RESPONDING TO EMERGING INFECTIOUS DISEASES:
FOCUS ON HIGHLY COMMUNICABLE CONTACT AND
RESPIRATORY TRANSMITTED INFECTIOUS DISEASES

David J. Weber, M.D., M.P.H.
Professor of Epidemiology, Medicine & Pediatrics
Medical Director, Hospital Epidemiology and
Associate Chief Medical Officer, UNC Health Care, NC, US
LECTURE TOPICS & GOALS

1 Lecture topics
   ■ Emerging viral pathogens: Definitions and driving factors
   ■ Lessons learned from emerging diseases in the UC
   ■ Droplet/airborne (contact) transmitted diseases: SARS-CoV, MERS-CoV, avian flu
   ■ Highly communicable contact transmitted diseases: Ebola, hemorrhagic fever viruses

1 Lecture goals
   ■ Understand the driving factors for emerging infectious diseases
   ■ Understand the epidemiology and clinical features of emerging viral diseases including Zika and MERS-CoV
   ■ Understand the key infection control issues in care for patients with highly communicable diseases

No conflicts
Emerging infectious diseases can be defined as infections that have newly appeared in the population, or have existed but are rapidly increasing in incidence or geographic range.
Since ~1950, accelerating pattern of emerging pathogens.
EMERGING ZOOLOGICAL INFECTIOUS DISEASES

- West Nile virus: >15,000 deaths in the United States
- HIV: >30 million deaths
- Hendra virus: Four deaths
- Nipah virus: >250 deaths
- 2002-2003: SARS coronavirus, 774 deaths
- 2012-2013: MERS coronavirus, 54 deaths

- 'Spanish flu': H1N1 influenza, ~50 million deaths
- 'Hong Kong flu': H3N2 influenza, ~700,000 deaths
- 'Russian flu': H1N1 influenza
- 'Avian flu': H5N1 influenza, >371 deaths
- 'Swine flu': H1N1 influenza, >15,000 deaths
- 1999-2002: H9N2 and H7N7 influenza, One death
- 1997: 'Avian flu': H7N9 influenza, 44 deaths

Speed of Global Travel in Relation to World Population Growth

From: Murphy and Nathanson Sems. Virol. 5, 87, 1994
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>5,061,064</td>
<td>5,336,027</td>
<td>+ 5.4</td>
<td>59,307,596</td>
<td>56,654,903</td>
<td>- 4.5</td>
</tr>
<tr>
<td>Mainland China</td>
<td>3,721,049</td>
<td>3,948,482</td>
<td>+ 6.1</td>
<td>45,842,360</td>
<td>42,778,145</td>
<td>- 6.7</td>
</tr>
<tr>
<td>Non-Mainland China</td>
<td>1,340,015</td>
<td>1,387,545</td>
<td>+ 3.5</td>
<td>13,465,236</td>
<td>13,876,758</td>
<td>+ 3.1</td>
</tr>
<tr>
<td>Taiwan</td>
<td>179,937</td>
<td>181,149</td>
<td>+ 0.7</td>
<td>2,015,797</td>
<td>2,011,428</td>
<td>- 0.2</td>
</tr>
<tr>
<td>Japan</td>
<td>100,783</td>
<td>111,163</td>
<td>+ 10.3</td>
<td>1,049,272</td>
<td>1,092,329</td>
<td>+ 4.1</td>
</tr>
<tr>
<td>South Korea</td>
<td>119,238</td>
<td>132,878</td>
<td>+ 11.4</td>
<td>1,243,293</td>
<td>1,392,367</td>
<td>+ 12.0</td>
</tr>
<tr>
<td>Indonesia</td>
<td>47,337</td>
<td>54,726</td>
<td>+ 15.6</td>
<td>413,568</td>
<td>464,406</td>
<td>+ 12.3</td>
</tr>
<tr>
<td>Malaysia</td>
<td>77,092</td>
<td>79,237</td>
<td>+ 2.8</td>
<td>544,688</td>
<td>535,542</td>
<td>- 1.7</td>
</tr>
<tr>
<td>Philippines</td>
<td>80,918</td>
<td>89,875</td>
<td>+ 11.1</td>
<td>704,082</td>
<td>791,171</td>
<td>+ 12.4</td>
</tr>
<tr>
<td>Singapore</td>
<td>95,808</td>
<td>92,996</td>
<td>- 2.9</td>
<td>675,411</td>
<td>674,006</td>
<td>- 0.2</td>
</tr>
<tr>
<td>Thailand</td>
<td>74,373</td>
<td>68,898</td>
<td>- 7.4</td>
<td>529,410</td>
<td>594,615</td>
<td>+ 12.3</td>
</tr>
<tr>
<td>Others</td>
<td>119,046</td>
<td>124,814</td>
<td>+ 4.8</td>
<td>1,122,601</td>
<td>1,096,706</td>
<td>- 2.3</td>
</tr>
<tr>
<td>USA</td>
<td>102,209</td>
<td>112,273</td>
<td>+ 9.8</td>
<td>1,181,024</td>
<td>1,211,539</td>
<td>+ 2.6</td>
</tr>
<tr>
<td>Canada</td>
<td>33,309</td>
<td>35,001</td>
<td>+ 5.1</td>
<td>358,448</td>
<td>369,363</td>
<td>+ 3.0</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>42,415</td>
<td>44,918</td>
<td>+ 5.9</td>
<td>529,505</td>
<td>551,930</td>
<td>+ 4.2</td>
</tr>
<tr>
<td>France</td>
<td>17,372</td>
<td>17,750</td>
<td>+ 2.2</td>
<td>209,825</td>
<td>213,641</td>
<td>+ 1.8</td>
</tr>
<tr>
<td>Germany</td>
<td>18,029</td>
<td>17,644</td>
<td>- 2.1</td>
<td>213,802</td>
<td>226,594</td>
<td>+ 6.0</td>
</tr>
<tr>
<td>Australia</td>
<td>53,728</td>
<td>51,816</td>
<td>- 3.6</td>
<td>574,270</td>
<td>575,812</td>
<td>+ 0.3</td>
</tr>
<tr>
<td>Others</td>
<td>103,583</td>
<td>105,493</td>
<td>+ 1.8</td>
<td>1,217,413</td>
<td>1,246,580</td>
<td>+ 2.4</td>
</tr>
<tr>
<td>India</td>
<td>43,760</td>
<td>36,510</td>
<td>- 16.6</td>
<td>531,770</td>
<td>480,906</td>
<td>- 9.6</td>
</tr>
<tr>
<td>GCC Markets</td>
<td>5,622</td>
<td>4,011</td>
<td>- 28.7</td>
<td>49,023</td>
<td>49,954</td>
<td>+ 1.9</td>
</tr>
<tr>
<td>Russia</td>
<td>12,886</td>
<td>13,374</td>
<td>+ 3.8</td>
<td>151,469</td>
<td>142,664</td>
<td>- 5.8</td>
</tr>
<tr>
<td>Netherlands</td>
<td>7,599</td>
<td>7,430</td>
<td>- 2.2</td>
<td>91,596</td>
<td>95,762</td>
<td>+ 4.5</td>
</tr>
<tr>
<td>Vietnam</td>
<td>4,971</td>
<td>5,589</td>
<td>+ 12.4</td>
<td>58,969</td>
<td>59,443</td>
<td>+ 0.8</td>
</tr>
</tbody>
</table>
FIGURE 2. Movement of imported African rodents to animal distributors and distribution of prairie dogs from an animal distributor associated with human cases of monkeypox — 11 states*, 2003†‡

Rodent shipment from Accra, Ghana

TX-1**
50 Gambian giant rats (GR)
53 rope squirrels (RS)
Two brushtail porcupines (BP)
47 tree squirrels (TS)
100 striped mice (SM)
510 dormice (DM)

NJ
RS, BP
TS, SM

TX-3
RS, SM
DM

TX-2
GR

4/9/03
4/11/03
4/16/03
4/17/03
4/19/03
4/21/03
4/26/03
4/28/03
5/16/03
5/18/03

TX-4
DM

TX-5
DM

TX-6
TS, SM
DM

TX-7
DM

TX-8
DM

TX-9
DM

TX-10
DM

IL-1**
GR, DM

IL-2
DM

200 prairie dogs (PD) at facility

WY
GR, DM

IN
IL†
Human cases: 17 confirmed 22 probable/suspect
42 PD traced

14 PD traced

14 PD traced

24 PD traced

MO
Human cases: seven confirmed nine probable/suspect

MI
No human cases

11 PD traced

SC
No human cases

KS
Human cases: one confirmed

Japan
DM

MN
DM

WI
DM

†‡Data from the World Health Organization.
## Selected Emerging Diseases of Infection Control Importance, US

<table>
<thead>
<tr>
<th>Disease (initial location)</th>
<th>Cases (United States)</th>
<th>Outcome</th>
<th>Person-to-person transmission</th>
<th>Patient-to-HCP transmission</th>
<th>Infection control risk</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legionnaires' disease</td>
<td>Unknown (thousands)</td>
<td>Endemic and epidemic</td>
<td>No</td>
<td>Yes (blood exposure, organ transplantation, vertical, sexual)</td>
<td>Yes (blood exposure)</td>
<td>High</td>
</tr>
<tr>
<td>HIV (Africa)</td>
<td>Millions (thousands)</td>
<td>Ongoing epidemic</td>
<td>No</td>
<td>Yes (blood, theoretically via contaminated medical instruments)</td>
<td>No</td>
<td>Moderate</td>
</tr>
<tr>
<td>vCJD</td>
<td>Hundreds</td>
<td>Controlled</td>
<td>Yes (blood, theoretically via contaminated medical instruments)</td>
<td>No</td>
<td>Low</td>
<td>1996</td>
</tr>
<tr>
<td>West Nile fever</td>
<td>(Thousands)</td>
<td>Endemic</td>
<td>Yes (blood transfusions, vertical, organ transplantation)</td>
<td>No*</td>
<td>Low</td>
<td>1999</td>
</tr>
<tr>
<td>SARS (China)</td>
<td>~8,000 (8)</td>
<td>Controlled</td>
<td>Yes (droplet, contact, airborne?)</td>
<td>Yes</td>
<td>High</td>
<td>2003-2004</td>
</tr>
<tr>
<td>Monkeypox (Africa)</td>
<td>(37 confirmed, 10 probable)</td>
<td>Eliminated in United States</td>
<td>Yes (droplet, contact)</td>
<td>Yes</td>
<td>High</td>
<td>2003</td>
</tr>
<tr>
<td>MERS (Middle East)</td>
<td>Thousands (2)</td>
<td>Controlled</td>
<td>Yes (droplet, contact)</td>
<td>Yes</td>
<td>High</td>
<td>2014-present</td>
</tr>
<tr>
<td>Ebola (West Africa)</td>
<td>Thousands (4)</td>
<td>Controlled United States, reduced Africa</td>
<td>Yes (contact, sexual)</td>
<td>Yes</td>
<td>High</td>
<td>2014-present</td>
</tr>
</tbody>
</table>

Emergence of infectious diseases is complex
Infectious diseases are dynamic
Most new infections are not caused by genuinely new pathogens
Agents involved in new and reemergent infections cross taxonomic lines
The concept of the microbe as the cause of disease is inadequate and incomplete
Human activities are the most potent factors driving disease emergence
Social, economic, political, climatic, technologic, and environmental factors shape disease patterns and influence emergence
Understanding and responding to disease emergence require a global prospective, conceptually and geographically
The current global situation favors disease emergence

FACTORS INFLUENCING NEW AND REEMERGING ZOONOSES

- Climate change influencing arthropods
- Translocation of infected animals or persons
- Tourism
- Changes in land use
- Pathogen adaptation to new host species
- Acquisition of new virulence traits
- Alteration in livestock management practices
- Companion animals
- Exotic foods (bush meat)
- Exotic pets

Infection of humans or animals

Stage 1: agent only in animals

- Rabies
- Ebola
- Dengue
- HIV-1 M

Transmission to humans:

- Only from animals
- From animals or (few cycles) humans
- From animals or (many cycles) humans
- Only from humans
- None

KEY ISSUES FOR INFECTION CONTROL

1. Pathogen
   - Taxonomy (provides clues regarding transmission routes, environmental stability, germicide susceptibility)
   - Hosts

2. Epidemiology
   - Locations of endemicity (ie, locations in the world where sources or reservoirs reside)
   - Incubation period
   - Transmission routes
   - Infectivity (ie, communicability)
   - Duration of infectivity

KEY ISSUES FOR INFECTION CONTROL

1 Clinical
   ■ Symptoms and signs
   ■ Risk factors for acquisition of infection
   ■ Morbidity and mortality (and risk factors for morbidity and mortality)
   ■ Diagnostic methods (sensitivity, specificity, positive and negative predictive values, biosafety)
   ■ Therapy (availability, efficacy, safety)

1 Infection control
   ■ Environmental survival and germicide susceptibility
   ■ Isolation recommendations and recommended personal protective equipment
   ■ Pre-exposure prophylaxis (availability, efficacy, safety)
   ■ Post-exposure prophylaxis (availability, efficacy, safety) and vaccine availability
   ■ Recommended biosafety level in the laboratory
   ■ Recommended waste disposal (liquids and solids)

The number of people that one sick person will infect (on average) is called $R_0$. Here are the maximum $R_0$ values for a few viruses.

- Hepatitis C (2)
- Ebola (2)
- HIV (4)
- SARS (4)
- Mumps (10)
- Measles (18)

http://www.npr.org/blogs/health/2014/10/02/352983774/no-seriously-how-contagious-is-ebola
KEY VULNERABILITIES AND SOLUTIONS

1. Failure to screen and recognize that a patient has a communicable disease (most important with highly transmissible and virulent pathogens) and/or failure to promptly institute proper isolation
   - Appropriate signage
   - Routinely obtain travel history with notation in EMR
   - Adequate isolation facilities (in ED, hospital) for highly communicable diseases

2. Failure to have adequate PPE or failure of HCP to properly don and doff PPE
   - Adequate supply of PPE
   - Proper training of HCP in donning and doffing of appropriate PPE
Total SARS Cases and %HCP by Country: Worldwide ~8,000 Cases; ~20% HCP
SARS-CoV 2002

Emerged Fall 2002
Southern China

Declared Extinct 2005 (wrong)

Originated from Horseshoe Bats

Cases-33 countries Within 6 months including USA

Civets and Raccoon Dogs Intermediate Hosts

Age Related Mortality 50% individuals >65

Acute Respiratory Distress Syndrome (ARDS) 10% Mortality Rates

8,273 reported cases and 775 human deaths

HCP, 21%

*No licensed vaccines or therapeutics; candidate hmAB, vaccines and drugs exist
SARS: KEY ISSUES FOR INFECTION CONTROL

1. Incubation period (days): 2-14 (occasionally up to 21)
2. Transmission routes:
   - Animal-to-human; person-to-person (direct, indirect); aerosol (droplet, airborne?)
3. Isolation:
   - Admit to AIIR; PPE = gown, gloves, N95, eye protection (consider PAPR for aerosol generating procedures)
4. Communicability: 0.3-4.1 (occasional super spreaders)
5. Environmental survival: 24hr (cotton gown, paper); 48hr (disposable gown)
6. Susceptibility to germicides (based, in part, on surrogates): Quats, phenols, alcohol, CHG

Contacts and social network of index and special interest cases

Person, place and time

Index case
Orange County

Family
Orange County

Workplace
Orange County

>100

ARDSTM
FP Clinic
Orange County

HCWS

ARDS Family
Wake County

HCWs
Western Wake
Wake County

CAP
2

Outpatient
Duke
Durham County

Inpatient
Western Wake
Wake County

Worried
well

“Tent City”
Screening
UNC-CH

Notes:
1. Acute respiratory distress syndrome
2. Community acquired pneumonia
3. Healthcare workers

Notes:
1. Acute respiratory distress syndrome
2. Community acquired pneumonia
3. Healthcare workers

NCPH

DHHS
Temporary Screening Facilities-Semi Rural Location USA
SARS-CoV: Chapel Hill, NC June 11, 2003 (Giles Horney Building)
LESSONS LEARNED FROM SARS

1. Initial detection via the astute observer (not via a surveillance system)
2. New disease can involve multiple countries
3. Continued threat from zoonotic agents jumping species boundaries
4. Healthcare workers at high risk with highly communicable diseases
5. Diagnostic methods key to control
6. Epidemics can be contained using quarantine and infection control methods
7. Need to nestle response to a highly communicable disease in hospital disaster plan
8. Inadequate supplies of PPE (i.e., stockpile)
9. Inadequate outpatient facilities to handle highly communicable diseases
10. Need to screen for travel to endemic area at entry to hospital or clinic
COUNTRIES WITH LAB-CONFIRMED MERS CASES

1. Countries in the Arabian Peninsula with Cases
   - Bahrain
   - Iran
   - Jordan
   - Kuwait
   - Lebanon
   - Oman
   - Qatar
   - Saudi Arabia
   - United Arab Emirates (UAE)
   - Yemen

2. Countries with Travel-Associated Cases
   - United States
   - Europe: Austria, France, Germany, Greece, Italy, Netherlands, Turkey, United Kingdom (UK)
   - Africa: Tunisia, Egypt, Algeria
   - Asia: Malaysia, Philippines, China, Thailand, Republic of Korea

1. Cases (as of Sept. 2012, WHO)
   - 1733 lab confirmed cases
   - At least 628 deaths

MERS-CoV, WHO, 20 MAY 2016
Confirmed global cases of MERS-CoV

Reported to WHO as of 29 Apr 2016 (n=1728)

- Republic of Korea
- Other Countries
- Saudi Arabia

Other countries: Algeria, Austria, Bahrain, China, Egypt, France, Germany, Greece, Iran, Italy, Jordan, Kuwait, Lebanon, Malaysia, Netherlands, Oman, Philippines, Qatar, South Africa, Thailand, Tunisia, Turkey, United Arab Emirates, United Kingdom, United States of America, Yemen

Please note that the underlying data is subject to change as the investigations around cases are ongoing. Onset date estimated if not available.
MERS IN SOUTH KOREA

1. Index case; 68 year-old national with recent history of travel to 4 countries in Middle East (asymptomatic on return, 4 May)
   - Developed symptoms on May 11: sought care at 2 clinics and 2 hospitals
   - Confirmed as MERS 20 May

2. As of 20 June, 172 lab-confirmed cases (27 deaths)
   - Cases include healthcare personnel, other patients, family members and visitors
   - Some patients who are cases were housed on the same ward (but not in the same room)
   - Exposures may have been as short as 5 minutes to a few hours
   - Evidence of superspreaders
MERS-CoV* 2012

- Emerged April 2012 Jordan
- Originated from bats: Neoromicia, Pipistrellus sp.
- Intermediate Hosts: Dromedary Camels
- Outbreak Ongoing
- Cases: 22 countries including USA
- Age Related Mortality: >50%, aged >65
- Acute Respiratory Distress Syndrome (ARDS): 38% Mortality Rates
- Currently: 905 Cases/362 deaths
MERS:
KEY ISSUES FOR INFECTION CONTROL

1. Incubation period (days): 2-15
2. Transmission routes:
   - Animal-to-human; person-to-person (direct, indirect); aerosol (droplet, airborne?); ingestion?
3. Isolation:
   - Admit to AIIR; PPE = gown, gloves, N95, eye protection (consider PAPR for aerosol generating procedures)
4. Communicability: $R_0 = 0.3-1.3$
5. Environmental survival: >48hr at 20°C 40% RH (surface)
6. Susceptibility to germicides (based, in part, on surrogates): Quats, phenols, alcohol, CHG
SIGNAGE FOR HEALTHCARE ENTRANCES

1. Notifies patients and visitors to obtain a mask if they meet CDC criteria for possible MERS:
   - Signs/symptoms of MERS plus travel to Arabian Peninsula within 14 days
   - Signs/symptoms of MERS plus contact with an ill person who has traveled to Arabian Peninsula within 14 days

   NOTICE
   MERS ALERT
   Middle Eastern Respiratory Syndrome
   If you have traveled within the last 14 days from the Arabian Peninsula:
   • Saudi Arabia
   • Bahrain
   • Kuwait
   • Oman
   • Qatar
   • United Arab Emirates

   OR
   You have been in close contact with a person who is ill and has traveled to one of the countries above in the last 14 days
   AND
   You have a fever or respiratory symptoms (cough, shortness of breath)

   A mask must be worn to enter the building
   If you need a mask, speak to a security guard before entering

   AVISO
   ALERTA SOBRE EL MERS
   Síndrome respiratorio del medio oriente
   Si usted ha viajado en los últimos 14 días desde la Península arábiga:
   • Arabia Saudita
   • Bahrein
   • Kuwait
   • Omán
   • Catar
   • UAE

   Ha estado en contacto cercano con una persona que está enferma y que ha viajado a uno de los países arriba indicados en los últimos 14 días.

   Y
   Usted ha tenido fiebre o síntomas respiratorios (tos, falta de aliento).
   Debe ponerse una mascarilla para entrar al edificio.
   Si necesita una mascarilla, habla con un guardia de seguridad antes de entrar.

Translated by: UNIC-Healthcare Interpreter Services, ONCTE11
**SPECIAL AIRBORNE PRECAUTIONS**

1. **Room type**
   - Direct out exhausted air
   - Negative air pressure
   - >12 air exchanges per hour

2. **Personal protective equipment (PPE)**
   - N-95 respirator
   - Gloves
   - Gowns
   - Protective eyeware (face shield)
     - Goggles for aerosol generating procedures
Influenza Virus Nomenclature

<table>
<thead>
<tr>
<th>Type of Nuclear Material</th>
<th>Hemagglutinin</th>
<th>Neuraminidase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virus type</td>
<td>18 different hemagglutinin subtypes</td>
<td>11 different neuraminidase subtypes</td>
</tr>
<tr>
<td>Geographic origin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strain number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year of isolation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virus subtype</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOVEL INFLUENZA VIRUSES

1. Avian influenza A (H7N9)
   - First reported in China, March 2013; spread to Malaysia in February 2014
   - Source: Infected poultry or contaminated environment
   - Clinical illness: Severe respiratory illness; mortality ~33%

2. Influenza A (H3N2v)
   - First detected in US pigs in 2010 and human in 2011
   - Source: Prolonged exposure to pigs at agricultural fairs
   - Similar to seasonal flu

3. Influenza A (H5N2), (H5N8), (H5N1)
   - Multiple reports of birds in US infected with these viruses (Asian origin) in CA, ID, OR, UT, WA in backyard flocks, wild birds, and wild aquatic birds

4. Influenza A (H5N1)
   - Ongoing poultry and human cases in Asia, Europe and North Africa
EBOLA OUTBREAK:
13 APRIL 2016

Summary

- Total cases 28,616, Total deaths: 11,227 (~40%), Lab confirmed cases: 15,227
- Healthcare personnel (HCP, Onset to 27 Sept.): 881 (deaths = 513)

Countries with former widespread transmission and current established control measures:
- Guinea: Total cases 3814, total deaths 2544, lab confirmed 3358
- Sierra Leone: Total cases 14,124, total deaths 3956, lab confirmed 8706
- Liberia: Total cases 10,678, total deaths 4810, lab confirmed 3163

Previously Affected Countries:
- Nigeria: Total case count 20, total deaths 8, lab confirmed 19
- Senegal: Total cases 1, total deaths 0, lab confirmed 1
- Spain: Total cases 1, total deaths 0, lab confirmed 1 (case in a HCP)
- Mali: Total cases 8, total deaths 6, lab confirmed 7
- UK: Total cases 1, total deaths 0, lab confirmed 1
- Italy: Total cases 1, total deaths 0, lab confirmed 1
- US: Total cases 4, total deaths 1, lab confirmed 4, HCP 2, (11 evacuees)
INITIAL CHALLENGES IN EBOLA PREPAREDNESS

1. Lack of funding
2. Lack of agreement with CDC recommendations by some experts
   - N95 respirator versus PAPR
   - Liquid and solid waste disposal
   - Incubation period (21 days vs 30 or longer)
3. Inadequate physical facilities for care of a patient
4. Inadequate personnel to provide care
5. Shortage of PPE
6. Inability to acquire needed POC lab equipment
EBOLA VIRUS RNA COPY LEVELS IN SERA OVER TIME

http://www.cdc.gov/vhf/ebola/transmission/human-transmission.html
Table 3. Clinical Characteristics of Hemorrhagic Fever Viruses Noted in Past Case Series or Outbreaks

<table>
<thead>
<tr>
<th>Virus</th>
<th>Distinctive Clinical Features</th>
<th>Person-to-Person Transmission</th>
<th>Incubation Period, d</th>
<th>Mortality, %</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ebola</td>
<td>High fever and severe prostration. A diffuse maculopapular rash may occur by day 5 of illness. Bleeding and disseminated intravascular coagulation are common.</td>
<td>Yes</td>
<td>2-21</td>
<td>50-90*</td>
<td>Supportive</td>
</tr>
<tr>
<td>Marburg</td>
<td>High fever, myalgias. Nonpruritic maculopapular rash of the face, neck, trunk, and arms may develop. Bleeding and disseminated intravascular coagulation are common.</td>
<td>Yes</td>
<td>2-14</td>
<td>23-70†</td>
<td>Supportive</td>
</tr>
<tr>
<td>Lassa fever</td>
<td>Gradual onset of fever, nausea, abdominal pain, severe sore throat, cough, conjunctivitis, ulceration of buccal mucosa, exudative pharyngitis, and cervical lymphadenopathy. Late signs include severe swelling of head and neck; pleural and pericardial effusions. Hemorrhagic complications less common.</td>
<td>Yes</td>
<td>5-16</td>
<td>15-20</td>
<td>Ribavirin, supportive</td>
</tr>
<tr>
<td>New World Arenaviruses</td>
<td>Gradual onset of fever, myalgias, nausea, abdominal pain, conjunctivitis, flushing of face and trunk, and generalized lymphadenopathy. May develop petechiae, bleeding, and central nervous system dysfunction (tremors of the tongue and upper extremities, myoclonic movements, dysarthria, and generalized seizures).</td>
<td>Yes</td>
<td>7-14</td>
<td>15-30</td>
<td>Ribavirin, supportive</td>
</tr>
<tr>
<td>Rift Valley fever</td>
<td>Fever, headache, retro-orbital pain, photophobia, and jaundice. Less than 1% develop hemorrhagic fever or encephalitis. Retinitis affects approximately 10%, which may occur at time of acute febrile illness or up to 4 weeks later.</td>
<td>No</td>
<td>2-6</td>
<td>&lt;1</td>
<td>Ribavirin, supportive</td>
</tr>
<tr>
<td>Yellow fever</td>
<td>Fever, myalgias, facial flushing, and conjunctival injection. Patients either recover or enter a short remission followed by fever, relative bradycardia, jaundice, renal failure, and hemorrhagic complications.</td>
<td>No</td>
<td>3-6</td>
<td>20</td>
<td>Supportive</td>
</tr>
<tr>
<td>Omsk hemorrhagic fever</td>
<td>Fever, cough, conjunctivitis, papulovesicular eruption on the soft palate, marked hyperemia of the face and trunk (but no rash), generalized lymphadenopathy, and splenomegaly. Some patients may develop pneumonia and central nervous system dysfunction.</td>
<td>No</td>
<td>2-9</td>
<td>0.5-10</td>
<td>Supportive</td>
</tr>
<tr>
<td>Kyasanur Forest disease</td>
<td>Similar to Omsk but biphasic illness: first phase lasts 6-11 days and is followed by an afebrile period of 9-21 days. Up to 50% of patients relapse and develop meningoencephalitis.</td>
<td>No</td>
<td>2-9</td>
<td>3-10</td>
<td>Supportive</td>
</tr>
</tbody>
</table>

*Reported Ebola data are for Sudan (50%) and Zaire (50%) subtypes. The Ivory Coast subtype has an indeterminate case-fatality rate, as there has been a single nonfatal human case.

The Reston subtype causes subclinical infection in humans.

†Mortality ranges from 23% in the 1967 outbreak in Germany to 70% in the largest outbreak of 1999 in the Democratic Republic of the Congo.

‡Also Sergey Netesov, MD, written communication, February 27, 2002.
<table>
<thead>
<tr>
<th>Critical issues</th>
<th>Additional issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surge capacity</td>
<td>Surveillance</td>
</tr>
<tr>
<td>Screening and recognition of cases</td>
<td>Diagnosis</td>
</tr>
<tr>
<td>Adequate training of HCP on donning and doffing PPE</td>
<td>Protecting personnel</td>
</tr>
<tr>
<td>Adequate isolation facilities (sequestered or dedicate area)</td>
<td>Occupational health</td>
</tr>
<tr>
<td>Maintaining adequate staffing</td>
<td>Stockpiling PPE</td>
</tr>
<tr>
<td>Provision of essential services/supplies</td>
<td>Triage of limited supplies/beds</td>
</tr>
<tr>
<td></td>
<td>Security</td>
</tr>
<tr>
<td></td>
<td>Communications</td>
</tr>
<tr>
<td></td>
<td>Transport</td>
</tr>
</tbody>
</table>
ATTENTION ALL PATIENTS

IF YOU
recently traveled internationally or had close contact with someone who recently traveled internationally and was ill,

AND YOU HAVE
fever, cough, trouble breathing, rash, vomiting or diarrhea,

PLEASE TELL STAFF IMMEDIATELY!

ATENCIÓN A TODOS LOS PACIENTES

SI USTED
realizó un viaje internacional recientemente o tuvo contacto cercano con alguien que recientemente realizó un viaje internacional y estuvo enfermo,

Y USTED TIENE
fiebre, tos, dificultad para respirar, sarpullido, vómitos o diarrea,

¡INFORME AL PERSONAL DE INMEDIATO!
OUTPATIENT EBOLA ISOLATION SIGN

OUTPATIENT CLINICS

SPECIAL CONTACT/DROPLET PRECAUTIONS

HEALTHCARE PERSONNEL MUST WEAR:

- Surgical mask
- Gloves - double glove (2 sets)
- Impervious blue gown
- Protective goggles or faceshield

Phones/pagers/jewelry must remain outside the room

After patient leaves, leave room closed and out of service until cleared by Hospital Epidemiology Department.
To ensure there is no entry, place tape across door.

For Questions:
Call Hospital Epidemiology at 919-966-1638 or Page 123-7427.

CLÍNICAS

PRECAUCIONES ESPECIALES PARA LA TRANSMISIÓN POR CONTACTO O POR GOTAS

EL PERSONAL DEL CUIDADO DE LA SALUD DEBE UTILIZAR:

- Mascarilla quirúrgica
- Guantes: guantes dobles (2 pares)
- Bata azul impermeable
- Gafas de seguridad o protector facial

Los teléfonos/buscapersonas/joyas deben permanecer fuera del cuarto.

Después que el paciente se vaya, dejar el cuarto cerrado y ponerlo fuera de servicio hasta que el Departamento de epidemiología del hospital dé la autorización. Para asegurarse de que nadie entre, favor de colocar cinta adhesiva en la puerta.

Para preguntas:
INPATIENT EBOLA ISOLATION SIGN

SPECIAL CONTACT/AIRBORNE PRECAUTIONS

Visitors, including family, must not enter—report to Nursing Station.

HEALTHCARE PERSONNEL MUST WEAR:

- N-95 Respirator (prior fit testing required)
- Gloves - double glove (2 sets)
- Tyvek “Bunny Suit”
- Protective goggles
- Shoe Covers (Foot Protection)

Phones/pagers must remain outside the room

Perform Hand Hygiene before entering the room and following removal of personal protective equipment and leaving the Patient’s room.

For Questions Call Hospital Epidemiology at 919-866-1638 or Page 123-7427.

PRECAUCIONES ESPECIALES PARA LA TRANSMISIÓN POR VÍA AÉREA O POR CONTACTO

Los visitantes, incluyendo la familia, no deben entrar —presentense a la estación de enfermeras.

EL PERSONAL DE CUIDADO DE LA SALUD DEBE USAR:

- mascarilla respiratoria N-95 (para poder usarla es obligatorio que pase antes la prueba para saber la medida correcta)
- guantes - dobles (2 pares)
- vestuario Tyvek “Bunny Suit”
- protección para los ojos
- cubiertas para los zapatos (protección para los pies)

Llave a cabo la higiene de las manos antes de entrar a la habitación y después de quitar el equipo de protección personal y salir de la habitación del paciente.

Si tiene preguntas llame a Hospital Epidemiology al 919-966-1506 o al buscaspacios 123-7427.
UNC HEALTH CARE EBOLA PREPAREDNESS: KEY FEATURES

1. Communication (ASK, ISOLATE, CALL): Information for students, alert signs in hospital, screening for travel/symptoms at all clinic encounters, scripting Health Link

2. Dedicated space in UNC ED (2 rooms pre-stocked with PPE)

3. Designated inpatient area with specifically designed unidirectional flow (designated hot and cold zones)
   - Pre-positioning of PPE supplies and lab equipment
   - Designated location for donning PPE
   - Designated location for doffing PPE
   - POC lab area
   - Equipment storage area (e.g., X-ray machine)
   - Showers for staff
   - Secure area
1. Ebola Care Team developed: Critical care physicians and nurses, lab technologists, respiratory care, radiology technologists

2. Ancillary support staff identified: Infection Control, pharmacy, security, etc.

3. HCP safety (PPE): Scrubs, Tyvek suits, Tyvek hood, 2 sets of extended cuff gloves, N95 respirator, face shield, impervious blue over gown, fluid impervious boots
   - PPE monitor 24/7 and safety officer 24/7
   - PPE stockpiled

4. Training in donning and doffing PPE (defined donning and doffing protocol)
   - Phase I: Basic PPE including breach protocol and disinfection protocol for spills-surfaces
   - Phase II: PPE training in simulation lab individualized for HCP specialty
   - Phase III: PPE team training
PREPAREDNESS FOR MANAGING A HIGHLY COMMUNICABLE EMERGING INFECTIOUS DISEASES

1. General

- Have a comprehensive facility plan for managing a highly communicable emerging infectious disease.
- Nestle the plan for emerging infectious diseases within the general disaster plan.
- Base the plan on the route(s) of transmission for the infectious agent.
- Incorporate the incident command structure in the plan.
- Periodically train key personnel on the plan.
- The plan should include care of single patients (eg, Ebola) and managing large number of patients in an epidemic (eg, novel influenza).
- Incorporate communications with local and state health department officials.

Screening and signage (when appropriate based on the threat of a highly communicable disease)

- Place signs at every entrance to the hospital and clinics that includes the following: epidemiologic clues to possible disease exposure (ie, travel locations), signs and symptoms of infection, and who to notify if the patient or visitor has both exposure and appropriate signs or symptoms.
- Include messaging about the signs and symptoms of the concerning disease in all telephone contacts with the patient (eg, reminders about appointments) and who to contact prior to arrival at the health care facility.
- Screen all patients immediately at the time of all health care visits.
- Include screening in the electronic medical record (also have alerts in the medical record that require screening)

SCREENING AND SIGNAGE (WHEN APPROPRIATE BASED ON THE THREAT OF A HIGHLY COMMUNICABLE DISEASE)

- Place an appropriate isolation sign on the door of all patients being isolated because of the possibility of a highly communicable disease.
- For diseases transmitted via the droplet or airborne routes emphasize respiratory hygiene (ie, immediate use of a mask and proper disposal of tissues).
- Emphasize the need for proper hand hygiene.
- All messaging should be in appropriate languages for the region.

PREPAREDNESS FOR MANAGING A HIGHLY COMMUNICABLE EMERGING INFECTIOUS DISEASES

1. Triage
   - Train frontline person in all clinics and the emergency department in appropriate use of personal protective equipment.
   - Have appropriate personal protective equipment available.
   - Have a designated location in the emergency department and all clinics in which to immediately place the patient (a private room; ideally with access to a sink and toilet, and if possible, one that meets standards for a disease transmitted by the airborne route (ie, negative pressure, out-exhausted air, >12 air exchanges per hour) if applicable.
   - For diseases transmitted by the airborne route and when an airborne isolation room is not available, ideally place a portable high-efficiency particulate air purifier in the room.

1. Triage
   - Have a well-defined process for alerting key health care facility officials about the presence of a patient with a possible highly communicative disease (e.g., disaster manager, infection preventionist).
   - Avoid blood tests or other procedures that may place the laboratory staff or other health care personnel at risk.
   - Have a well-defined and safe method for transporting a patient either to a properly equipped emergency department or hospital facility able to safely care for a patient.

PREPAREDNESS FOR MANAGING A HIGHLY COMMUNICABLE EMERGING INFECTIOUS DISEASES

1. Inpatient care
   - Have a well-defined plan for the inpatient location that will provide care to a patient with a highly communicative disease (or a plan for transporting such a patient to facility that can provide such care).
   - In the inpatient care unit designate areas that are hot (ie, potentially contaminated) and cold (ie, areas that are not contaminated).
   - Have a well-trained medical care team. For highly communicable diseases (eg, Lassa, Ebola), ideally provide 3-step training: (1) basic individual training on personal protective equipment donning and doffing (and including how to manage contamination of the environment from a spill and breach of the personal protective equipment. Such training should be individualized to the specialty of the health care providers [ie, physician, nurse, respiratory therapist]); (2) team training using mannequins; and (3) team training in the designated containment unit.
   - Train team personnel on donning and doffing using an explicit written list of all donning and doffing steps.

PREPAREDNESS FOR MANAGING A HIGHLY COMMUNICABLE EMERGING INFECTIOUS DISEASES

1. Inpatient care
   - Screen and exclude health care personnel unable to wear the proper personal protective equipment. Consider excluding from the care team personnel at high risk for disease acquisition or more severe illness, such as persons with nonintact skin, pregnancy, and immunocompromised persons. Consider excluding trainees from providing care.
   - Store an adequate supply of personal protective equipment.
   - If needed, have dedicated point of care laboratory equipment
   - Develop a method to safely dispose of solid and liquid wastes.
   - Restrict visitors (if indicated) and maintain a log of all visitors.
   - Maintain a log of all health care personnel providing care.
   - Develop a plan for managing health care personnel with unprotected exposure to the infectious agent (eg, needlestick).
   - Assure that care team members receive proper rest.

SUMMARY

1. Expect new and emerging diseases in the future
2. Develop and implement policies and procedures to minimize risk to healthcare facility and HCP
3. Key vulnerabilities
   - Failure to recognize a patient infected with a highly communicable disease, and promptly institute proper isolation precautions
   - Failure to have proper PPE available and/or train HCP in donning and doffing of PPE
4. Key public health control measures
   - Sensitive and specific diagnostic test
   - Worldwide cooperative response
THANK YOU