Contagion, the movie – How real is it?

Prof. Lance Jennings, University of Otago, New Zealand

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

Contagion, the movie –
How real is it?

Lance C Jennings

Canterbury Health Laboratories & Pathology Department
University of Otago, Christchurch

Broadcast live from New Zealand

Teleclass broadcast sponsored by Johnson & Johnson MEDICAL

Canterbury Health Laboratories

www.webbertraining.com August 30, 2012

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?

Like **SARS**, the movie's fictional **MEV-1 virus** is initially passed on to the public via unsanitary restaurant practices, and like *Nipah*, the virus enters the food chain when, as the **`the *wrong bat* met up with the *wrong pig'.***

Steven *Soderbergh's* pandemic thriller *`Contagion'*.

Provides a thought provoking and realistic look the nightmare scenario presented by a severe pandemic. Understated and *scientifically plausible*, this film is designed to make you *`think'* as well as feel.

http://cii.columbia.edu/team/lipkin.html

Emerging disease

- **WHO 2004 World Health Report: Infectious diseases account for 26% of the 57M deaths in 2002.**
- **Collectively, <u>ID are the 2nd leading cause of death globally</u>** after cardiovascular disease.
- **<u>Approximately 75% of emerging pathogens are zoonotic</u>:** that is communicated from animals to humans - when human encroach upon a new environment they 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: antimicrobials, vaccines or public health measures.
- **Partnerships** between government, industry and academia are necessary to maintain our armatarium in the struggle to outwit the microbes that pose a never-ending threat to mankind

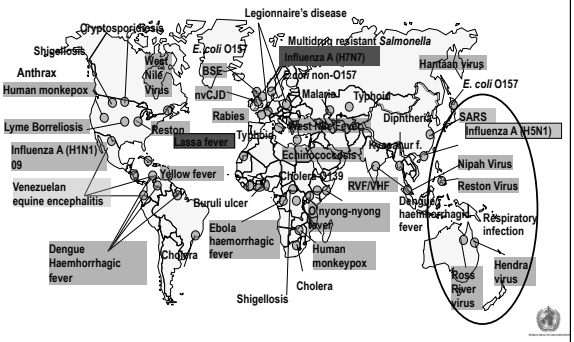
One World One Health

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

Terrestrial Animal Health Code: Article 1.1.3.1.e .

Emerging/re-emerging infectious diseases, 1996–2009



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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 habitat
  - International travel
  - Human population movement (war, economic migration etc)

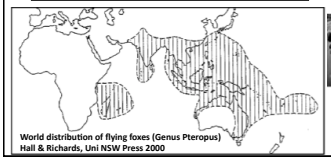
Morse S. Rev Sci Tech OIE 2004;23:443-51; Breed et al. Biol Con 2006;131:211-20

Recent emerging infectious diseases from wildlife reservoirs

Virus	Host	Location	Ref Year
Hantaan virus	Common Serotine & horseshoe bat	Korea	1998
Rift Valley fever virus	Micropteropus & Hipposideros sp.	Republic of Guinea	1998
Yellow fever	Old World fruit bat Epomoporius sp	Ethiopia	1998
Venezuelan equine encephalitis virus	Bat species	Guatemala	1998
St Louis encephalitis	Bat species	Guatemala	1998
Eastern equine encephalitis virus	Bat species	Guatemala	1998
Bat-variant rabies virus	Bat species	USA	2000
Australian bat lyssavirus	Flying foxes Pteropus spp. Yellow-bellied sheath bat	Australia	2000
Hendra virus	Flying foxes *Pteropus* spp.	Australia	2001
Menangle virus	Flying foxes Pteropus spp.	Australia	1999
Nipah virus	Flying foxes Pteropus spp.	Malaysia, Thailand, Cambodia, Bangladesh	2001 - 2005
SARS coronavirus	Horseshoe bats: Rhinolophus spp	China	2005
Ebola virus	Old World fruit bats	Gabon, Republic of Congo	2005

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*, (50 species) largest genus of Old World fruit bats (Family *Pteropodiae*)
- Viruses do not cause disease in bats but can be highly lethal when crossing the species barrier



Severe Acute Respiratory Syndrome (SARS)

- SARS began to emerge late 2002 in *Guandong* 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 global spread of SARS

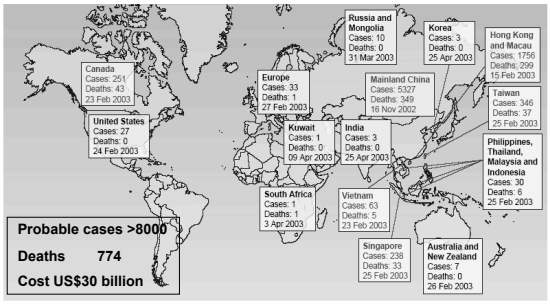


Figure 1 The global spread of SARS. The number of probable cases of SARS and the date of onset of the first case in each country (or group of countries) is denoted. The countries denoted in red are those where substantial local transmission occurred. The data are based on World Health Organization, http://www.who.int/csr/sars/country/table2004_04_21/en/21/en/print.html and the figure is adapted from ref. 15.

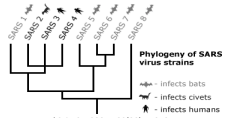
The origin of SARS Coronavirus?

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)

Wet meat /live animal markets

Palm cirvet cats



Lau, S.K et al. *Proc Nat Acad Sci USA* 2005;102(39):14040-45
http://evolution.berkeley.edu/evolibrary/news/060101_batsars

Chinese Horseshoe Bat

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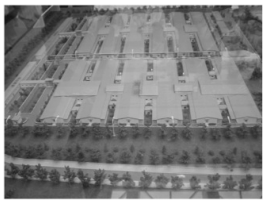
Public health response, China

Fever Clinics: Beijing



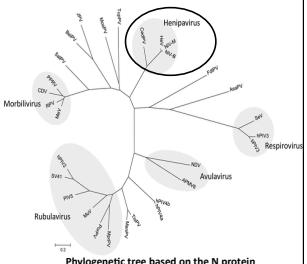
Xiaotangshan Hospital, Beijing

1000 beds/10 days

Newly emerged paramyxoviruses

- **Family: *Paramyxoviridae***
- **Subfamily: *Paramyxovirinae***
- **Genus: *Heniparvirus***

- **Hendra virus (HeV) Australia, 1994**
- **Nipah virus (NIV) Malaysia, 1998**

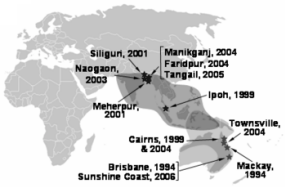


Phylogenetic tree based on the N protein sequences of selected paramyxoviruses.

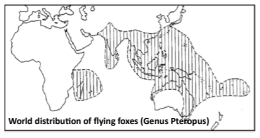
Marsh GA, *et al*. PLoS Pathogens 8(8): e1002836. doi:10.1371/journal.ppat.1002836
http://www.plospathogens.org/article/info:doi/10.1371/journal.ppat.1002836

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



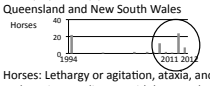
Genus Pteropus



World distribution of flying foxes (Genus Pteropus)

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, ataxia, anorexia and respiratory distress with haemorrhagic nasal discharge. 70% mortality
- Humans: ILI, meningitis, encephalitis

http://www.daff.qld.gov.au/4790_11112.htm

Hendra virus

Epidemiology

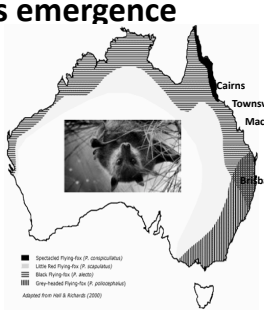
- Bat-to-horse
  - Contamination of pastures & feed with bat urine & gestational products.
- Horse-to-human
  - Droplet spread to mucosal surfaces with infected respiratory secretions
  - Direct contact with excretions & secretions
- Horse-to-horse
  - Contaminated horse stable environment
- Human-to-human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

Flying fox *Pteropus* sp

Field *et al*. EID 2005;16:338-40; Ksiazek *et al*. Virus Res 2010;162:173-183

Hendra virus emergence

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



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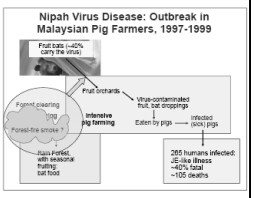
Nipah virus

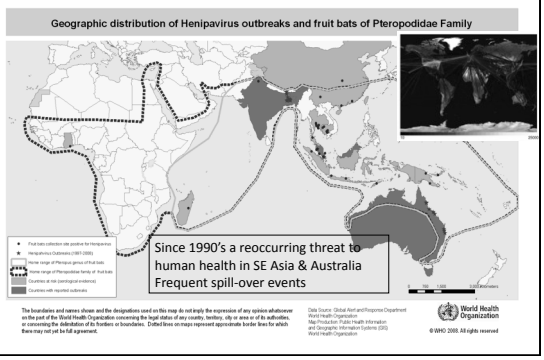
- First outbreak 1998/99 in Sungai Nipah, peninsular Malaysia. Thought to be due to JEV. (Chua et al. Science 2000;288:1432-5)
- Exposure to infected pigs principle mode of human infection.
- Emergence due to large pig farms encroaching forested areas of high fruit bat activity.
- Spill over into pigs, 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
- NiV & HeV similar genetically, thus flying foxes likely reservoir (Genus *Pteropus)*

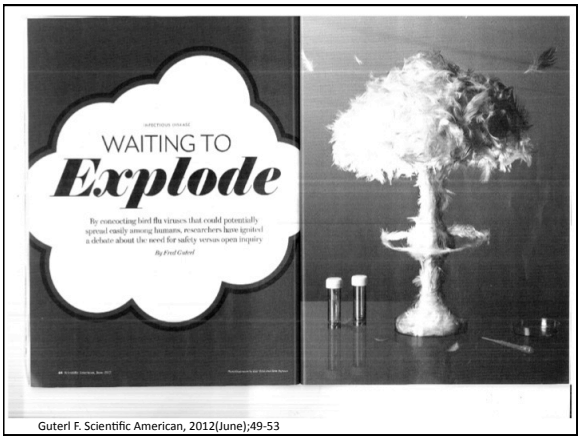


Nipah virus

- 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 *Pteropis*)
      - Roosting/feeding areas, palm sap tapping
    - Human-to-human
    - ?other mammals –to-human

Henipaviruses summary

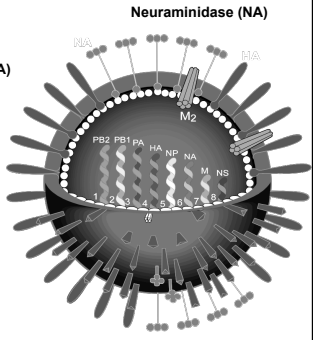




Guterl F. Scientific American, 2012(June);49-53

Influenza virus

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



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Spanish 'Flu Symptoms

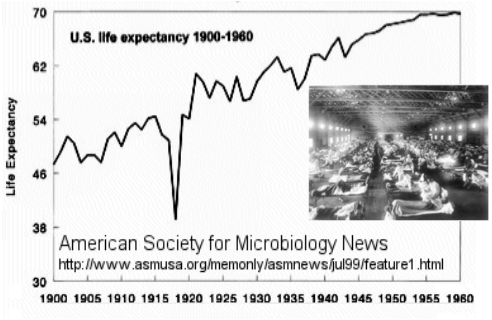
A letter from a physician at a US Army camp to a colleague

- **"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:

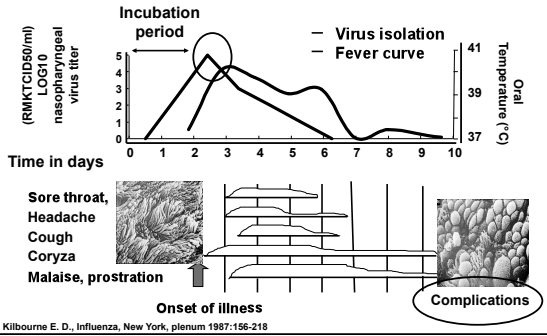
Life expectancy shortened to <40 yrs



Influenza: a human respiratory disease

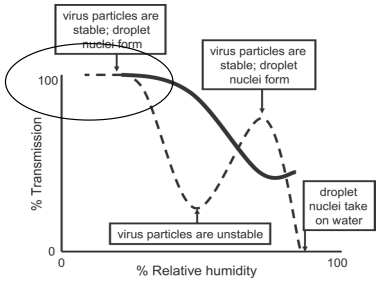
Transmitted by small & large droplets

Human influenza



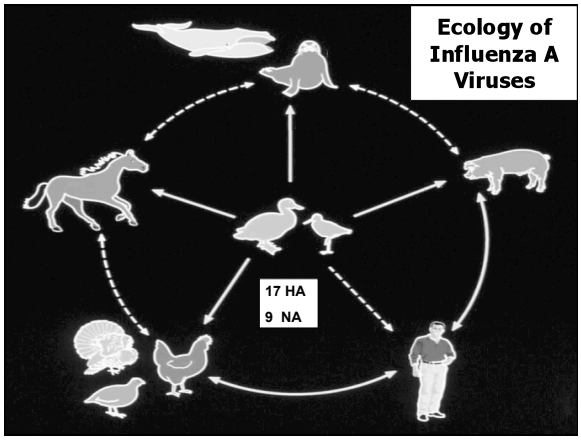
Kilbourne E. D., Influenza, New York, plenum 1987:156-218

Transmission Efficiency of Influenza: Guinea Pig Model



Lowen AC et al. PLoSPathog 2007;3(10):e151

Ecology of Influenza A Viruses



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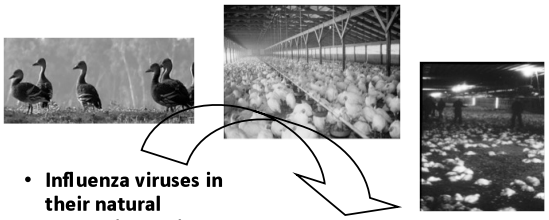
The ecology of Influenza A viruses



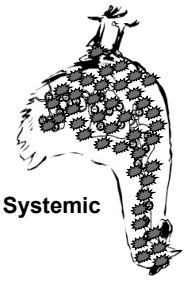
- Influenza viruses in their natural reservoirs are in evolutionary stasis
- Rapid evolution (Low path to High path) occurs after transfer to new hosts

Avian influenza viruses

Low Pathgenicity (H 1-16)

Highly Pathogenic (H5,H7)

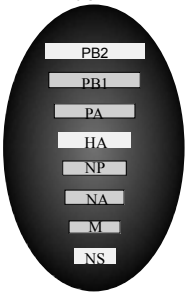
Localized Respiratory, GI tract



Systemic

Viral factors influencing interspecies transmission

A polygenic trait



627 PB2

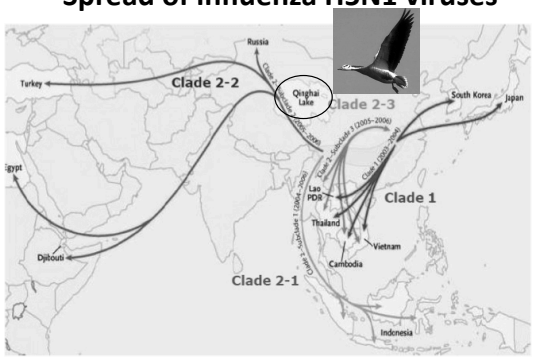
226 228 HA

PQRERRRKKRGLF

92 NS1

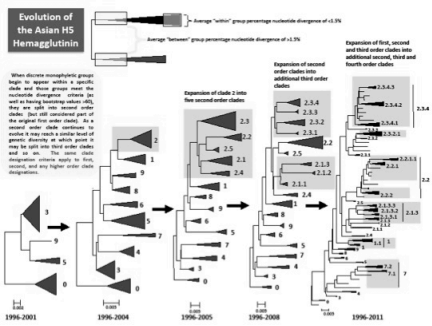
Cytokine agonist (Cheung et al. Lancet 2002)

Spread of influenza H5N1 viruses

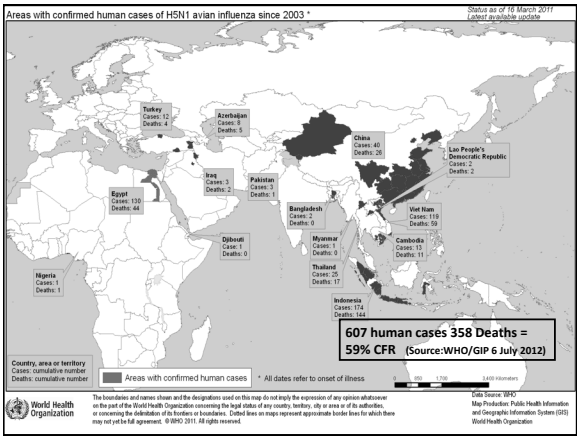


Webster RG, Govorkova EA. N Engl J Med 2006;355:2164-7.

H5N1 evolution



http://www.who.int/influenza/human_animal_interface/en/



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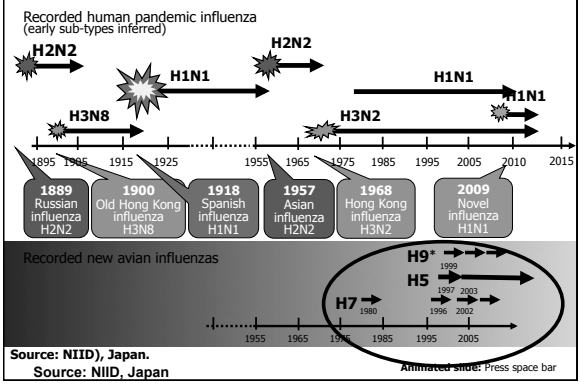
Human exposure

Human exposure/transmission

www.photobucket.com

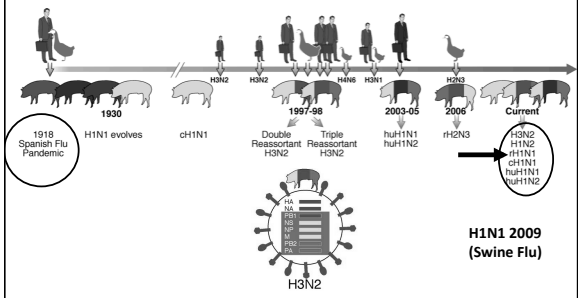
Pandemics of influenza



Source: NIID), Japan.
Source: NIID, Japan

Animated slide: Press space bar

Reassortant events among swine influenza viruses in North America



H1N1 2009 (Swine Flu)

Source: Dr. Amy Vincent, NADC, USDA

H3N2v an influenza virus of concern

Ohio officials probe possible swine flu cases

Wednesday August 1, 2012 9:15 AM

HAMILTON, Ohio (AP) — Ohio health and agriculture officials are investigating 10 sick humans whose cases have similarities to a swine flu virus. All had attended a southern Ohio cou

CDC Preparing Vaccine for New Swine Flu

No sustained person-to-person transmission yet, but this virus has a gene linked to pandemic flu

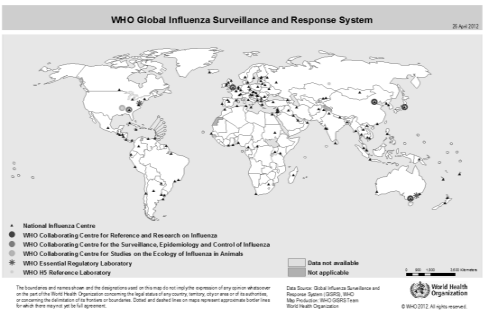
HealthDay

By Steven Reinberg
HealthDay Reporter

FRIDAY, Aug. 3 (HealthDay News) -- Only 29 human cases of a new strain of "swine" flu have been identified in two years, but the U.S. Centers for Disease Control and Prevention is making sure it's prepared should the H3N2 strain become more widespread.

"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

WHO GISRN



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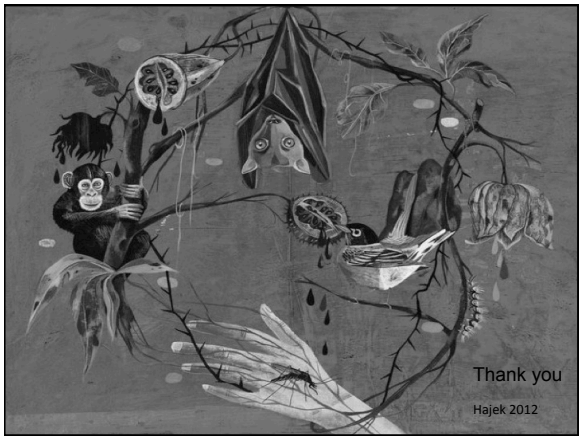
Non-pharmaceutical/public health interventions

- 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.....

This could happen again?



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