Emerging Infectious Diseases

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• “The time has come to close the book on infectious diseases. We have basically wiped out infection in the United States.”
  – Dr William Stewart, Surgeon General, USA, 1967
Globalisation ... global health

• Recent issue of connectedness

• Problems and solutions can travel rapidly

• Networking is important

• Information sharing is paramount

Internet traffic ... note Africa ....

Emerging infections

• Newly identified, previously unknown infections causing public health problems

• Re-emerging
  – ... perhaps an old infection in a new locality ...
  – Infection which had fallen to such low levels but now are rising again in incidence/prevalence
Reasons for emergence ...

- Microbial adaptation/change
  - Resistance
  - Pathogen resistance to antimicrobials
  - Vector resistance to control methods

- New/increased coexistence of humans and pathogens/vectors
  - Encroachment of farming and housing territories
    - Climate change
    - Increased need to provide food (urbanisation, deforestation)
    - Increased travel opportunities
    - Displaced people: war, natural disasters

- Immunosupression (e.g. HIV)
- Mechanised food industry – handling and processing

Emerging infections

- 2/3 have animal reservoirs
  - Influenza
  - Lassa
  - Malaria, dengue ...

Global Examples of Emerging and Re-Emerging Infectious Diseases

FAUCI – updated from Nature article 2004
Progress in control of Infections

- Recognition of microbes as pathogens
- Sanitation, hygiene, vector control
- Antimicrobials
- Vaccines
- Advances in detection
- Communications
- Nutrition

Declining infections as a cause of mortality in richer settings

Global distribution of per capita GDP.

Global distribution of malaria.
Poverty

• Approximately 1.4 billion people in the world live in extreme poverty, with incomes so low that they cannot fill their basic needs.

• If population increases so does the number living in poverty and ill health.
Connected world

• Global health becomes local health
  — Returning travellers

• Local problems become global problems
  — Global economy, globalization ...

• Local economy determines income group

• Income group affects health (as seen with mortality data)
Increasing population, globalization, and Climate change
Temperature rising over time

Globalisation and Health

• Interconnectedness
  – Economic intensity
  – Consequent environmental and social changes

• Interrelated pressures, stresses, and tensions arising from an overly large world population

• Environmental impact of
  – Economic activities
  – Urbanization
  – Consumerism

• Widening gap between rich and poor
Changes

- Population migrations
- Trading
- Cultural diffusion
- Pushing or distorting natural global systems beyond boundaries considered to be safe for continued human social and biologic well-being
- The loss of biodiversity
- Human-induced climate change

Environment change

- Excessive population pressure on regional environments
  - Soil exhaustion
  - Water depletion
  - Loss of various wild animal and plant food species
- Exacerbates various environmental changes
  - Potentiates poverty/disadvantage
    - Poverty assoc with high birth rate
• Is technology just
  – “kicking the can down the street”?
  – Need education
  – Need societal change

Infections and globalisation

• Globally important infections: (quasi-Malthusian), SARS, influenza ...
  – new strains of influenza virus in Southeast Asia and East Asia?
  – risk increases with population growth; backyard animal farming and intensified commercial poultry production

Infections and globalisation

• Freshwater shortages
  – River flows threatened with climate change and industrialisation of rivers/diversions

• Growing food/crops to feed an increasing world population:
  – land degradation, water shortages, and climate change
  – rising demand for animal foods methane producing and requiring more space)
Climate change and infections

- Example
  - China:
    - medium-scenario warming model
      - schistosomiasis will extend northward
      - 20 million MORE people at risk by 2050
  - Dengue

Global Warming and Malaria
Key Tasks in Dealing with Emerging Diseases

- Surveillance at national, regional, global level
  - epidemiological,
  - laboratory
  - ecological
  - anthropological
- Investigation and early control measures
- Implement prevention measures
  - behavioural, political, environmental
- Monitoring, evaluation

What skills are needed?

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

Multiple expertise needed!
Examples of Emerging infections

HIV

• Worldwide disease
Global summary of the AIDS epidemic | 2011

Number of people living with HIV

<table>
<thead>
<tr>
<th>Category</th>
<th>Total</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>34.0 million</td>
<td>(31.4 million–35.9 million)</td>
</tr>
<tr>
<td>Adults</td>
<td>36.7 million</td>
<td>(36.2 million–37.1 million)</td>
</tr>
<tr>
<td>Women</td>
<td>16.2 million</td>
<td>(15.4 million–17.0 million)</td>
</tr>
<tr>
<td>Children (≤15 years)</td>
<td>3.3 million</td>
<td>(3.1 million–3.5 million)</td>
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</tbody>
</table>

People newly infected with HIV in 2011

<table>
<thead>
<tr>
<th>Category</th>
<th>Total</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2.5 million</td>
<td>(2.2 million–2.8 million)</td>
</tr>
<tr>
<td>Adults</td>
<td>2.2 million</td>
<td>(2.0 million–2.4 million)</td>
</tr>
<tr>
<td>Children (≤15 years)</td>
<td>330,000</td>
<td>(250,000–430,000)</td>
</tr>
</tbody>
</table>

AIDS deaths in 2011

<table>
<thead>
<tr>
<th>Category</th>
<th>Total</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>1.7 million</td>
<td>(1.5 million–1.9 million)</td>
</tr>
<tr>
<td>Adults</td>
<td>1.5 million</td>
<td>(1.3 million–1.7 million)</td>
</tr>
<tr>
<td>Children (≤15 years)</td>
<td>230,000</td>
<td>(150,000–370,000)</td>
</tr>
</tbody>
</table>

Advisory on the use of antiretroviral therapy in adults and children with HIV infection (2013)
Irish UNAIDS data (2009)

- Number of people living with HIV
  - 6,900 [5,200 - 8,700]

- Adults aged 15 to 49 prevalence rate
  - 0.2% [0.2% - 0.3%]

- Women aged 15 and up living with HIV
  - 2,000 [1,500 - 2,600]

- Deaths due to AIDS
  - <100

TUBERCULOSIS!!
The TB Epidemic in the Western World

In 2011, there were 8.7 million new cases of active tuberculosis worldwide. Recent advances in diagnostics, drugs, and vaccines and enhanced implementation of interventions are helping to improve the prospects for global tuberculosis control.

Tuberculosis

- 95% of all TB cases occur in developing countries
- 9-43% of the world’s population is infected
- 8 million new cases/year
  - 3 million deaths/yr
  - 7% of total worldwide mortality rate
- 23% of active cases are estimated to receive appropriate anti-TB treatment
Global Incidence of Tuberculosis.

Global Numbers of Cases of Multidrug-Resistant Tuberculosis.

Tuberculosis

• Ireland
  – 230 notifications per 100,000 population in 1952 (first records kept)
  – 9.7 per 100,000 in 2001
  – 11.3 per 100,000 in 2007
  – 9.2 per 100,000 in 2010

• In 2010, 40.7% of cases were born outside Ireland compared to 43.0% in 2009 and 43.3% in 2008
  – GLOBAL INTERCONNECTEDNESS

• WHO:
  – Reduce the global incidence of active TB to less than 1 case per million by 2050
Resurgence Of Tuberculosis

Factors leading to an increase in TB:

- **Failure to tackle poverty in society** and...
- HIV Africa
- Decaying Public Health Infrastructure Eastern Europe
- Migration Ireland / Europe

MultiDrug Resistant Tuberculosis (MDR TB)

- *Acquired drug resistance*: found in a patient who has received at least 1 month of prior antiTB drug treatment
- *Primary resistance*: presence of resistant strains of M Tuberculosis in a patient with no history of such prior treatment
- *Multidrug resistance* (MDR): resistance to at least Isoniazid and Rifampicin.
Other Viral diseases

SARS: The First Emerging Infectious Disease Of The 21st Century

2003 Spread of SARS from Hotel Metropole

SARS Cases 19 February to 5 July 2003

Total: 8,439 cases, 712 deaths, 30 countries in 7-8 months

Source: www.who.int/csr/sars
Isolation of a Novel Coronavirus from a Man with Pneumonia in Saudi Arabia

MersCoV

Number of Dengue and Severe Dengue Cases Reported to WHO Annually, 1950-2010

Chikungunya Virus: An Emerging Threat

Crossed Atlantic in December 2013
48+50 countries in Region of the Americas report cases of >12,000 probable or confirmed cases

2010 Global Distribution ~40 Countries
What is Viral Hemorrhagic Fever?

- Severe multisystem syndrome
- Damage to overall vascular system
- Symptoms often accompanied by hemorrhage
  - Rarely life threatening in itself
  - Includes conjunctivitis, petechia, echymosis
Common process - multifactorial

• Vascular damage
  – Viral invasion
  – Complement/cytokine activation
  – Immune complex deposition

• Coagulation problems
  – Low platelets
  – Reduced clotting factors
  – DIC

• Immune failure

• End organ damage
  – Viral cytopathy
  – Host response
Hemorrhagic Fever

Symptoms

If you have recently developed the following symptoms, go to the hospital now:

- Marked Fever
- Muscle Aches
- Fatigue
- Loss of Strength
- Dizziness
- Exhaustion

Viral Hemorrhagic Fever

- Viruses of four distinct families
  - Arenaviruses
  - Filoviruses
  - Bunyaviruses
  - Flaviviruses

- RNA viruses
  - Enveloped in lipid coating

- Either insect vector or transmitted in excreta of animals (e.g. rats)
Arenaviridae

- Junin virus
- Machupo virus
- Guanarito virus
- Lassa virus
- Sabia virus

Lassa fever – West Africa

- 1969 - nurse in Lassa, Nigeria died with LF
- 2 more nurses developed illness
  - Isolated the virus from them
  - Initially suspected to be much worse mortality
- Mouse host – chronic asymptomatic infection
  - Urine and saliva
  - Aerosol infectiousness
Lassa fever

- Often asymptomatic
- 100,000 cases/yr; 5,000 deaths/yr
- Nosocomial spread is possible and does happen
- Most common directly transmissible VHF of international travellers
  - Facilitated by long incubation period (5d – 3 wks)

Lassa Fever

- Incubation 5 days – 3 wks
- Classical features of vhf
  - Fever, myalgia, conjunctival injection, pharyngitis, chest pain, abdo pain, D+V
- Deafness can occur in 30%
- 15% of hospitalised cases die
  - If fever, pharyngitis, vomiting – high risk of death
Lassa fever - treatment

- IV ribavirin – high dose for 6 days
- Oral ribavirin for contacts
- Convalescent serum can be used!
  – High antibody titres
- ?role for monoclonal antibody
- No vaccine

Bunyaviridae

Rift Valley Fever virus
Crimean-Congo Hemorrhagic Fever virus
Hantavirus

Flaviviridae

Dengue virus
Yellow Fever virus
Omsk Hemorrhagic Fever virus
Kyassnur Forest Disease virus
Filoviridae

Marburg virus
Ebola virus

Filoviridae History

• 1967: Marburg virus
  – European laboratory workers – Germany
    – Traced to a vervet monkey from Uganda
• 1976: Ebola virus
  – Ebola Zaire
  – Ebola Sudan
• 1989 and 1992: Ebola Reston
  – USA and Italy
  – Imported macaques from Philippines
• 1994: Ebola Côte d’Ivoire

• Nosocomial spread was a major feature
  – Marburg
  – Ebola

• Outbreaks

• Funerals and body preparation can predispose to infection spread
Filoviridae Transmission

- Reservoir is UNKNOWN
  - Bats implicated with Marburg and probably Ebola
  - 3000 animals tested; 500 bats, 30000 arthropods

- Nosocomial transmission
  - Reuse of needles and syringes
  - Exposure to infectious tissues, excretions, and hospital wastes

- Aerosol transmission
  - Primates

Filoviridae Epidemiology

- Marburg – Africa
  - Case fatality – 23-33%

- Ebola - Sudan, Zaire and Côte d’Ivoire
  - Case fatality – 53-88%

- Ebola – Reston – Philippines

- Pattern of disease is UNKNOWN
Filoviridae Humans

• Most severe hemorrhagic fever
• Incubation period: 4–10 days
• Abrupt onset
  – Fever, chills, malaise, and myalgia
• Hemorrhage and DIC
• Death around day 7–11
• Painful recovery

Ebola

• 1976
  – First documented outbreaks
  – Simultaneously in Zaire (=Congo) and Sudan

• Subsequently
  – Rare/intermittent outbreaks in Africa
    • Mainly central Africa
    • <500 cases
  – 30% cases were healthcare workers in Zaire, 1995
  – 7% in Uganda, 2000

Current Ebola Outbreak

• August 8: WHO:
  – “International Public Health Emergency”
  – “the outbreak is an extraordinary event and a public health risk to other states”
  – “...serious in view of the virulence of the virus, the intensive community and health facility transmission patterns and the weak health systems in the currently affected countries”
  – a coordinated international response is deemed essential to stop the spread of ebola”
Current Ebola outbreak

- Initial cases noted:
  - February 2014:
    - in forested areas of Southwestern Guinea
    - Spread to Liberia, Sierra Leone
    - (Nigeria – fewer cases)
  - Mainly rural, but including some large, densely populated cities (e.g. Monrovia)
  - Many healthcare workers infected
    - Compounding problem – patients not wishing to attend hospitals

Ebola outbreak – as of Aug 26, CDC

- 3069 suspect and confirmed cases of EVD
  - 1752 laboratory-confirmed cases

- 1552 deaths

- In Nigeria:
  - 17 suspect cases
    - 13 laboratory-confirmed
    - 6 deaths.

- No definite treatment – (serum a possibility)
  - Possible use of experimental agents
    - Monoclonal antibodies – Zmapp
    - Vaccines

- Ethical questions regarding use of experimental agents and fast-tracking possible therapeutics
Ebola

- Incubation 4 – 10 days
  - Death at around Day 10 if fatal
- Fever
- Headache
- Myalgia
- Abdo pain
- Diarrhoea
- Sore throat
- Conjunctival injection
- Bleeding
- Neurological manifestations
  - Hemiplegia, convulsions, psychosis
• Mortality
  – Zaire – 60-90%
  – Sudan 50-60%

• Diagnose – Grade 4 lab
  – Isolate virus
    • Cell culture
    • PCR
    • Antigen capture ELISA
  – Rarely serology

Recent outbreaks

• Uganda - 2012

• West Africa – 2013/4
  – Difficult to control
    • Connectedness
    • Education
    • Communication
Levels of PPM

Treatment

• Returning traveller is different from patient in an outbreak

• Main principles
  – Identify, diagnose and treat patient
  – Limit further spread
  – Identify other at-risk patients

Case identification

• Travel history – very specific

• Exposures
  – Caving/bats, rats, monkeys

• Timing
  – Under 3 weeks ago

• Clinical
  – Pharyngitis
  – Conjunctival injection
  – Chest pain
  – Bleeding
Diagnosis

• Beware of the samples!
• Label them as highly dangerous
• Liase with the lab first
• Aim for Biosafety level 4 facilities
• Can make the samples non-infectious with gamma-radiation but still analyse with ELISA
• National Centre for VHF
  – Mater Misericordiae Hospital
  – Contact regarding possible cases for transfer/advice

Management

• Strict isolation of affected patients is required
  – Especially if suspected to have direct spreading dx
  – Gowns, goggles, gloves, masks for staff – single use unless disinfected
  – Patient to use chemical toilet
  – If patient dies – rapid disposal/burial/cremation of body

• Report to health authorities
  – May use a health coordinator/outbreak coordinator
Contact tracing

• High risk
  – Exposed to blood, secretions, fluids
  – Close physical contact

• Check temp x2/day for 3 weeks

• If febrile (>38.5) isolate in hospital and give ribavirin if likely susceptible virus

• Lower risk
  – Advise to present if fever develops

• Educate community leaders

• Media management
Prevention and Control

• Avoid contact with host species
  – Rodents
    • Control rodent populations
    • Discourage rodents from entering or living in human populations
    • Safe clean up of rodent nests and droppings
  – Insects
    • Use insect repellents
    • Proper clothing and bed nets
    • Window screens and other barriers to insects
Prevention and Control

• Protective clothing
  – Disposable gowns, gloves, masks and shoe covers, protective eyewear when splashing might occur, or if patient is disoriented or uncooperative

• WHO and CDC developed manual
  – “Infection Control for Viral Hemorrhagic Fevers in the African Health Care Setting”

Prevention and Control

• Anyone suspected of having a VHF must use a chemical toilet

• Disinfect and dispose of instruments
  – Use a 0.5% solution of sodium hypochlorite (1:10 dilution of bleach)
Conclusion

• Emerging infections are likely to remain a feature in a globally connected world with an increasing population
  – Multifactorial
  – Far reaching consequences

• Complex, resource-intense, multifaceted management required
  – for individual cases and overall control

Is there hope in a connected world?

• Connectedness makes all infectious diseases applicable to all of us

• It also makes scientific advances applicable to all, even remote, populations

• And facilitates coordination of efforts