Contagion, the movie – How real is it?

Prof. Lance Jennings, University of Otago, New Zealand

Teleclass broadcast sponsored by Johnson & Johnson (www.jnj.com)

Outline

• What is an emerging disease?
• SARS
• Measles-like viruses & bats
• Influenza
  – why should we be concerned?
  – H5N1 transmissibility
  – Swine flu variant
• Contagion—how real is it OR could it happen again?

Emerging disease

• Collectively, ID are the 2nd leading cause of death globally after cardiovascular disease.
• Approximately 75% of emerging pathogens are zoonotic: that is, they are communicable from animals to humans, which means humans become exposed to microbes that they otherwise would not have encountered.
• Two fundamental characteristics of microbes allow them to circumvent our attempts to control them:
  – Human generations approx every 2 decades,
  – Microbes can occur in minutes, allowing them to rapidly replicate.
  – Can mutate & evolve.
  – Allows them to circumvent human interventions: antibiotics, vaccines or public health measures.
• Partnerships between government, industry and academia are necessary to maintain our armamentarium in the struggle to outwit the microbes that pose a never-ending threat to mankind.

World Organisation for Animal Health definition (OIE)

• OIE’s (Office International des Epizooties) definition of "Emerging disease" is:
  – "A new infection resulting from the evolution or change of an existing pathogenic agent, a known infection spreading to a new geographic area or population, or a previously unrecognized pathogenic agent or disease diagnosed for the 1st time and which has a significant impact on animal or public health."
• An emerging disease with significant morbidity or mortality, or zoonotic potential
  – must be notified

Broadcast live from the New Zealand NDICN Conference (www.ndicn.nz)
A Webber Training Teleclass
www.webbertraining.com
EIDs: complex interplay between host, environment & pathogen

- EIDs & wildlife interact in two ways
  - Wildlife are reservoirs of pathogens that threaten domestic animal & human health
  - Wildlife populations are themselves affected by emerging wildlife diseases

- Emergence is usually multifactorial
  - Agricultural & food-processing changes
  - Pathogen or host invasion into new regions
  - Human encroachment into wildlife habitats
  - International travel
  - Human population movement (war, economic migration etc)


Recent emerging infectious diseases from wildlife reservoirs

<table>
<thead>
<tr>
<th>Virus</th>
<th>Host</th>
<th>Location</th>
<th>Ref Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ebola virus</td>
<td>Flying foxes/fruit bats</td>
<td>Democratic Congo</td>
<td>2001</td>
</tr>
<tr>
<td>Nipah virus</td>
<td>Yellow-‐bellied sheath bat</td>
<td>Bangladesh</td>
<td>2001</td>
</tr>
<tr>
<td>Hendra virus</td>
<td>Australian bat species</td>
<td>Australia</td>
<td>2000</td>
</tr>
<tr>
<td>Ebola virus</td>
<td>Flying foxes/fruit bats</td>
<td>Australia</td>
<td>2001</td>
</tr>
<tr>
<td>West Nile virus</td>
<td>Flying foxes/fruit bats</td>
<td>Australia</td>
<td>2005</td>
</tr>
<tr>
<td>Lyssavirus</td>
<td>Common Serotine &amp; horseshoe bat</td>
<td>Belgium</td>
<td>2000</td>
</tr>
<tr>
<td>Eastern equine encephalitis virus</td>
<td>Flying foxes/fruit bats</td>
<td>USA</td>
<td>1950</td>
</tr>
</tbody>
</table>

Why are bats an important EID reservoir?

- Bats account for 20% of all known mammalian species on earth, second only to rodents
- Flying foxes/fruit bats Genus Pteropus, (30 species) largest genus of Old World fruit bats (Family Pteropodidae)
- Viruses do not cause disease in bats but can be highly lethal when crossing the species barrier
- Additional factors include
  - EIDs & wildlife interact in two ways
  - Agricultural & food-processing changes
  - Pathogen or host invasion into new regions
  - Human encroachment into wildlife habitats
  - International travel
  - Human population movement (war, economic migration etc)


Severe Acute Respiratory Syndrome (SARS)

- SARS began to emerge late 2002 in Guangdong province, in Southern China (1st case: Foshan City 16 Oct 2002)
- Small clusters of cases over next 3 months
- February 2003: outbreak of viral pneumonia in Guangzhou,
  - 300 cases, 5 deaths
  - Spread outside Guangdong province to Hong Kong on 21 February 2003
- International spread late-Feb
- High AR in hospital staff

The origin of SARS Coronavirus?

Community Outbreak

- Dec 2003/Jan 2004: 3 Chinese SARS cases associated with a "wild food" restaurants
- Wet meat markets in southern China origin outbreak
- SARS has a zoonotic origin
  - Himalayan Palm cirvet cats implicated (secondary market reservoir species)
  - Chinese Horseshoe Bats (Rhinolophus spp)

Broadcast live from the New Zealand NDICN Conference (www.ndicn.nz)
A Webber Training Teleclass
www.webbertraining.com
Contagion, the movie – How real is it?
Prof. Lance Jennings, University of Otago, New Zealand
Teleclass broadcast sponsored by Johnson & Johnson (www.jnj.com)

Public health response, China

Fever Clinics: Beijing

Newly emerged paramyxoviruses

• Family: Paramyxoviridae
• Subfamily: Paramyxovirinae
• Genus: Henipavirus
• Hendra virus (HeV) Australia, 1994
• Nipah virus (NiV) Malaysia, 1998

Heniparviruses: Hendra & Nipah

• Since emergence in 1990’s the heniparviruses have been a reoccurring threat to human health in SE Asia & Australia
• Both HeV & NiV are contagious, highly virulent & capable of infecting wide range of mammalian species.
• Natural reservoir are flying foxes/fruit bats

Hendra virus

• First isolated in 1994, in race horses & man in Hendra, a suburb of Brisbane.
• Natural host shown to be flying foxes of Genus Pteropus, not horses.
• All events associated with flying fox activity, and index horses in paddocks with fruiting trees.
• Human exposure to body fluids and excretions of infected horses.
• 1994 – 2010, 44 horses & 7 humans infected
• 2011 (18); 2012 (6) outbreaks in 2011 in Queensland and New South Wales

Horses:
- Lethargy or agitation, ATE, anorexia and respiratory distress with haemorrhagic nasal discharge. 70% mortality

Humans:
- ILI, meningitis, encephalitis

Hendra virus emergence

• Increasing frequency of ‘spill-over’ events in 2011/12
• Bat range expansion
- Increasing urbanisation
• Disrupted ecosystems
- Habitat destruction
- Hunting
- Global warming

Hendra virus

Epidemiology
• Bat-to-horse
  - Contamination of pastures & feed with bat urine & gestational products.
• Horse-to-human
  - Droplet spread to mucosal surfaces with infected respiratory secretions
  - Direct contact with excretions & secretions
• Horse-to-horse
  - Contaminated horse stable environment
• Human-to-human
  - Not demonstrated/HCWs

Fever Clinics: Beijing

Xiaotangshan Hospital, Beijing
1,000 beds/10 days

Phylogenetic tree based on the N protein sequences of selected paramyxoviruses.

Field et al. PLoS Pathogens 14, e1002836. doi:10.1371/journal.ppat.1002836
http://www.plospathogens.org/article/info:doi/10.1371/journal.ppat.1002836

Broadcast live from the New Zealand NDICN Conference (www.ndicn.nz)
A Webber Training Teleclass
www.webbertraining.com
Contagion, the movie – How real is it?
Prof. Lance Jennings, University of Otago, New Zealand
Teleclass broadcast sponsored by Johnson & Johnson (www.jnj.com)

Nipah virus
- First outbreak 1998/99 in Sungai Nipah, peninsular Malaysia. Thought to be due to JEV. (Chua et al. Science 2000;288:1412-5)
- Exposure to infected pigs principle mode of human infection.
- Emergence due to large pig farms encroaching forested areas of high fruit bat activity.
- Spill over into pigs, then movement of pigs to urban farms increased human exposure.
- 12 outbreaks, in south peninsula/Singapore involving pigs & humans.
  - 1998-99: 265 human cases; 40% died
- Clinical features: encephalitis
- Outbreak contained by culling >1.1 m pigs
- NV & HeV similar genetically, thus flying foxes likely reservoir (Genus Pteropus)

2001 outbreak in Siliguri, India. Involved family members & HCWs
- No intermediate host identified
- 2001-2009 Bangladesh/West Bengal
  - 8 smaller outbreaks
  - Clinical features
    - Pulmonary disease, late encephalitis
    - 70% CFR
  - Transmission
    - No intermediate host identified, number of possible routes for human infection
    - Bat-to-human (Genus Pteropus)
      - Roosting/feeding areas, palm sap tapping
    - Human-to-human
  - Other mammals –to-human

Henipaviruses summary
Since 1990's a reoccurring threat to human health in SE Asia & Australia
Frequent spill-over events

Influenza virus
- Family: Orthomyxoviridae
- Genus: Influenza virus
- Types: A & B (C)
- ss RNA genome
  - 8 segments encode different proteins

Broadcast live from the New Zealand NDICN Conference (www.ndicn.nz)
A Webber Training Teleclass
www.webbertraining.com
Contagion, the movie – How real is it?
Prof. Lance Jennings, University of Otago, New Zealand
Teleclass broadcast sponsored by Johnson & Johnson (www.jnj.com)

Spanish ‘Flu Symptoms
A letter from a physician at a US Army camp to a colleague

• “These men start with what appears to be an ordinary attack of La Grippe or Influenza, and when brought to the hospital they very rapidly develop the most vicious type of pneumonia that has ever been seen…
• and a few hours later you can begin to see the cyanosis extending from their ears and spreading all over their face, until it is hard to distinguish the coloured men from the white.
• It is only a matter of a few hours until death”

Grist NR BMJ 1959

1918-19 Pandemic:
Life expectancy shortened to <40 yrs

Influenza: a human respiratory disease
Transmitted by small & large droplets

Human influenza

Transmission Efficiency of Influenza: Guinea Pig Model

Ecology of Influenza A Viruses

Broadcast live from the New Zealand NDICN Conference (www.ndicn.nz)
A Webber Training Teleclass
www.webbertraining.com
Contagion, the movie – How real is it?
Prof. Lance Jennings, University of Otago, New Zealand
Teleclass broadcast sponsored by Johnson & Johnson (www.jnj.com)

The ecology of Influenza A viruses

- Influenza viruses in their natural reservoirs are in evolutionary stasis
- Rapid evolution (Low path to High path) occurs after transfer to new hosts

Avian influenza viruses
Low Pathogenicity (H1-16)  
Highly Pathogenic (H5,H7)

Localized Respiratory, GI tract  
Systemic

Viral factors influencing interspecies transmission

A polygenic trait

PB2
PB1
PA
HA
NS

627

PB2

226

HA

PQRERRRKKRGLF

92

NS1

Cytokine agonist (Cheung et al. Lancet 2002)

Spread of influenza H5N1 viruses


H5N1 evolution


Broadcast live from the New Zealand NDICN Conference (www.ndicn.nz)
A Webber Training Teleclass
www.webbertraining.com
Contagion, the movie – How real is it?
Prof. Lance Jennings, University of Otago, New Zealand

Teleclass broadcast sponsored by Johnson & Johnson (www.jnj.com)

H3N2v an influenza virus of concern
Ohio officials probe possible swine flu cases

“Two pigs have been sent home from the Ohio State Fair because they have the swine flu (influenza) virus. The state veterinarian discovered the sick hogs Thursday [2 Aug 2012].”
Source: Promed Influenza (66) 8 August 2012

Broadcast live from the New Zealand NDICN Conference (www.ndicn.nz)
A Webber Training Teleclass
www.webbertraining.com
Contagion, the movie – How real is it?
Prof. Lance Jennings, University of Otago, New Zealand
Teleclass broadcast sponsored by Johnson & Johnson (www.jnj.com)

Non-pharmaceutical/public health interventions
- The only option for some countries
- Measures to limit international spread
  - Entry screening
  - Travel advice & restrictions
  - Border closure
- Measures to reduce national and community spread
  - Quarantine
  - Social distancing
  - School closures etc
- Measures taken by individuals
  - PPE-masks
  - Respiratory and hand hygiene
- Risk communication

Perhaps Hollywood has the answers for the control of EIDs......

Broadcast live from the New Zealand NDICN Conference (www.ndicn.nz)
A Webber Training Teleclass
www.webbertraining.com