Emerging Diseases
Category A Priority Pathogens

Category A pathogens are those organisms/biological agents that pose the highest risk to national security and public health because they:

- Can be easily disseminated or transmitted from person to person
- Result in high mortality rates and have the potential for major public health impact
- Might cause public panic and social disruption
- Require special action for public health preparedness
Category B Priority Pathogens

Category B pathogens are the second highest priority organisms/biological agents. They:

- Are moderately easy to disseminate
- Result in moderate morbidity rates and low mortality rates
- Require specific enhancements for diagnostic capacity and enhanced disease surveillance
Category C Priority Pathogens

Category C pathogens are the third highest priority and include emerging pathogens that could be engineered for mass dissemination in the future because of

- Availability
- Ease of production and dissemination
- Potential for high morbidity and mortality rates and major health impact
Relative risk of Emergence of New Pathogens

Breaches in species barrier: selected emerging infections in humans identified since 1976

<table>
<thead>
<tr>
<th>Infection</th>
<th>Animal linked to transmission</th>
<th>Year infection first reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ebola virus</td>
<td>Bats</td>
<td>1976</td>
</tr>
<tr>
<td>HIV-1</td>
<td>Primates</td>
<td>1981</td>
</tr>
<tr>
<td>E. coli O157:H7</td>
<td>Cattle</td>
<td>1982</td>
</tr>
<tr>
<td>Borrelia burgdorferi</td>
<td>Rodents</td>
<td>1982</td>
</tr>
<tr>
<td>HIV-2</td>
<td>Primate</td>
<td>1986</td>
</tr>
<tr>
<td>Hendra virus</td>
<td>Bats</td>
<td>1994</td>
</tr>
<tr>
<td>BSEvCJD</td>
<td>Cattle</td>
<td>1996</td>
</tr>
<tr>
<td>Australian lyssavirus</td>
<td>Bats</td>
<td>1996</td>
</tr>
<tr>
<td>H5N1 influenza A</td>
<td>Chickens</td>
<td>1997</td>
</tr>
<tr>
<td>Nipah virus</td>
<td>Bats</td>
<td>1999</td>
</tr>
<tr>
<td>SARS coronavirus</td>
<td>Palm civets</td>
<td>2003</td>
</tr>
<tr>
<td>Influenza (H1N1)</td>
<td>Swine</td>
<td>2009</td>
</tr>
</tbody>
</table>
Dengue

- Dengue present in more than 124 countries and territories
- Every year:
  - 70 to 100 million infected persons
  - Estimated over 2 million severe forms (among which 90% are children)
  - Approximately 21,000 deaths

There is no specific treatment and the care of the disease is based on symptomatic treatment.

Preventing and managing dengue is a Public Health priority!
Average annual number of DF/DHF cases reported to WHO & average annual number of countries reporting dengue

Emergence of DEN/DHF

Geographic spread

Transmission of Dengue

Mosquitoes
- Aedes aegypti
- Aedes albopictus

Other
- Blood
- Transplacental

Incubation: 8-12 days in mosquito
Dengue Characteristics

Types
- DENU1, DENU2, DENU3, DENU4

Clinical Outcomes
- Incubation period (post-bite), 4-10 days
- Asymptomatic to mild disease – majority
- “Break bone” fever
- Vomiting, headache
- Hemorrhagic fever – severe, high case fatality

Treatment
- Supportive; e.g., acetaminophen – No ASA
- Platelet replacement (hemorrhagic fever)
Prevention and control

At present, the only method to control or prevent the transmission of dengue virus is to combat vector mosquitoes through:

- preventing mosquitoes from accessing egg-laying habitats by environmental management and modification;
- disposing of solid waste properly and removing artificial man-made habitats;
- covering, emptying and cleaning of domestic water storage containers on a weekly basis;
- applying appropriate insecticides to water storage outdoor containers;
- using of personal household protection such as window screens, long-sleeved clothes, insecticide treated materials, coils and vaporizers;
- improving community participation and mobilization for sustained vector control;
- applying insecticides as space spraying during outbreaks as one of the emergency vector control measures;
- active monitoring and surveillance of vectors should be carried out to determine effectiveness of control interventions.
Changing Nipah virus epidemiology: Bangladesh and India

- Human-to-human transmission first suspected 2001, hospitalized patients, India
- Human to human transmission suspected again in 2003, 2005, and 2007, Bangladesh
  - cases could not be linked to domestic animal exposure, including pigs
  - index cases not identified: one potential exposure to bat urine in palm wine
- Also a food-borne disease
- Bats (?)
SARS; the First Pandemic of 21st Century Changed the World...

SARS: an unknown *coronavirus*
- 8098 cases/ 774 deaths
- 26 countries affected
- trends in airline passenger movement drop
- Tourism dropped 40%
- Economic loss: US$ 60 billion

WHO travel recommendations
- 2 April
- 25 May
- 23 June

Screening of exit passengers
- 27 March

Number of passengers
- 102 165
- 36 116
Clinical Characteristics of SARS

- High fever
- Headache
- Diarrhea (10-20%)
- Pneumonia
- Case fatality 774/8098 (10%)
- Treatment – supportive care
Sudden Acute Respiratory Syndrome (SARS)

- Emerged in 2003 – hotel in Hong Kong
- Rapid spread worldwide – 8098 persons within 3-4 months
- Last case in 2004
- Person-to-person respiratory spread – droplets
- Source – wet markets (live animals)
- Reservoir – ferrets
- Agent – corona virus
Can entry screening delay local transmission?

Entry screening did not substantially delay local transmission; should be balanced against the cost of implementing these measures.
GONORRHEA (N. gonorrheae)

#2 infectious disease in the U.S. – 600,000 cases/yr (2012)

Drug resistance:
- Penicillin – 1940s
- Tetracycline – 1980s
- Fluoroquinolones – 2007
- Cephalosporins - 2014

Next?
Gonorrhea

Pandemic (H1N1) 2009
Countries, territories and areas with lab confirmed cases and number of deaths as reported to WHO

Status as of 01 August 2010

Chinese Taipei has reported forty-six deaths associated with pandemic (H1N1) 2009.

Cumulative deaths
- 1 - 10
- 11 - 50
- 51 - 100
- 101 and more

Country/territory/area with confirmed cases

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.

Map produced: 05 August 2010, 13:00 GMT

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

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As of 2 October 2007, total of 329 cases and 201 deaths, from 12 countries, were reported.
EPIDEMIOLOGY AND BIOLOGY OF H5N1 INFLUENZA
Characteristics of H5N1 Avian Influenza

1. Highly infectious and pathogenic for domestic poultry
2. Wild fowl, ducks asymptomatic reservoir
3. Now endemic in poultry in Southeast Asia
4. Proportion of humans with subclinical infection unknown
5. Case fatality in humans is >50%
Spread of H$_5$N$_1$ Avian Influenza

- South Korea: December, 2003
- Vietnam, Japan: January 2004
- Thailand, Cambodia, China & Laos: 2004
- Indonesia: Feb 2005-6, 2006-7
- Resurgence in Thailand, Vietnam, Cambodia and Indonesia
- Europe, Africa
A New Global Concern...

Acknowledgment: Mike Perdue
Intervention Strategies (H5N1)

- Culling (killing of infected flocks)
- Innovative surveillance strategies
  - Identification and analysis of human to human clusters
  - Characterization of strains
    * Necessity for vaccine development (Science 304:968-9, 5/2004)
- Vaccination of bird handlers (vaccine being developed)
- Vaccination of commercial bird flocks
Barriers to H5N1 Control

- Reservoir in wild birds and ducks
- Economic impact of culling of poultry stocks
- Popularity of “wet markets” promotes transmission within poultry and to other species (e.g., pigs)
- Resistance to antivirals and vaccines
- Mistrust of rich nations
Don’t get the flu vaccine!
FACTORS CONTRIBUTING TO EMERGENCE OR RE-EMERGENCE OF INFECTIOUS DISEASES (1)

- Human **demographic change** by which persons begin to live in previously uninhabited remote areas of the world and are exposed to new environmental sources of infectious agents, insects and animals.

- Unsustainable **urbanization** causes breakdowns of sanitary and other public health measures in overcrowded cities (e.g., slums).
FACTORS CONTRIBUTING TO EMERGENCE OR RE-EMERGENCE OF INFECTIOUS DISEASES (2)

• **Economic development** and changes in the use of land, including deforestation, reforestation, and urbanization

• **Global warming** - climate changes cause changes in geographical distribution of agents and vectors

• **Changing human behaviours**, such as increased use of child-care facilities, sexual and drug use behaviours, and patterns of outdoor recreation

• Social inequality
FACTORS CONTRIBUTING TO EMERGENCE OR RE-EMERGENCE OF INFECTIOUS DISEASES (3)

• International **travel and commerce** that quickly transport people and goods vast distances

• Changes in **food processing and handling**, including foods prepared from many different individual animals and countries, and transported great distances
FACTORS CONTRIBUTING TO EMERGENCE OR RE-EMERGENCE OF INFECTIOUS DISEASES (4)

• Evolution of pathogenic infectious agents by which they may infect new hosts, produce toxins, or adapt by responding to changes in the host immunity. (e.g. influenza, HIV)

• Development of resistance by infectious agents such as *Mycobacterium tuberculosis* and *Neisseria gonorrhoeae* to chemoprophylactic or chemotherapeutic medicines.
FACTORS CONTRIBUTING TO EMERGENCE OR RE-EMERGENCE OF INFECTIOUS DISEASES (5)

- **Resistance of the vectors** of vector-borne infectious diseases to pesticides.
- **Immunosuppression of persons** due to medical treatments or new diseases that result in infectious diseases caused by agents not usually pathogenic in healthy hosts (e.g. leukemia patients)
FACTORS CONTRIBUTING TO EMERGENCE OR RE-EMERGENCE OF INFECTIOUS DISEASES (6)

- **Deterioration in surveillance systems** for infectious diseases, including laboratory support, to detect new or emerging disease problems at an early stage (e.g. Indonesian resistance to “scientific colonialism”)

- **Illiteracy** limits knowledge and implementation of prevention strategies

- **Lack of political will** – corruption, other priorities
FACTORS CONTRIBUTING TO EMERGENCE OR RE-EMERGENCE OF INFECTIOUS DISEASES (7)

- **Biowarfare/bioterrorism**: An unfortunate potential source of new or emerging disease threats (e.g. anthrax and letters)

- **War, civil unrest** – creates refugees, food and housing shortages, increased density of living, etc.

- **Famine** causing reduced immune capacity, etc.

- **Manufacturing strategies**; e.g., pooling of plasma, etc.
STRATEGIES TO REDUCE THREATS (1)

• DEVELOP POLITICAL WILL AND FUNDING
• IMPROVE GLOBAL EARLY RESPONSE CAPACITY
  – WHO
  – National Disease Control Units (e.g. USCDC, CCDC)
  – Training programs
STRATEGIES TO REDUCE THREATS (2)

• IMPROVE GLOBAL SURVEILLANCE
  – Improve diagnostic capacity (training, regulations)
  – Improve communication systems (web, e-mail etc.) and sharing of surveillance data
  – Rapid data analysis
  – Develop innovative surveillance and analysis strategies
STRATEGIES TO REDUCE THREATS (3)

• IMPROVE GLOBAL SURVEILLANCE (continued)
  – Utilize geographical information systems
  – Utilize global positioning systems
  – Utilize the Global Atlas of Infectious Diseases (WHO)
  – Increase and improve laboratory capacity
  – Coordinate human and animal surveillance
CDC has six GDD Regional Centers, one per WHO region. Centers are selected in consultation with invited countries, internal experts, and national and international partners, and based on:

- Public health significance
- Established regional scope
- Established CDC presence
- International partner presence
STRATEGIES TO REDUCE THREATS (4)

• USE OF VACCINES
  – Increase coverage and acceptability (e.g., oral)
  – New strategies for delivery (e.g., nasal spray administration)
  – Develop new vaccines
  – Decrease cost
  – Decrease dependency on “cold chain”

• NEW DRUG DEVELOPMENT
STRATEGIES TO REDUCE THREATS (5)

• DECREASE INAPPROPRIATE DRUG USE
  – Improve education of clinicians and public
  – Decrease antimicrobial use in agriculture and food production

• IMPROVE VECTOR AND ZOONOTIC CONTROL
  – Develop new safe insecticides
  – Develop more non-chemical strategies e.g. organic strategies

• BETTER AND MORE WIDESPREAD HEALTH EDUCATION (e.g., west Nile virus; bed nets, mosquito repellent)
STRATEGIES TO REDUCE THREATS (6)

• DEVELOPMENT OF PREDICTIVE MODELS BASED ON:
  – Epidemiologic data
  – Climate change surveillance
  – Human behavior

• ESTABLISH PRIORITIES
  – The risk of disease
  – The magnitude of disease burden
    • Morbidity/disability
    • Mortality
    • Economic cost
  – REDUCE POTENTIAL FOR RAPID SPREAD
  – DEVELOP MORE FEASIBLE CONTROL STRATEGIES

Figure 2. Components of a predictive model of infectious disease based on satellite imaging to assess environmental change. SST, sea surface temperature; SSH, sea surface height.
STRATEGIES TO REDUCE THREATS (7)

• Develop new strategies requiring low-cost technology
• Social and political mobilization of communities
• Greater support for research
• Reduce poverty and inequality
BASIC ELEMENTS IN PREPAREDNESS

• International Health Regulations
• International -- WHO
  – Global Outbreak Alert and Response Network (GOARN)
    • 120 technical institutions participating
    • 2000-02 -- Responded to 34 events in 26 countries
    • Coordination of SARS and H5N1 threats
  – Global Public Health Information Network (GPHIN)
Daily Flow of GPHIN Information

1. scanning global news
2. filtering & sorting process
3. review for relevancy

800-1000 articles selected daily
Ongoing 24/7
Mon-Fri 7am-5pm EST (Hours are extended during a public health crisis)
The virtue of vaccines

A higher vaccination rate will help protect California schoolchildren from disease. A bill seeks to make it harder for parents to decline vaccinations.

California is among the 13 states that make it easy for parents to refuse to vaccinate their children who attend public schools. All they have to do is sign a form saying that inoculations run counter to their personal beliefs. Most states require a religious-belief exemption, which results in dramatically higher vaccination rates.

A bill by Assemblyman Richard Pan (D-Sacramento), a pediatrician, would tighten the state's rules. To claim the personal-belief exemption, parents would be required under AB 2109 to discuss the risks and benefits of vaccination with a health professional; then they would be free to make up their own minds. The bill is modeled on a new law in Washington state, where 6.2% of parents were taking personal-belief exemptions. During its first year, the number of such exemptions dropped more than 25%.
ESSENTIAL FACTORS FOR DISEASE ERADICATION

• Knowledge of its epidemiology and transmission patterns/mode
• Availability of effective tools for diagnosis, treatment and prevention
• Knowledge of local cultural and political characteristics
• Community acceptance and mobilization
• Political will and leadership
• Adequate and sustained funding
ROLE OF THE PUBLIC HEALTH PROFESSIONAL

- Establish surveillance for:
  - Unusual diseases
  - Drug resistant agents
- Assure laboratory capacity to investigate new agents (e.g., high-throughput labs)
- Develop plans for handling outbreaks of unknown agents
- Inform physicians about responsible antimicrobial use