugs
Emerging Viral Infections

International Travel and Commerce

• Movement of persons infected with an exotic disease (SARS, VHF, …)
• Exotic pet trade (Monkey pox)

Microbial Adaptation and Change

• Increased virulence
• Jumping species from animals to humans (avian influenza, HIV?, SARS?)
Emerging viral Infections
Poverty, Social Inequality, Breakdown of Public Health Measures

• Lack of basic hygienic infrastructure (safe water, safe foods, etc… Marburg angola 2004)
• Discontinued mosquito control efforts (dengue, WNV, RVF)
• Lack of monitoring and reporting (SARS)
Examples of Emergence of new viral pathogens / Case studies

• 1. Hantavirus Pulmonary Syndrome-1993
• 2. Hendra virus- Australia 1994
• 3. Nipah virus-Malaysia -1999
• 4. SARS-China 2003
• 5. Marburg - Angola 2004
• 6. MERS in Middle east -2012
Examples of recent emerging diseases

Source: NATURE; Vol 430; July 2004;
www.nature.com/nature
Hantavirus outbreak in 1993

- May, 1993 - unexplained acute resp. failure in New Mexico - healthy adults of 20-24 yr age
  - 60% fatality, associated with a field mice - ‘Hantavirus’
- Hantavirus pulmonary syndrome - Sin Nombre virus, deer mouse - reservoir
- 1992- ElNino- heavy rainfall- increased pinyon nuts, more mice – increased exposure
Hendra virus-1994

• severe respiratory disease with high mortality in thoroughbred horses in Brisbane, Australia

• Two persons at the stable developed a severe influenza-like disease and one died. A new virus- **Hendra virus** of Paramyxoviridae, was isolated from both affected horses and a human,

• sporadic but continuing cases of this devastating disease in both horses and humans, including veterinarians who performed necropsies on affected horses.

• **Fruit bats**- reservoir host
Nipah virus outbreak in 1998

- Sept, 1998- encephalitis in Malaysia mainly in pig farmers (also resp. illness & encephalitis in pigs) - 40 % fatalities
- New virus ‘Nipah’ was isolated, related to Hendra
- possible transmission from pigs
- Singapore-import ban on pigs from Malaysia
- Malaysia - >1 million pigs culled,
- **Fruit bats** (*Pteropus giganteus*) – reservoirs
  (Hendra and Nipah belong to Henipavirus of Paramyxoviridae)
Reasons for Nipah emergence

- Fruit bats habitat reduced by deforestation,
- 1997-98 drought led to fires further decreasing avail. of fruits
- Bats urine and eaten fruits dropped onto pigs

2001-2012 Bangladesh - Nipah
161 deaths / 209 cases 77% fatality
Feb, 2013 - 10 deaths / 12 cases
Person to person transmission (no pig involvement),
   Suspected date palm juice

India - 2001-2007 - 50 deaths / 71 cases in West Bengal - 70% fatality (WHO, 2013)

Fruit bats (*Pteropus giganteus*) seropositive to Nipah
**SARS: First Emerging Infectious Disease Of The 21st Century** - First case in Nov, 2002 - atypical pneumonia in Guangdong, China, spread to Vietnam, Canada, Singapore, - corona virus

No infectious disease has spread so fast and far as SARS did in 2003

[SARS Cases 19 February to 5 July 2003](#)

**Total:** 8,439 cases, 812 deaths, 30 countries in 7-8 months

Source: [www.who.int/csr/sars](http://www.who.int/csr/sars)
Marburg and Ebola hemorrhagic fevers

- In 1967, 31 cases of hemorrhagic fever, with seven deaths among laboratory workers in Germany and Yugoslavia who were processing kidneys from African green monkeys imported from Uganda - ‘Marburg virus’

- 1976, two epidemics of hemorrhagic fever with high mortality occurred, in Zaire (Democratic Republic of Congo) and southern Sudan - ‘Ebola virus’

- June, 1997 - 1054 cases with 754 deaths by WHO

- 2004-05 - Marburg VHF in Angola children, 95 deaths out of 102 cases,
• **Ebola and Marburg viruses** cause a **most devastating clinical disease** in humans and non-human primates, including chimpanzees, gorillas, and macaques, with extremely rapid and florid tissue damage, and with a very high mortality rate.

• **Fruit bats** reservoir hosts of ebola- and marburg viruses (Filoviridae)
Avian and Swine flu

- **1997-H5N1** Avian influenza - movements of birds, both migratory fowl and domestic poultry,
- **2009-H1N1-Swine flu** emerged from pigs - virus was emerged after complex exchanges of human, swine and avian influenza virus genes
- Early 2013- **new H7N9 avian** influenza - China-132 cases , 28% fatalities(Li Q et al., 2013)
- China, May, 2013- new **H6N1** avian influenza virus (Nov, 15, 2013, *Deccan Herald*) in a Taiwan woman- flu like illness
New Influenza A (H1N1),
Number of laboratory confirmed cases and deaths as reported to WHO

Status as of 27 May 2009
06:00 GMT

Total:
13 398 cases
95 deaths

Chinese Taipei has reported 4 confirmed cases of Influenza A (H1N1) with 0 deaths. These cases have been included in the cumulative total.

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Public Health Information and Geographic Information Systems (GIS)
World Health Organization

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Map produced: 27 May 2009 06:30 GMT
Reemerging viral pathogens

- First appeared long ago, survived and persisted, continue to appear in new locations
- **Dengue fever** – millions of cases annually
- **West Nile virus** - 1990-middle east- Europe-Americas, leading cause of Encephalitis
- 2007-2010-**WNV in India** – children in Northeastern states (Khan *et al* 2011), 2013-**Kerala**
- **Yellow fever**- Africa and South America
- **CCHF**- more cases, ticks vectors
Dengue fever

Adapted from EID Dispatch.
Monkey pox in 2003 in US

- Transmitted from imported African rodents (rope squirrel, giant pouched rat)– to prairie dogs (co-housed) - to humans
- 82 infections in children and adults
- US-Ban on import of African rodents
- > 500 human cases in Congo 1996-97
- Signs and symptoms similar to Smallpox
- Virus is maintained in rodents and non human primates
PRACTICAL APPROACHES IN LIMITING THE EMERGENCE OF INFECTIOUS DISEASE

– (1) promptly investigate and monitor emerging pathogens, the diseases they cause, and factors of emergence;
– (2) integrate laboratory science and epidemiology to optimize public health practice;
– (3) enhance communication of public health information about emerging diseases and ensure prompt implementation prevention strategies; and
– (4) strengthen local, state, and national public health infrastructures to support surveillance and implement prevention and control programs.
• Microbial genetics
  Methods for disease detection, control & prevention
• Improved diagnostic techniques & new vaccines
• Geographic Imaging Systems
  Monitor environmental changes that influence disease emergence & transmission
• Coordinated, well-prepared, well-equipped public health systems
• Improved methods for detection & surveillance
• Effective preventive & therapeutic measures
• Political commitment & adequate resources to address underlying socio-economic factors
• International collaboration & communication
Key tasks - carried out by whom?
What skills are needed?

Multiple expertise needed!

- Infectious diseases
- Epidemiology
- Public Health
- International field experience
- Laboratory
- Telecom. & Informatics
- Information management