VIRUS THREATS OLD AND NEW

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Conference Chairman  (*morning sessions*)
25 DISEASES CAUSING MAJOR MORBIDITY

TEMPERATE
- 10 of 15 diseases of crowding
- Tend to be acute diseases
- 8 of 15 derived from domestic animals

TROPICAL
- 8 of 10 vector transmitted and have animal reservoirs
- 4 out of 10 not human primate origin

Factors Leading to New Zoonotic Diseases

FOREST CLEARANCE

Guanarito Arena virus
Venezuela 1989

DAM BUILDING

- Increased vector density
- Animals and people congregate

Cotton rat host

Infective dust

Rift Valley Fever - 200,000 deaths following construction of Aswan Dam

Population

Dams

0 25 50 75 100
1.7 3.3 5.0 6.7

1850 1900 1950 2000

Population in billions

Year

Manx BioMed
Bio Business Conference 10th December 2015
Increased opportunities to travel the world and contract interesting diseases

Days to Circumnavigate The Earth

Population Billions

1850 1900 1950 2000

1.7 3.4 6.8
Ebola and Marburg viruses are filoviruses first identified in the 1960-70s and the causal agents of haemorrhagic fevers. (You leak to death)

• Ebola-Zaire 65 to 90% mortality
• Ebola-Sudan 50% to 65% mortality
• Ebola-Taï Forest 1 case non-fatal
• Ebola-Bundibugyo 32% mortality
• Ebola-Reston 7 cases non fatal

• Marburg first reported through infection of laboratory workers infected by grivet monkeys. 31 infected 8 deaths. 2014 1 death 5 possible infected in Uganda
Ebola Transmission: Ebola is controllable

Ebola is controlled once you prevent 50% of infectious contacts

<table>
<thead>
<tr>
<th></th>
<th>Reproduction Rate</th>
<th>Time to New Infection (Generation Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Influenza</td>
<td>3-5</td>
<td>3 days</td>
</tr>
<tr>
<td>Ebola</td>
<td>1.3-1.8</td>
<td>14 days</td>
</tr>
</tbody>
</table>
3 New Zoonotic Virus Infections (Henipaviruses) Arising From Flying Foxes (*Pteropus* spp.)

- Nipah virus
- Hendra virus
- Menangle virus
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**Image Description:**
- **Virus:** A viral particle is shown at the microscopic level with a scale of 100nm.
- **Nucleocapsid:** The nucleocapsid is depicted as a structure within the viral particle.

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**Diagram:**
- **Pteropus Spp (flying fox):** 
- **Ixodes holocylus:** Question mark indicates uncertainty.
- **15 horses killed:**
- **2 human deaths:** 

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**Legend:**
- **Aerosol:** Indication of potential transmission route.
SV40 Contaminated Poliovirus Vaccines

Primary kidney cells

10 – 30 million of 98 million vaccinated received SV40 1955-63
Seasonal and Pandemic Influenza

- **Annual winter epidemics**
  - 10-20% of world population is infected
  - In the US:
    - 25-50 million individuals infected
    - >20,000 deaths and >110,000 hospitalizations
    - >$12 billion in direct and indirect health costs

- **Worldwide pandemics**
  - 1918-19 Spanish Flu: 20-40 million deaths
  - 1957 Asian/1968 Hong Kong: >1.5 million deaths
  - 1997/2008 H5/N1?
Viruses attach to cells via the haemagglutinin
It's sex but not as we know it*

*But not too dissimilar to sex in Edinburgh
A single amino acid change could enable human to human transmission.

View of Binding pocket of Haemagglutinin

- Human strains wide pockets
- Avian strains narrow pockets
- Mutated 1918 avian strain wide pocket
Infection to transmission

- Viruses are constantly being transmitted across species barriers.
- In most cases, these are end infections—sometimes dead ends.
- From infection to infectious:
  - HIV: weeks
  - SARS: 10 days
  - Influenza: 2 days

HIV Weeks

- Human infection but no onward transmission "end host"
- Many variants "Quasispecies"
- Ebola: Acute disease
- HIV: Slow onset of disease
- Explosive short outbreak
- Pandemic
Infection to transmission

Flu 2 days
Flu moves fast

Its safe here
Automated handling and injection

One superzize omelet coming up
Problems with egg supplied vaccines

- Long lead times & no flexibility for increased demand
- Avian flu strains don’t grow well in eggs
- Avian flu strains may kill chickens....
- Not the capacity to produce 180 million eggs in the US & ..
Problems with egg supplied vaccines

- Long lead times & no flexibility for increased demand
- Avian flu strains don’t grow well in eggs
- Avian flu strains may kill chickens…..

And the cockerel gets knackered
Cell culture based vaccines

Reverse Genetics

- Genes for H5 N1 plus genes from non-pathogenic virus
- Vaccine virus

Production

Inactivated virus or live temperature sensitive mutant

Purify Proteins

KPMG
Cell culture vaccine production plant

Fermenter 4
(2500 L)
Virus Production

Fermenter 3
Cell propagation
High Cell Density

Fermenter 2
Cell propagation

Fermenter 1
Cell propagation
Conclusion: Whatever you do.......
Don’t kiss a fruit bat