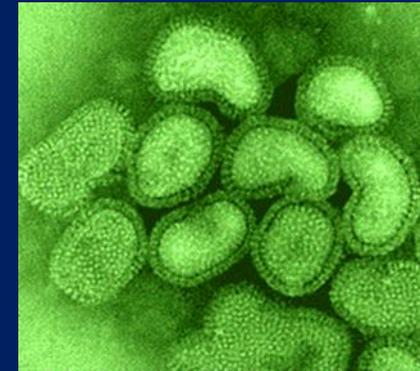


Biosafety 2015: What the Montana Rural Provider Needs to Know



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Take Home Messages

- Anywhere in Montana is accessible within the incubation period of an exotic disease
- Tourism by definition means people coming from somewhere else, and they may be carrying disease
- The alert HCW who recognizes when things don't add up is the first line of defense
- Travel and symptom history should always be asked early on in any interaction
- Prompt implementation of Standard or Transmission based Isolation guidelines will protect you and your patients

Issues to Discuss

- Historical overview and why this is of growing importance
- Definition of terms
- Exotic pathogens only a plane ride away that have **already** affected Montana
- Potential bioterrorism agents
- Protection from infection by thorough **knowledge of** and **application** of Standard (aka **Universal**, a.k.a. **ALL PATIENTS, ALL THE TIME**) Isolation Guidelines

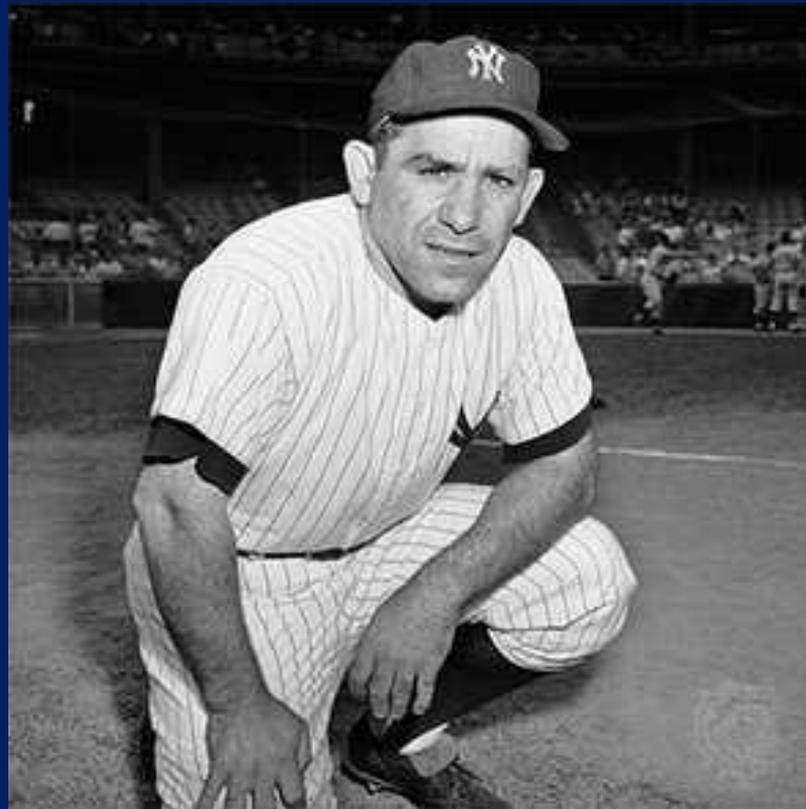
The End of the Innocence

- In 1967 United States Surgeon General William Stewart is credited with saying that “the time has come to close the book on infectious diseases.” He believed it was time to shift national attention to what he termed “The New Dimensions” of health: chronic diseases such as heart disease and cancer. His opinion, which was shared by many in Public Health, was that it was only a matter of time before the war against infection would be won by a combination of antibiotics and vaccines.



“Predictions are difficult; especially when they involve the future.”

Yogi Berra



Some Examples of Newly Recognized Human Pathogens Since 1967

- Human immunodeficiency viruses 1 and 2
- HTLV I, II viruses
- Hepatitis viruses C, D, E, Gb
- Lassa fever virus
- Filoviruses (Ebola, Marburg)
- Henipaviruses (Hendra, Nipah)
- Highly pathogenic avian influenza viruses (several)
- SARS, MERS coronaviruses
- Human metapneumovirus
- **New World Hantaviruses** (several variants)
- Variant Creutzfeldt Jacob disease
- *Legionella pneumophila*
- Vancomycin resistant *Staphylococcus aureus*
- Vancomycin resistant *Enterococcus sp.*
- *Mycoplasma genitalium*
- Heartland virus
- Bourbon virus

* **First described in the US**

Sources of New Diseases

- Zoonotic transmission
- Travel. Every spot on the globe is within reach during the incubation period of a pathogen
- Habitat destruction and human encroachment into remote areas
- Continued population growth and density
- Migration from rural to urban areas
- Increased worldwide transport of animals and food products
- Changes in food processing and handling
- Global climate change

Definitions

- Biosafety
- Bioterrorism
- Standard Isolation Guidelines
- Transmission based isolation guidelines

Biosafety

- **Biosafety.** The discipline addressing the safe handling and containment of infectious microorganisms and hazardous biological materials

Standard and Transmission Based Precautions

Biosafety for the Health Care Worker

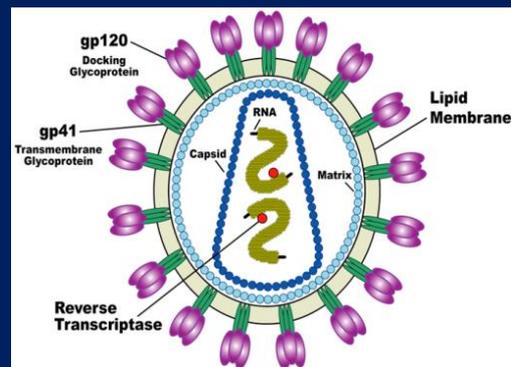
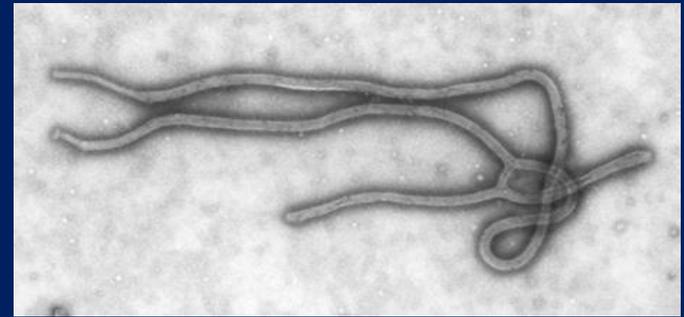
- A set of basic infection practices intended to prevent transmission of infectious diseases from one person to another
- Because the person may not be demonstrating clinical illness(es), Standard Precautions are applied to **every person every time** to assure that transmission of disease does not occur
- Standard Precautions has replaced the earlier term “Universal Precautions”
- **Transmission based** precautions are layered on top of Standard precautions
 - Contact
 - Droplet
 - Airborne

Bioterrorism

- The deliberate release of viruses, bacteria or other agents in order to cause illness or death in people, animals or plants
- Mother Nature may inadvertently behave like a bioterrorist

Exotic Infections in Montana: Hits and Near Misses

- Human Immunodeficiency Virus
- West Nile virus
- Monkeypox
- Ebola
- Influenza

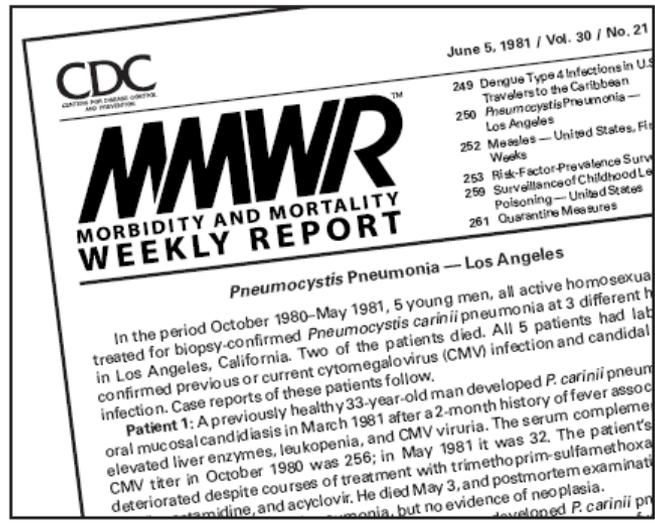


Human Immunodeficiency Virus

Medscape®

www.medscape.com

FIGURE. MMWR report on *Pneumocystis pneumonia* in five previously healthy young men in Los Angeles — June 5, 1981



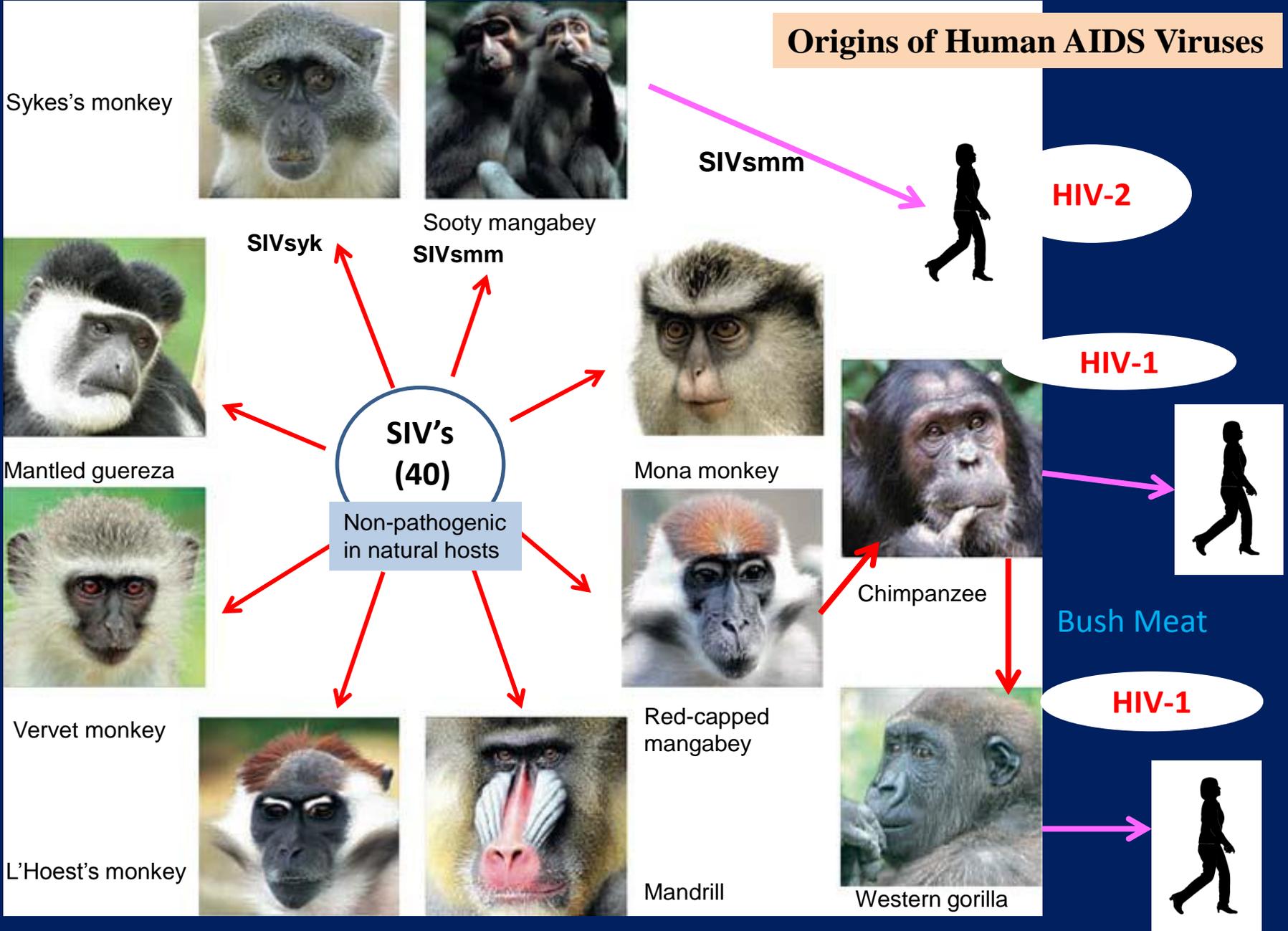
Source: MMWR © 2006 Centers for Disease Control and Prevention (CDC)



The disease that forced a re-assessment of isolation guidelines

Kaposi's sarcoma

Origins of Human AIDS Viruses



Out of Africa...

- Strains of HIV have been found in specimens stored from 1959 and 1960 in Leopoldville (now Kinshasa)
- These strains had already become very divergent
- Knowing rate of mutation allows back calculation.
- HIV entered the human population for the first time some time between 1882 and 1916



Pre-AIDS AIDS

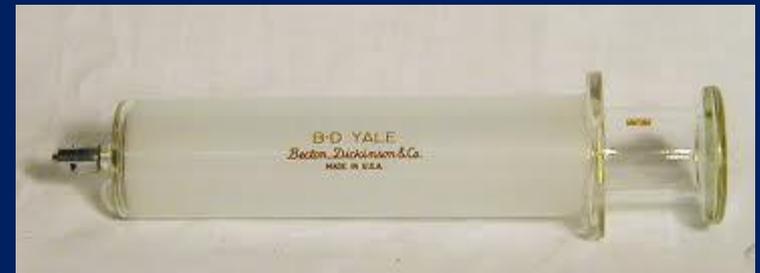
- 1939 Danzig, Germany
- 1941 Switzerland
- 1942 Austria
- 1946 Italy
- 1955-58 mini-epidemic of PCP in Limburg, the Netherlands (81 cases)
- 1959 Britain via Morocco
- 1961 Norway via Cameroon
 - Sailor treated for gonorrhoea after shore leave there
 - Died of dementia and pneumonia age 29
 - Wife and daughter also died of OI's
 - Stored blood tested HIV positive

From Sporadic Cases to a Pandemic

- Prior to 1910, no central African city had a population of > 10,000
- Cheap re-usable syringes were developed in 1950's
- Campaigns to eliminate several diseases used multi-use syringes
- Traditional healers began to adopt injections as part of their practices
- 80% of families in Uganda in the 1960's owned their own syringe.
- War and displacement
- The Trans-African highway
- International travel
- STD's as co-factors for transmission
- Transfusion of blood and blood products prior to screening methods



Leopoldville, 1896



Impact of HIV

- Since the beginning of the epidemic 78 million people have been infected and 39 million have died
- Globally 35 million persons were living with HIV at the end of 2013
- 1.5 million persons died from AIDS related illnesses in 2013
- **Montana:** as of 12/31/13:
 - 1,225 cases
 - 400 deaths
 - 75 new HIV diagnoses in 2013

Source: WHO

Source: Peter Choi, MT Dept of Public Health

From Africa to Queens

- August 1999 Dr. Deborah Asnis notes two patients with encephalitis in the same hospital in northern Queens, notifies state health department
- Preliminary epidemiologic investigation reveals 6 more cases in local hospitals
- *Culex* mosquito breeding sites found in yards and neighborhoods of affected patients
- All patients have IgM antibodies to SLE
- Mosquito control measures instituted



Introduction cont'd

- Simultaneously, an epizootic outbreak of unknown cause was occurring with the death of substantial numbers of birds
- Not thought connected to humans
- WNV isolated from the brain of a flamingo with fatal encephalitis at the Bronx zoo (NY 99 strain)
- Supplemental testing of human cases revealed WNV antibodies that had cross reacted with SLE
- No previous record of this virus in Western hemisphere; a new epidemic recognized



West Nile Virus Transmission Cycle

Mosquito vector



Incidental infections



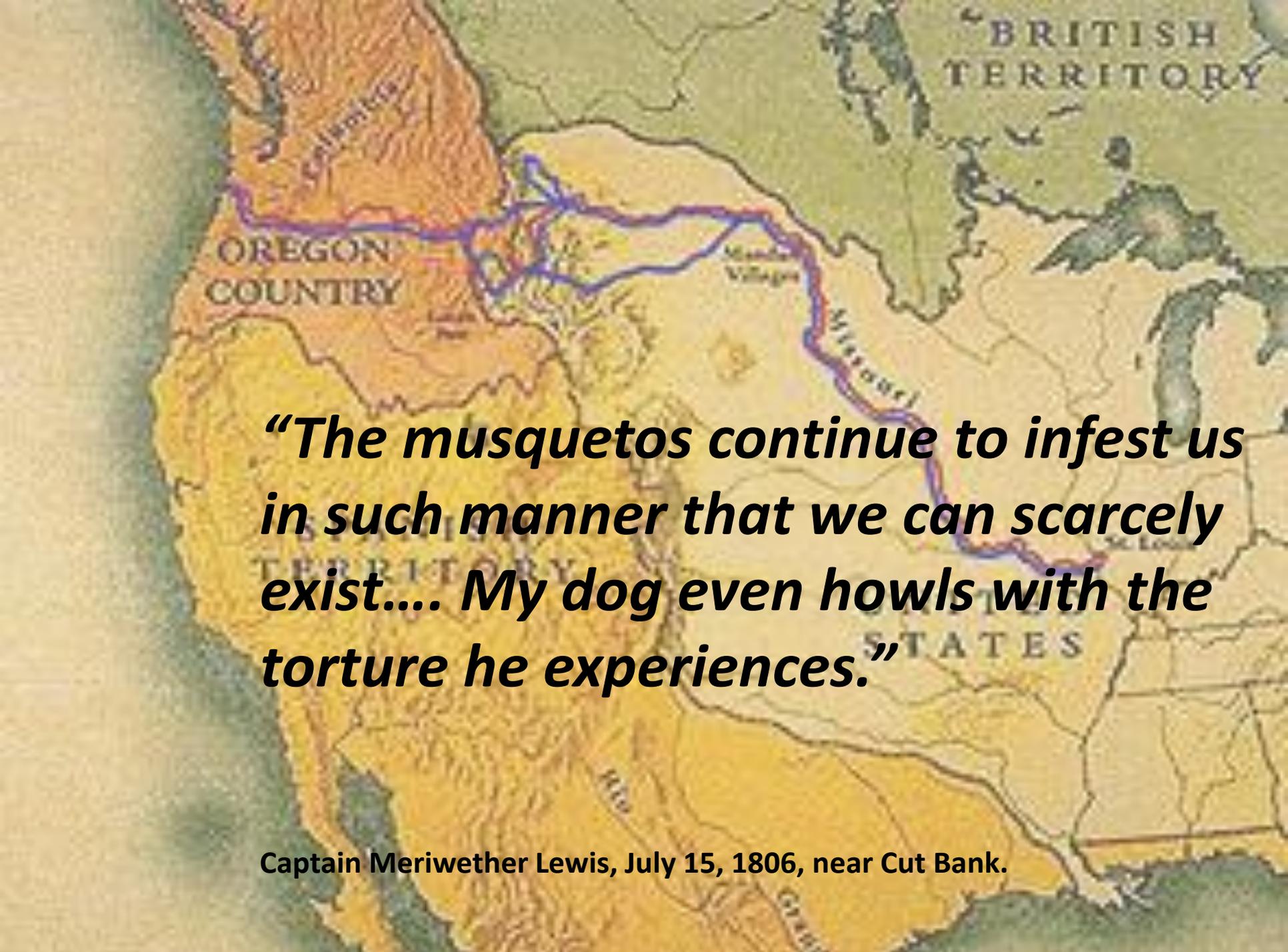
High levels of viremia



**Bird
reservoir
hosts**

Incidental infections



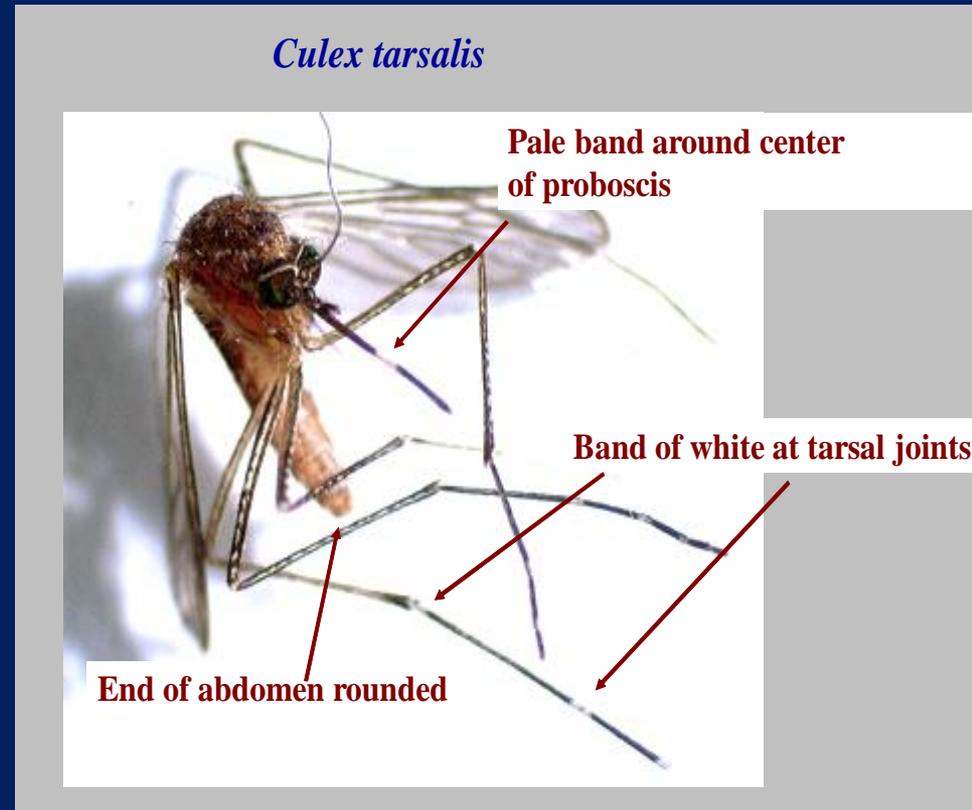


“The musketos continue to infest us in such manner that we can scarcely exist.... My dog even howls with the torture he experiences.”

Captain Meriwether Lewis, July 15, 1806, near Cut Bank.

Competent Vectors for WNV

- At least 25 common species in the state
- *Culex tarsalis* (occupies same niche in west as *C. pipiens* in the south and east) the most likely to cause problems with WNV
 - Prefers to bite birds
 - Once birds fledge *C. tarsalis* moves onto other animals to include horses and humans
 - Generally regarded as container species
 - Feed primarily at dusk, less at dawn (cooler, wetter)
- *Culiseta inornata*
- *Aedes vexans* and *nigromaculis*
- *Culex* and *Culiseta* overwinter as adults



Avian Transmission of WNV via Migration

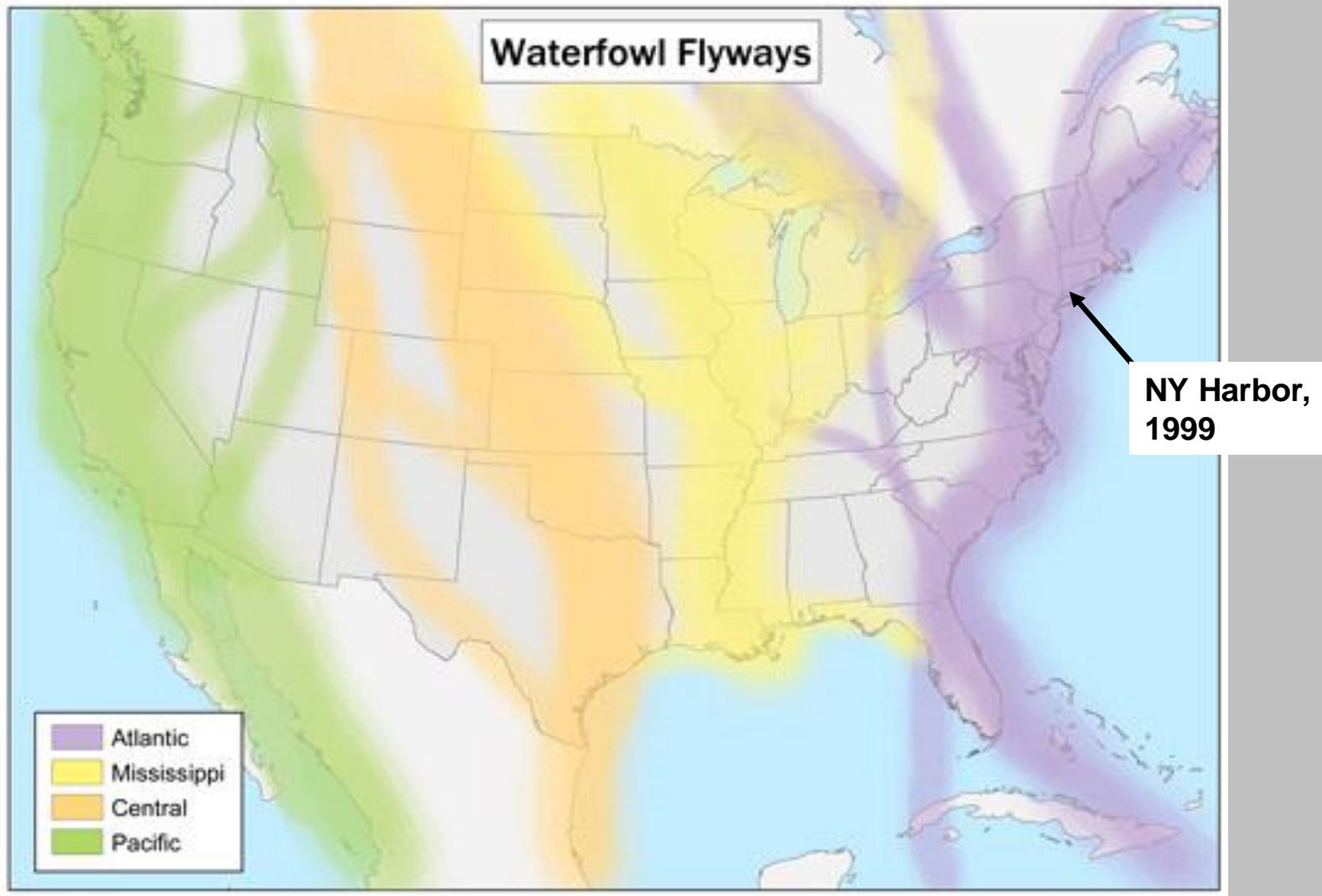


Figure 1: Number of WNV Cases: United States and MT 2002—2014

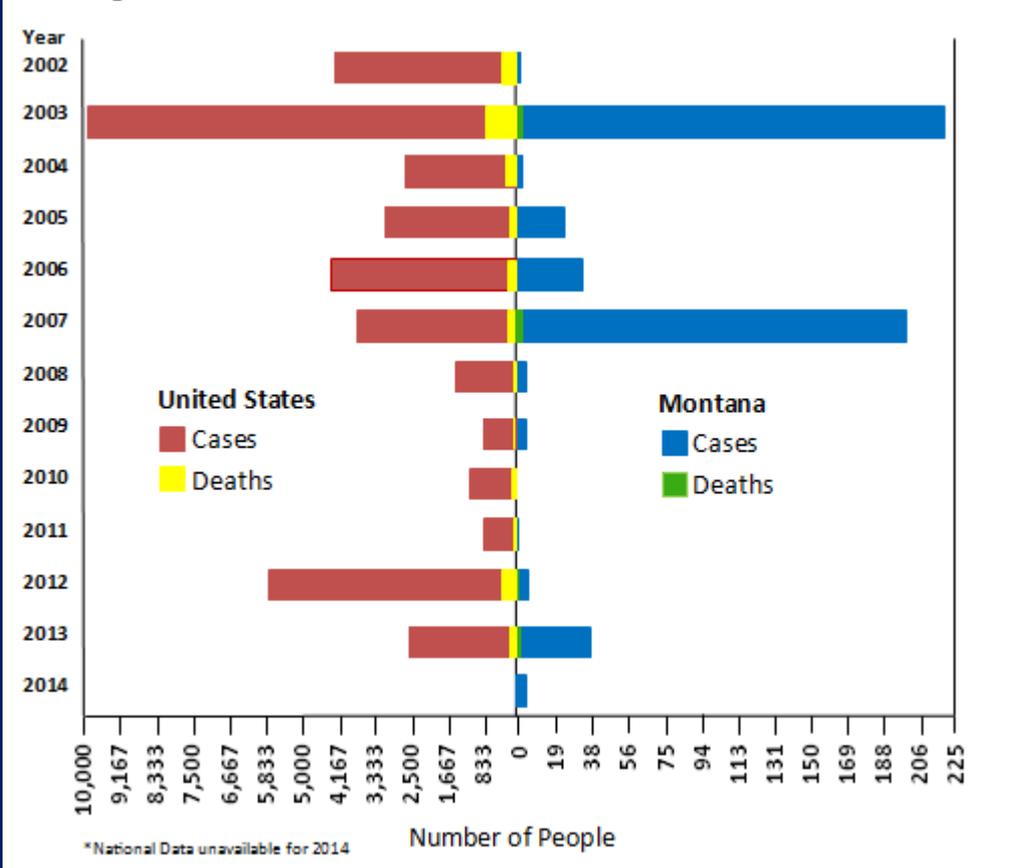
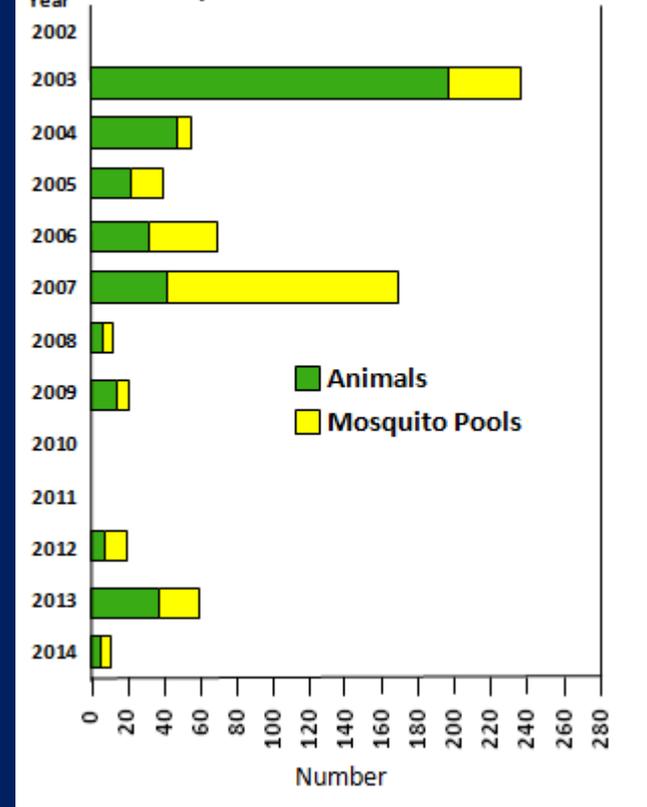


Figure 2: Number of Positive WNV Animal and Mosquito Pools: MT 2002—2014



As of 8/22/2015: One asymptomatic but viremic blood donor
 One symptomatic human case (Richland County)
 One positive horse
 Nine positive mosquito pools

Monkeypox

Name is a misnomer, several species of rodents serve as the primary reservoir
An orthopox virus related to smallpox
Vaccinia (the smallpox vaccine) is protective against monkeypox



Primary hosts:
Rodents
(squirrels, rats)



Incidental hosts:
Non-human primates
(low prevalence)

Monkeypox Transmission Cycle in Central Africa



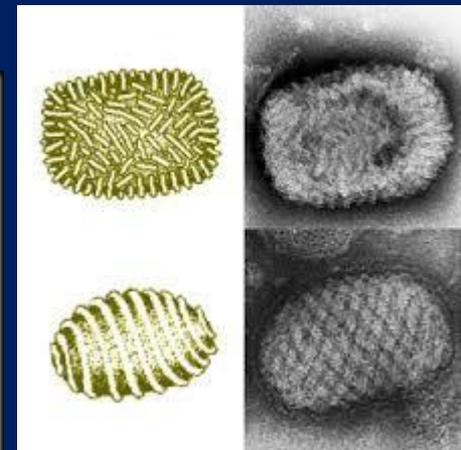
Bushmeat hunting



Humans

Secondary transmission

Other humans



The Gambian Giant Pouched Rat

Up to 32 inches long
Up to 10 pounds
Consumed in Africa
Considered an exotic pet
in the U.S.



Monkeypox, United States, 2003

- April 9, 2003 a Texas animal importer received a shipment of Gambian giant pouched rats from Ghana, West Africa
- The rats were sold to Phil's Pocket Pets in suburban Chicago. They were housed near domestic prairie dogs.
- The prairie dogs were sold or traded at "swap meets" to persons from Illinois, Ohio, Wisconsin and Indiana.
- Many of the prairie dogs became ill and died from what was later diagnosed as monkeypox.
- Illness was transmitted to their owners
- 72 cases of human monkeypox were reported to CDC from Wisconsin, Illinois, Indiana, Ohio, Kansas and Missouri.

HCW Responses

- In Rockford, Illinois a 10 year old girl is admitted with fever and rash, suspected diagnosis of monkeypox.
- Majority of the medical and nursing staff refused to care for the patient
- One physician and 4 nurses the only ones who agree to provide care for the patient. Over 4 days they live in the hospital and work in shifts
- Marshfield Clinic, Wisconsin. Similar case, but **no** HCW reluctance. No occupational transmission



Montana Visitor Has Probable Case of Monkeypox

Helena (AP):

“An Illinois girl who spent part of this week in Whitehall is hospitalized in her home state with a suspected case of monkeypox. She arrived in Whitehall, southwestern Montana along the Jefferson River on Monday and became feverish on Tuesday. She developed a rash and pox on Wednesday and left the state on Thursday. She was hospitalized on Friday. She had been exposed to a pet prairie dog purchased from a quarantined distributor.”

Source: The Montana Standard, June 20, 2003

The Middle of Nowhere



Gueckedou prefecture
31 houses

Ground Zero



- A hollow tree that housed a colony of insectivorous free tailed bats
- Located about 50 m from the home of the index case
- Index case was a 2 year old boy who played in the tree before getting ill
- His mother, sister and grandmother all contract disease and succumb
- Relatives come from several villages in different countries to assist in burial
- They carry disease back to other villages and to urban centers in Kailahun, Kenema and Conakry





- National Capital (1,120,000 in 198)
- over 80,000
- over 40,000
- over 20,000
- other main city
- other city



Last Fall



How Did it Get So Bad?

- > 4 months from beginning of outbreak and acknowledgement by Guinean ministry of health of a “mysterious disease” (14 March)
- Outbreak occurred at the junction between Guinea, Liberia and Sierra Leone with highly mobile population across very porous borders
- First introduction of Ebola into a densely urban setting
- Misdiagnosis of initial cases in Sierra Leone
- Guinean MOH only shares information on confirmed cases and deaths, obscuring the true magnitude of the outbreak
- Traditional burial practices enhance transmission
- Fear and mistrust of politicians and health officials
- Hiding of cases
- WHO response has been severely criticized

The Kenema Government Hospital, Sierra Leone, 2014



Hitting the Ground Running



Toll on Health Care Workers

- 881 cases among African HCW's*
- 513 deaths*
- Many cases acquired outside an ETU
- Lack of supplies and poor training blamed for HCW infections



MSF Headgear and Masks. N-95 and surgical mask to cover more of the face to protect against splashes

Source: WHO Sit Rep, Sept 23, 2015

Influenza A

- A classic zoonosis
- All influenza A viruses are normal inhabitants of the GI tracts of aquatic and migratory wild birds
- No illness caused in the natural host
- Humans are infected either directly from birds or through an intermediary host

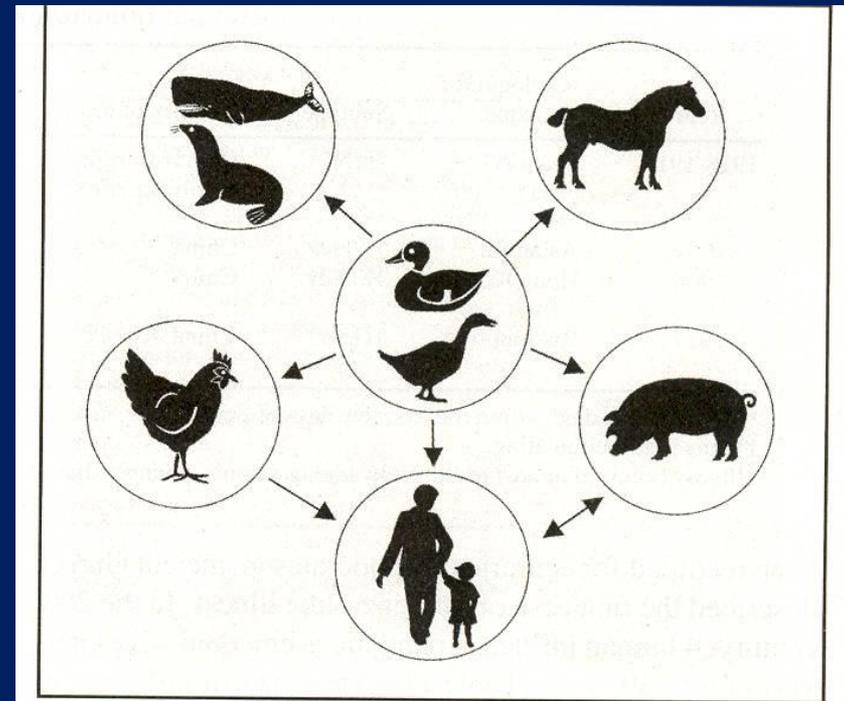
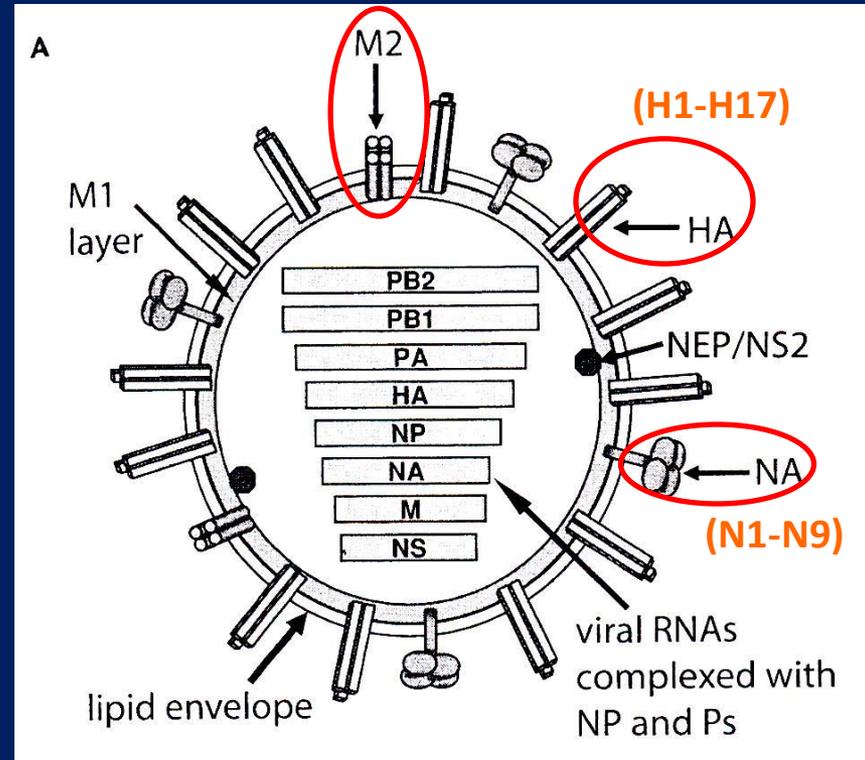


Figure 1. Wild aquatic birds are the main reservoir for influenza A viruses, from which viruses can be transmitted to other hosts such as horses, pigs, poultry, whales, seals, and humans. As indicated by arrows, humans can also be infected by pigs and poultry.

The Virus

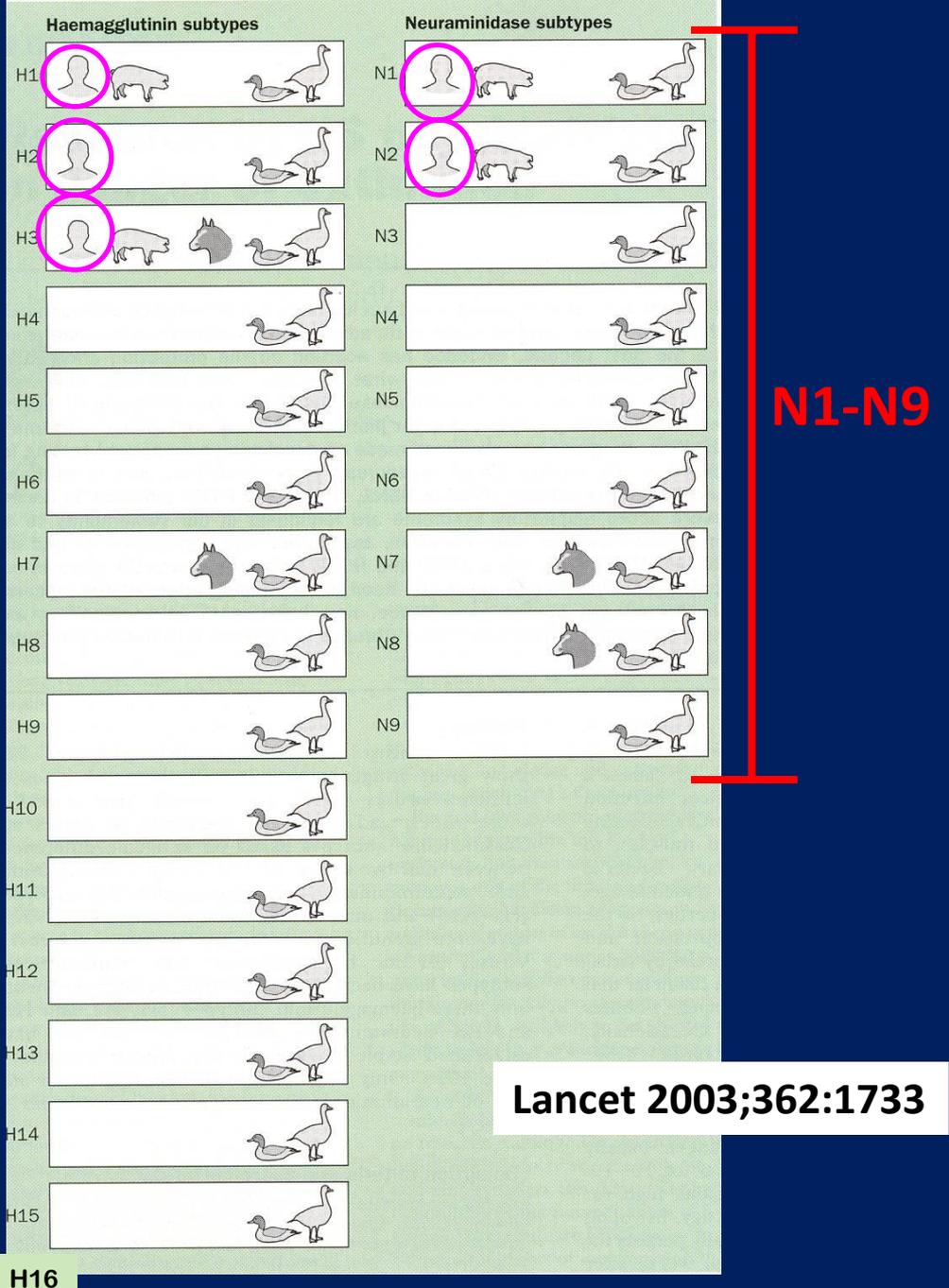
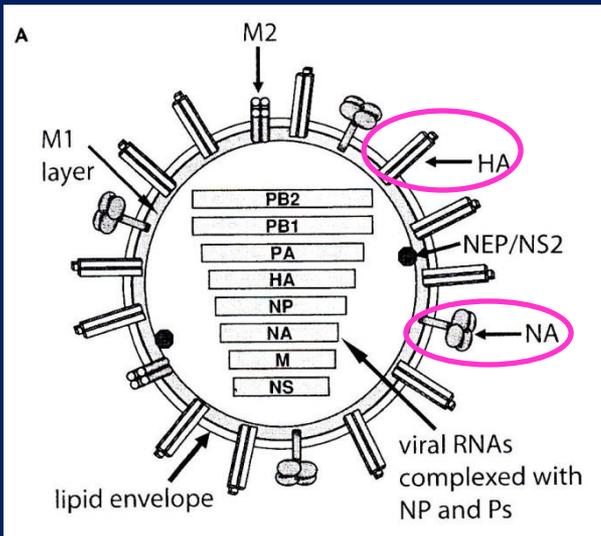
- Family *Orthomyxoviridae*
- Lipid enveloped
- Genome composed of 8 separate fragments of RNA
- Polymerase lacks a proofreading function so frequent mutations
- Two major surface proteins
 - **Hemagglutinin**- binds to host cells via sialic acid residues
 - **Neuraminidase**- facilitates exit of the virus from the host cell
- Other surface proteins are present in smaller amounts and elicit less host antibody response



Field's Virology, 5th ed, p 1649

Hosts Allowing Stable Lineage of Influenza A

H1-H17



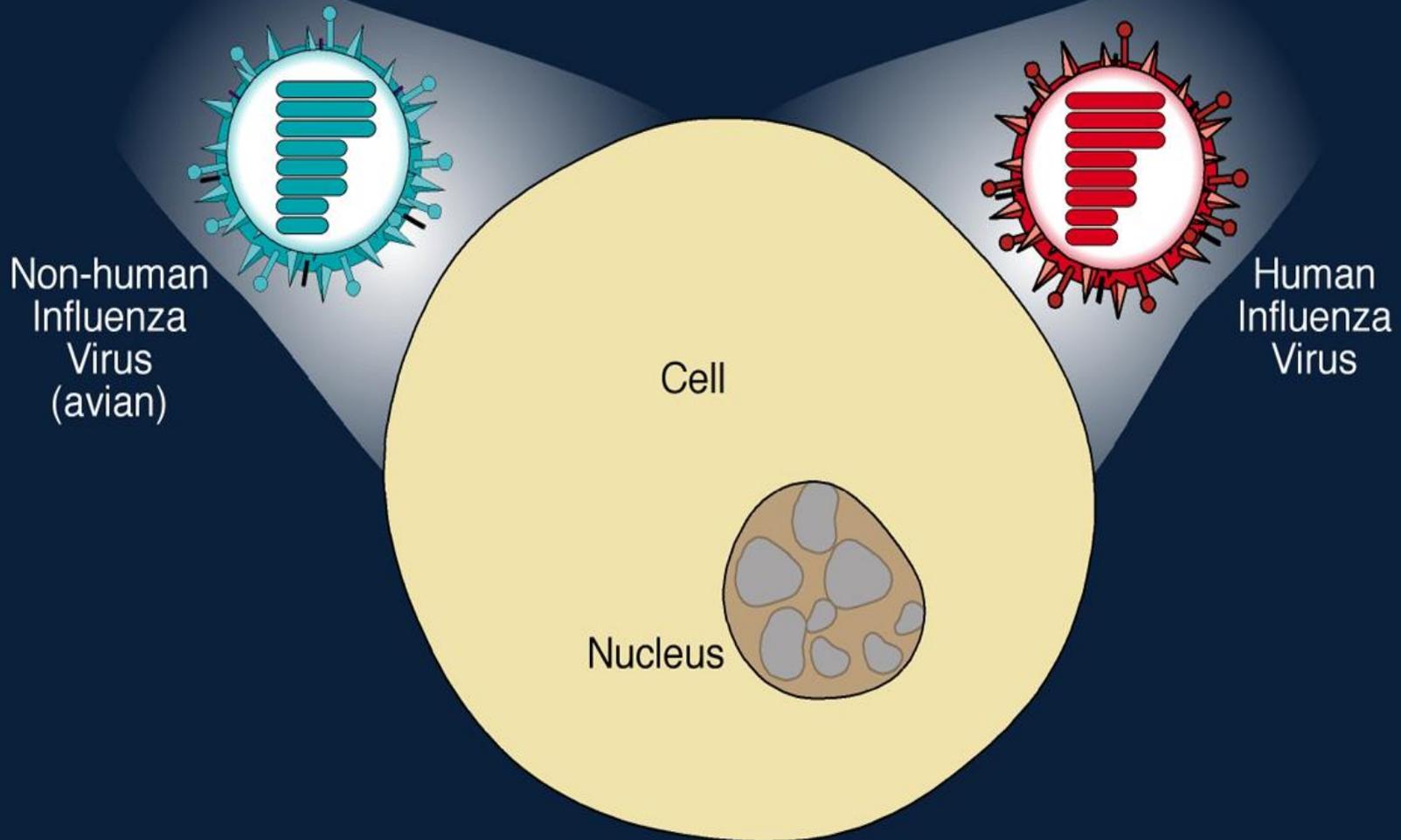
H16

H17 Just described in Bats

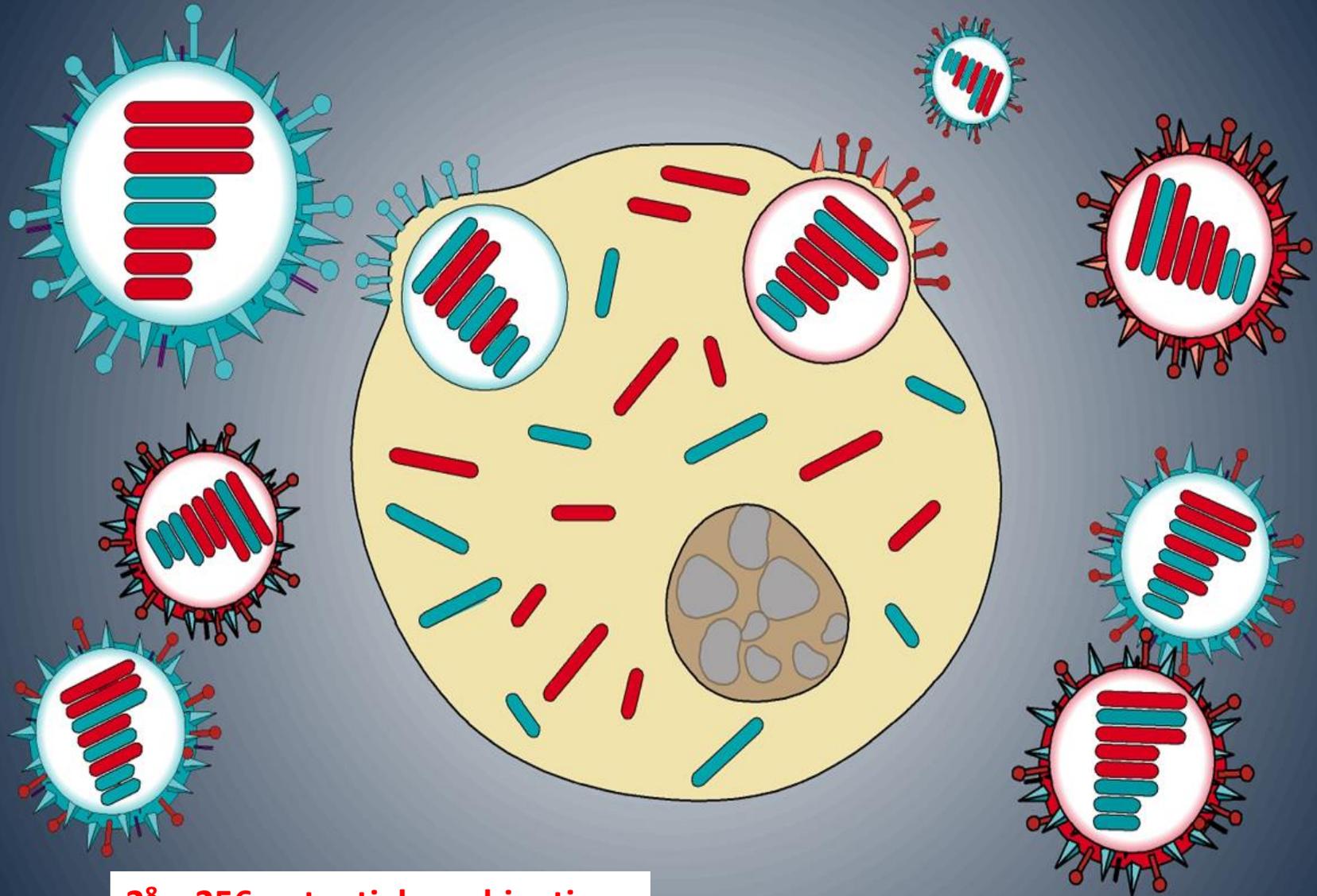
Antigenic Drift and Shift

- **Drift:** Gradual alteration of the influenza surface proteins (mainly HA) within a subtype resulting in the inability of antibody to previous strains to neutralize new viruses
- Results from point mutations in the HA and NA genes
- Because of this the antigenic composition of the vaccine must be updated annually to match circulating strains.
- **Shift:** Rapid change in the makeup of the virus as the result of reassortment within an infected cell between the genomes of two viruses that infect the cell simultaneously

Generation of New Pandemic Virus by Gene Exchange: Antigenic Shift



Replication Followed by Reassortment



$2^8 = 256$ potential combinations

What Happened in 1918?

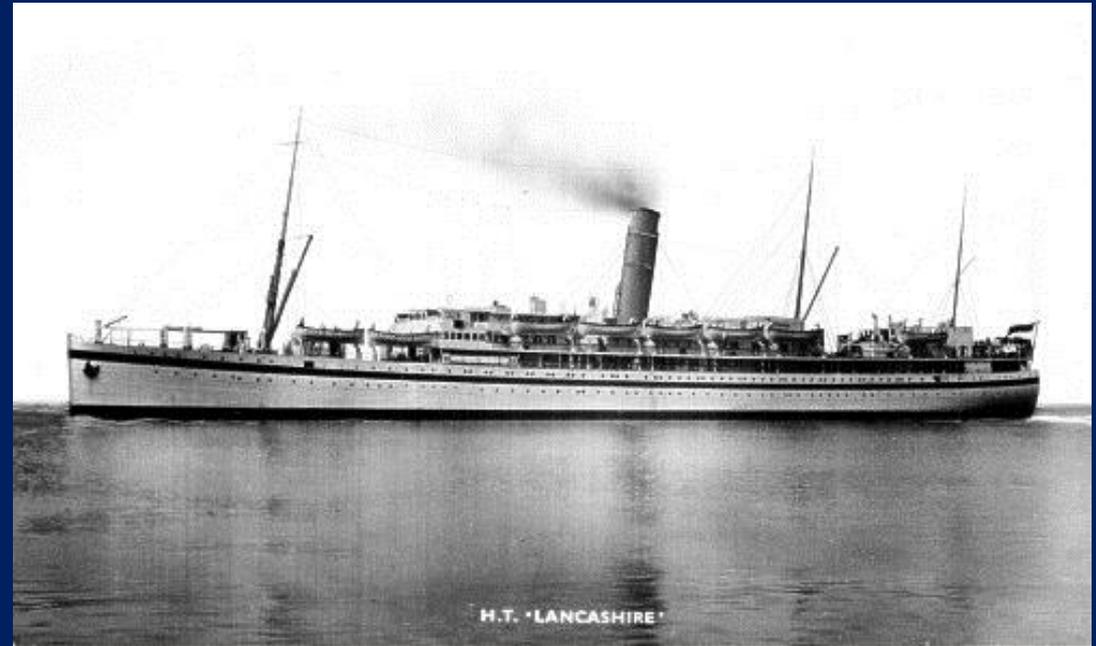
- First case attributed to a soldier at Camp Funston, Kansas, who had been cleaning pig pens
- An existing virus of avian origin became genetically adapted to attack and transmit between humans. The original avian source is still unknown
- There were 3 successive waves of disease within a 9 month span
- Mortality rate from W2 and W3 infections was 2.5% (vs 0.1% for seasonal influenza)



**Camp Funston (now Ft Riley),
Kansas, circa 1918**

Making a Bad Situation Worse...

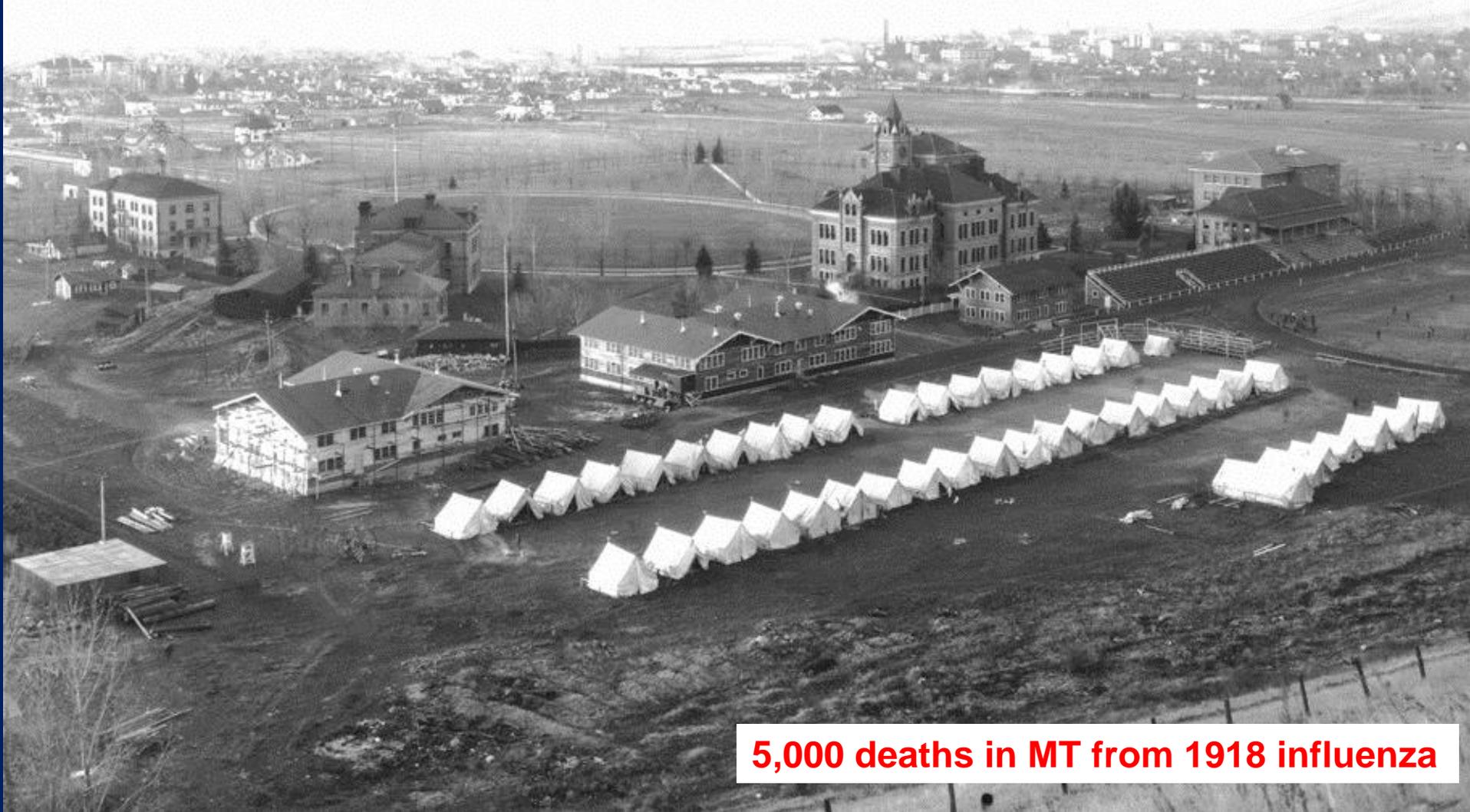
**Concentrate
susceptibles**



Stressful situations



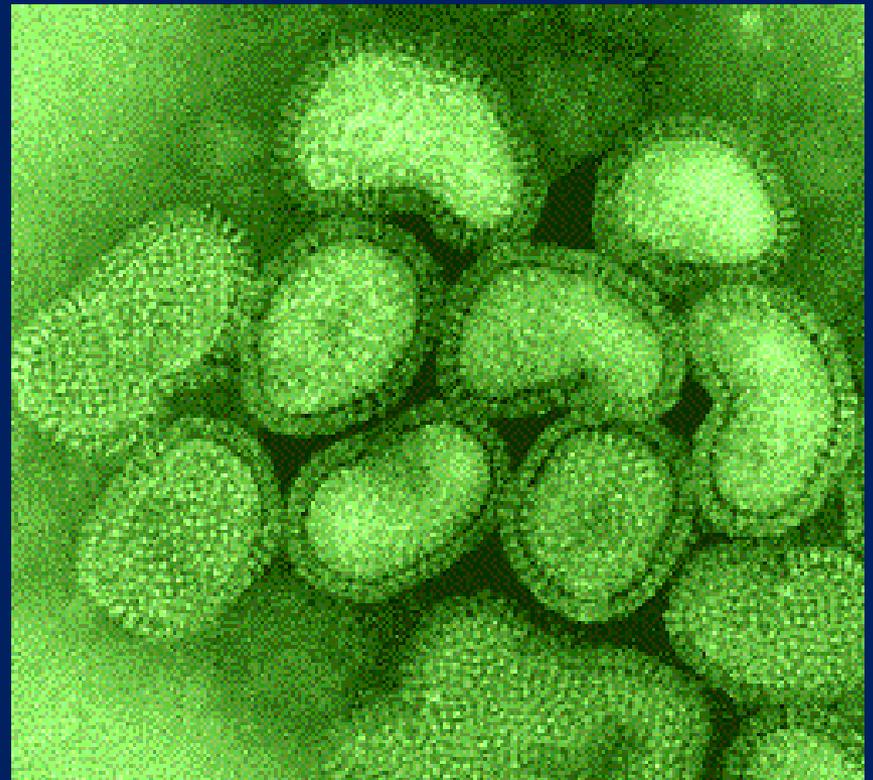
The University of Montana, 1918



5,000 deaths in MT from 1918 influenza

Infection by Other Influenza A Viruses

- 17 Hemagglutinin proteins H1-H17
- 9 Neuraminidase proteins N1-N9
- Humans **thought to be** susceptible only to those strains that could establish stable lineage, i.e., H 1,2,3 and N 1,2



Human Infection by Avian Viruses

So far, no evidence of stable human to human transmission of any of these

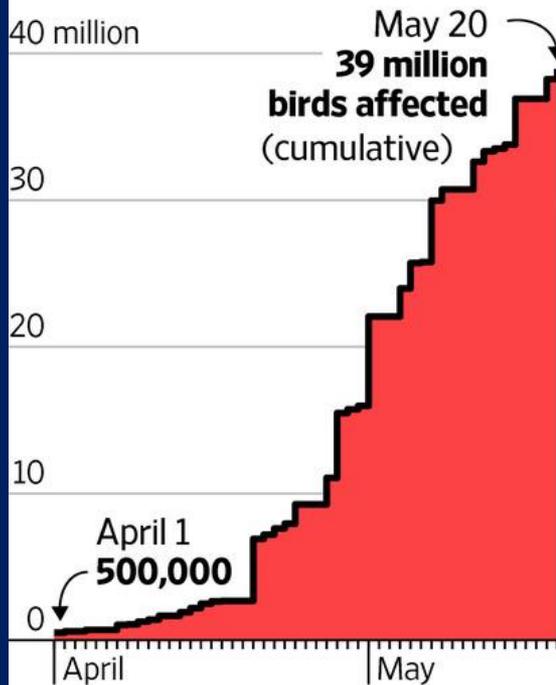
- H5N1 (“Bird flu”)
 - Hong Kong, 1997: 18 cases, 6 deaths
 - Hong Kong, 2003: 3 cases, 2 deaths
 - Vietnam, Thailand, 2004: 44 cases, 32 deaths (72% mortality)
 - Ongoing
- H7
 - H7N7 The Netherlands, 2003: 79 cases of conjunctivitis, 13 influenza-like illnesses, 1 death. 3 person-to-person transmissions
 - H7N9 China, 2013. >135 cases, 45 deaths. New cases being seen in the fall of 2013. **New wave feared**
- H9
 - Hong Kong and southern China, 1999: 7 cases
 - High seroprevalence in Chinese poultry workers, 1999
 - Hong Kong, 2003: 2 cases

Not Just Humans

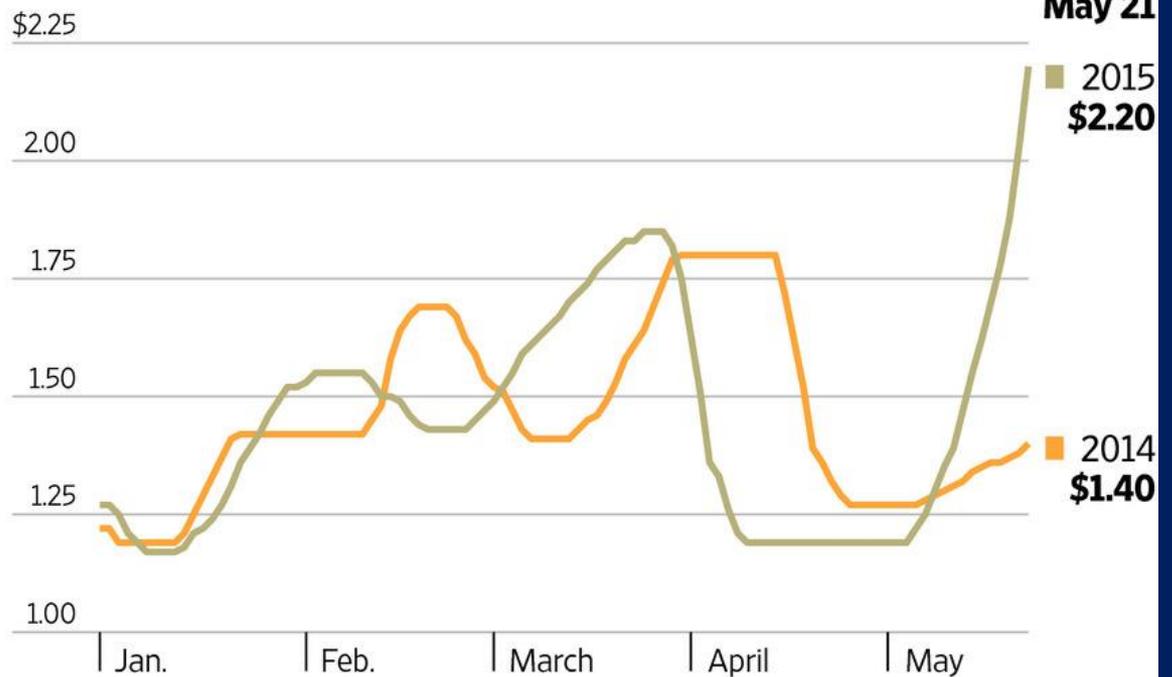
Fast-Spreading Virus

The highly infectious H5N2 strain of avian influenza has forced turkey and egg farmers to cull millions of birds. Egg prices are rising sharply.

U.S. avian flu outbreak this year



Wholesale price for a dozen large white eggs*



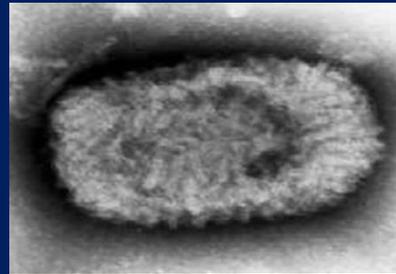
*Midwest price Sources: U.S. Department of Agriculture (birds); Urner Barry (eggs)

True Bioterrorist Agents

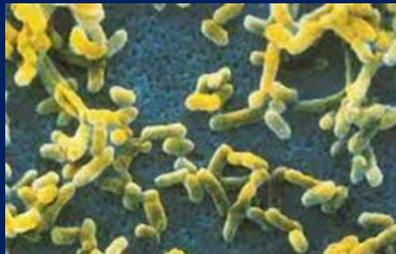
- Anthrax



- Smallpox

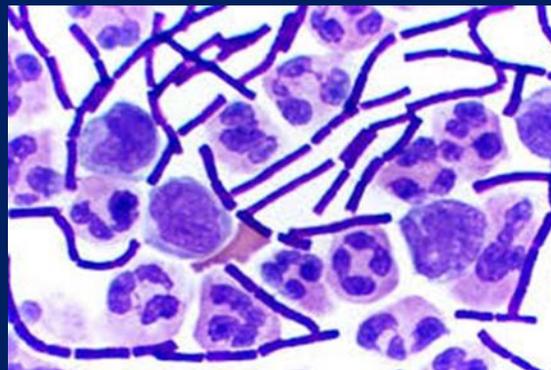


- Plague



The Astute Clinician: Again

- September, 2001. Robert Stevens, a photographer for the tabloid “Sun” in Boca Raton, Fla becomes ill after opening a letter laced with white powder
- Dr Larry M Bush, ID clinician examines the CSF of the patient and appreciates gram positive rods
- Anthrax suspected, diagnosis confirmed within 48 hours of patient presenting

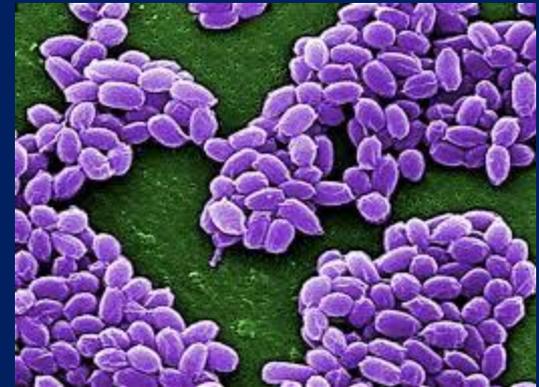


Bush LM, Perez MT, *Annals of Internal Medicine* 2012;156(1):41

White Powder Incidents



- 22 individuals infected
 - 11 inhalational disease
 - 11 cutaneous disease
- 5 deaths
- 10,000 Americans considered exposed and given vaccine and prophylaxis
- \$100 million spent in remediation, \$23 million in the US Capitol complex alone



Bacillus anthracis

- A large, aerobic, gram positive bacillus with the ability to form spores
- Spores remain viable for decades
- A worldwide disease of domesticated and wild animals that can infect humans
- Worldwide 200-2000 cases annually
- Not transmissible person to person
- Three major clinical presentations
 - Inhalational
 - Cutaneous
 - Gastrointestinal



Billings Gazette, 2010

Anthrax as a Biologic Weapon

- WW I Germany ships infected horses to Allies
- WW II Japan intentionally infects Chinese residents in Manchuria
- Anthrax manufactured for biowarfare accidentally released in Sverdlosk, Russia 1979. 70 cases of inhalational disease
- Saddam Hussein places 6,500 liters of anthrax into munitions in the 1st Gulf War

Prevention and Treatment

- Prompt diagnosis
- Antibiotics
 - Ciprofloxacin or levofloxacin
 - Doxycycline
 - Amoxicillin if pen sensitive
 - RESISTANT to 3rd generation cephalosporins
- Vaccine: Anthrax vaccine adsorbed (AVA, Biothrax)
 - Approved for pre-exposure prophylaxis
 - Used in the attacks, given at 0,2 and 4 weeks

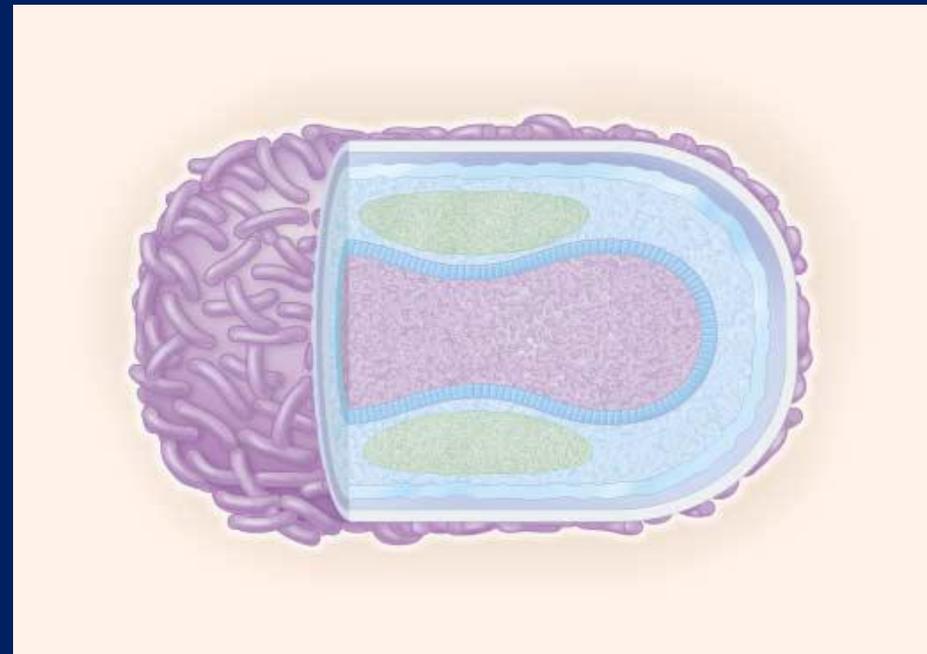
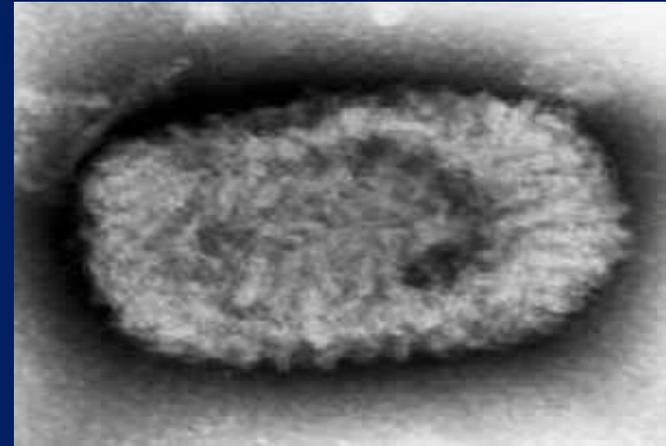


The Organism

- Variola virus (Latin *varius* “spotted” or *varus* “pimple”)
- Belongs to the genus *Orthopoxvirus*, members of which cause skin lesions in mammals
- Variola only infects humans, i.e. there is no non-human reservoir in nature
- Other poxviruses (cowpox, monkeypox, etc.) are maintained in one or a few host species
- Other poxviruses that can infect humans
 - Vaccinia
 - Cowpox
 - Monkeypox

The Largest and Most Complex

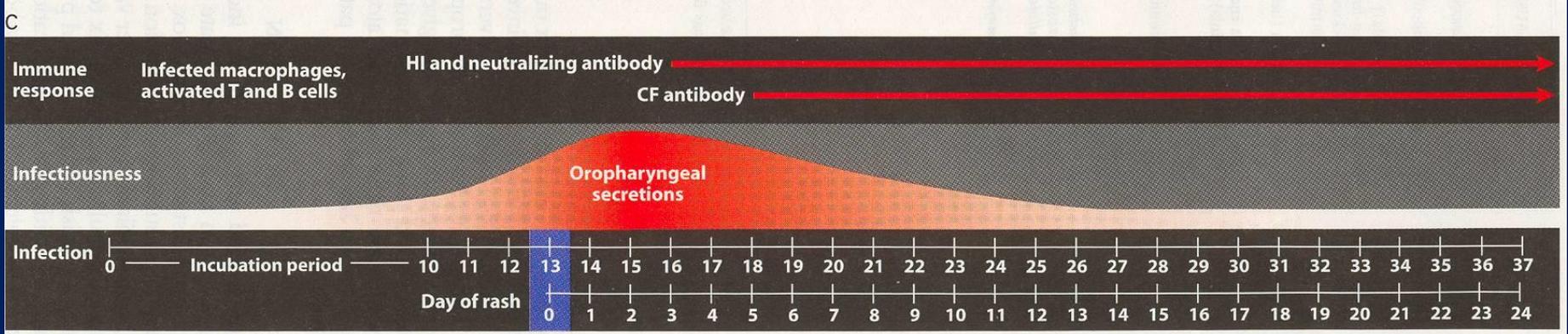
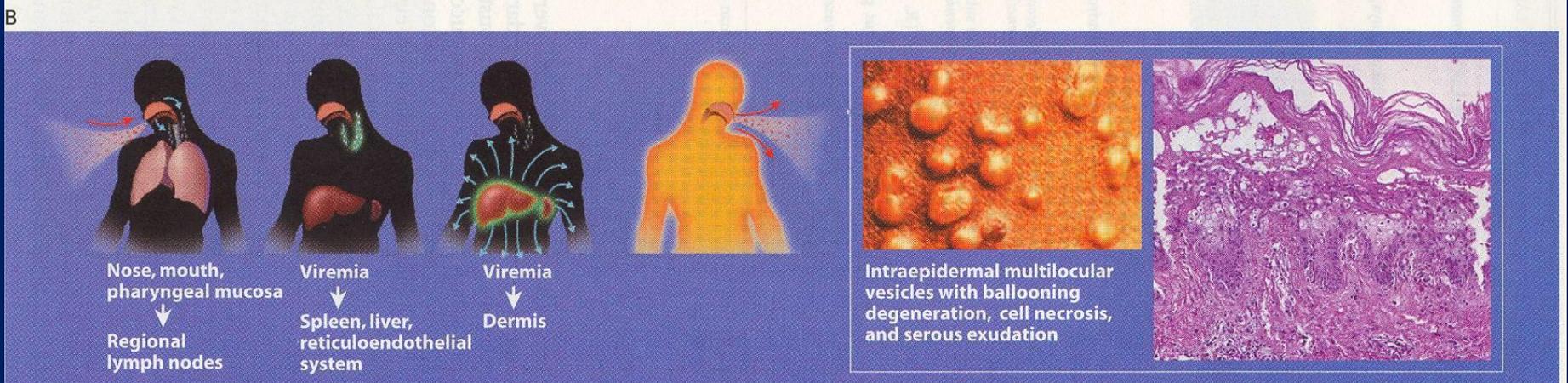
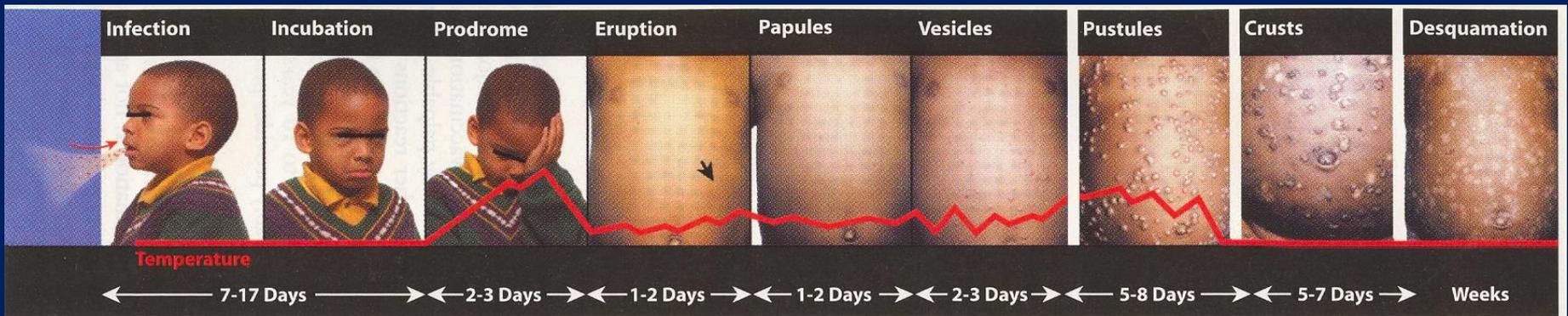
- Can be seen by light microscopy
- Brick shaped, 200 nm in diameter
- Codes for over 200 proteins
- Original animal reservoir probably a rodent that is now extinct
- Closest relative is Camelpox, enzootic in SW Asia



How it Causes Disease

- Transmitted from person to person **primarily** via large droplets
- Contaminated clothing/bedding, droplet nuclei also possible
- Virus is deposited on mucous membranes of next victim
- Taken up by dendritic cells and macrophages, uncoats and begins to replicate

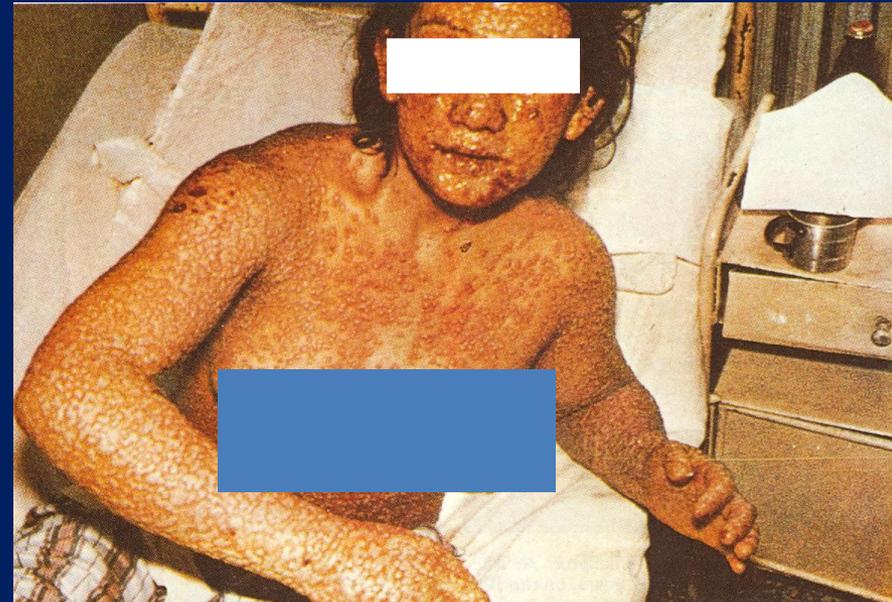
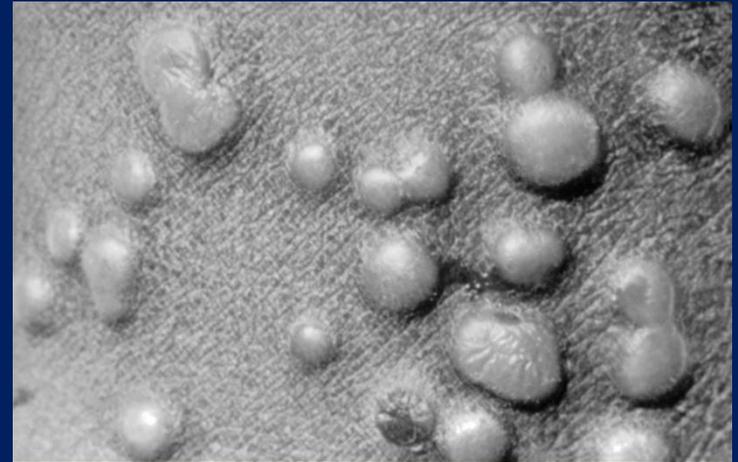




Lesions all in the Same Stage of Evolution



Varicella





1796 Edward Jenner inoculates James Phipps, age 8 with cowpox



James Gilray, 1802

Vaccination Method

Recommended vaccination method:

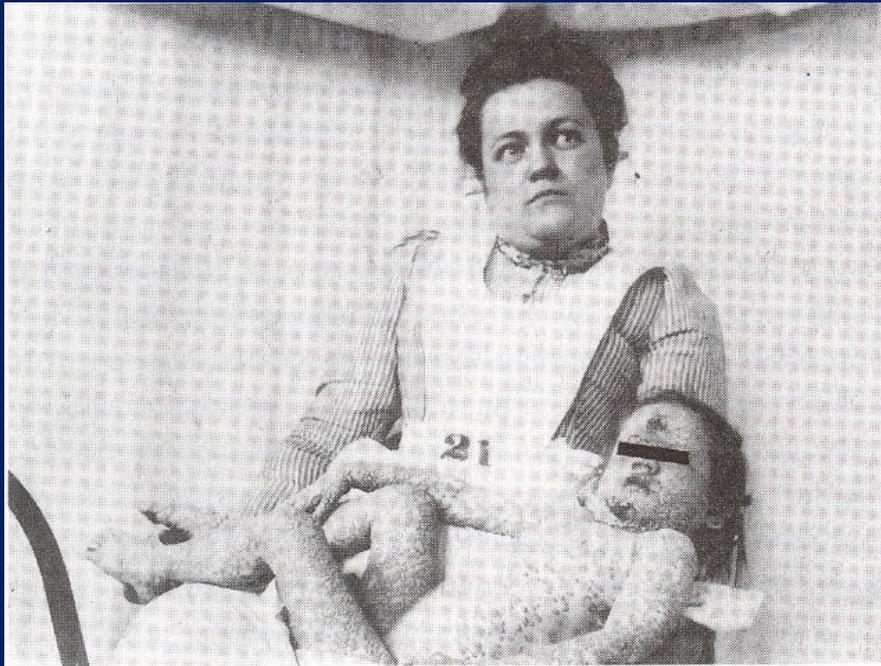
Multiple puncture vaccination on the deltoid area of the upper arm, using an individually wrapped, sterile, bifurcated needle.



Bifurcated Needle



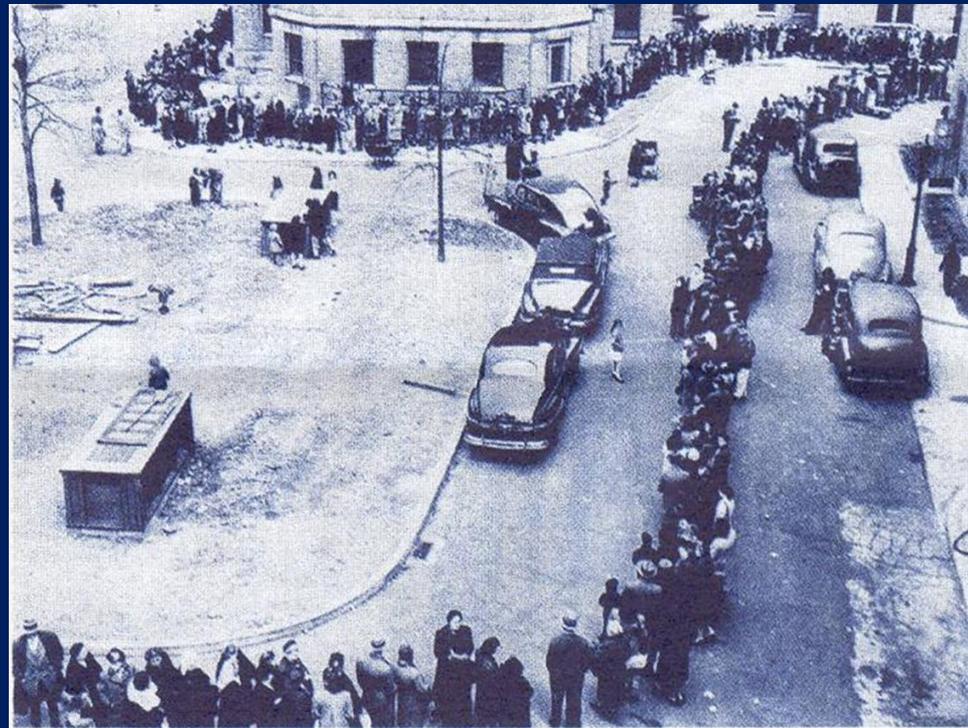
The Smallpox Epidemic in Boston, 1901-1903



Albert MR, *Annals of Internal Medicine*
2002;137:993

Elimination in the US

- 1947 a businessman traveled by bus from Mexico to NYC, where he was hospitalized and died of smallpox
- 4 direct infections and 7 secondary ones
- Near hysteria in NYC
- Last outbreak in US was 1949, imported from Mexico to the Rio Grande valley of Texas. 7 secondary cases and one death





Nomadic tribesmen, Africa



Rebecca Ansa Ansamoah, the 25 millionth American to receive smallpox vaccine, being comforted by William Stewart, US Surgeon General

Ali Maalin, the Last Case of Naturally Occurring Smallpox in the World Somalia, 1977

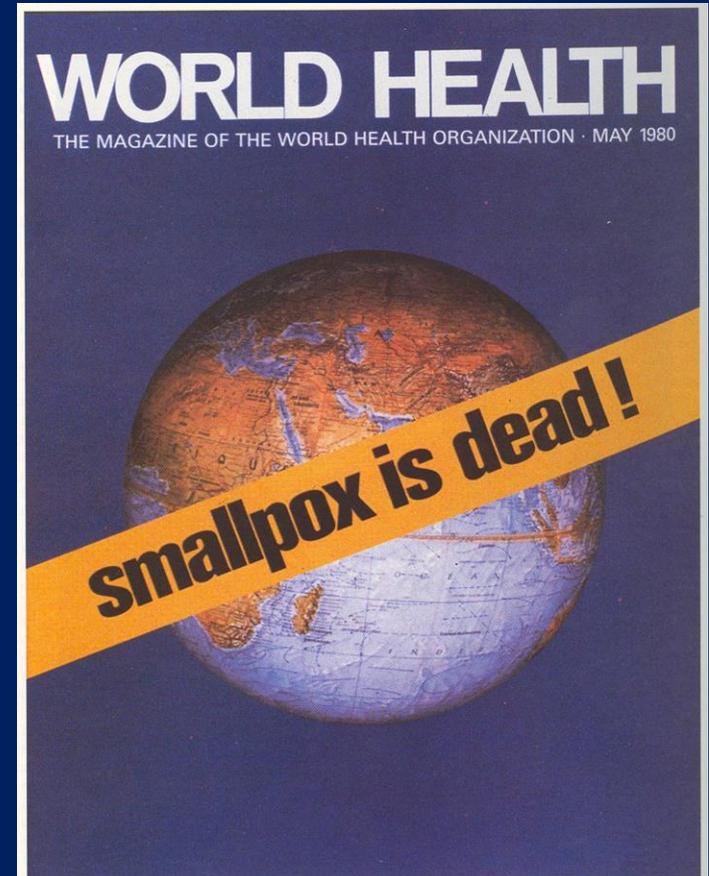
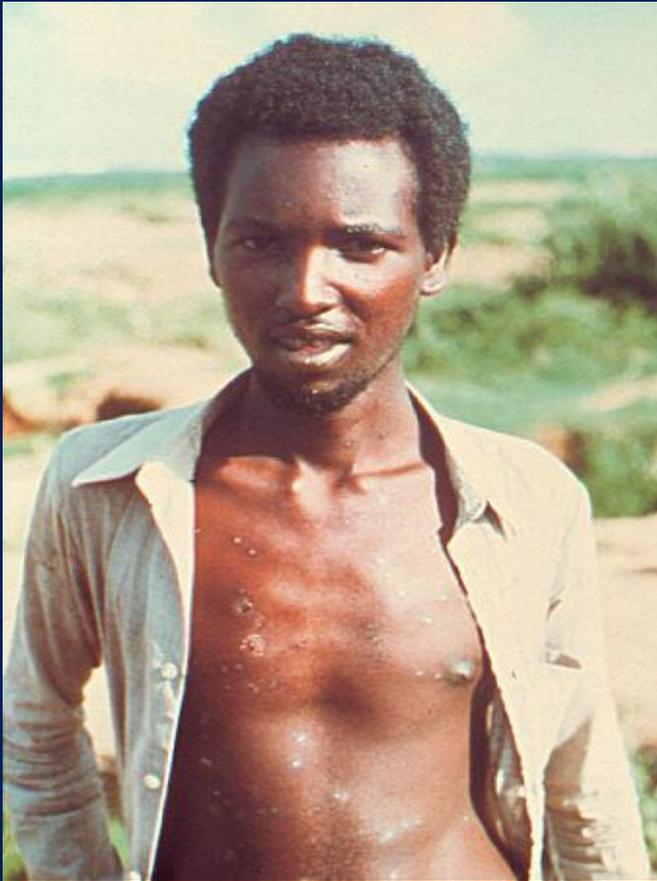


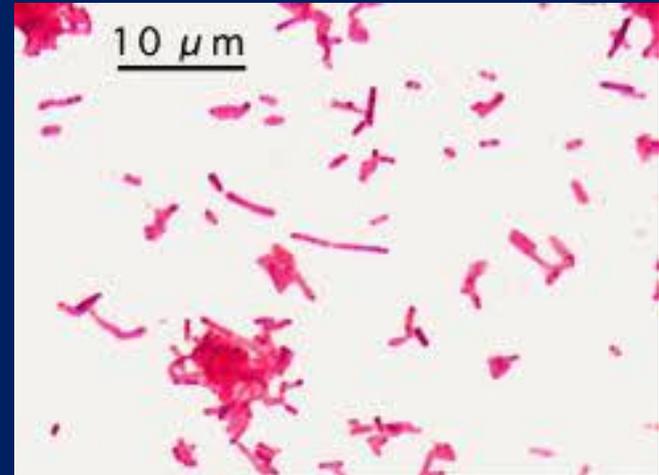
Plate 24.2. A complete issue of the WHO magazine *World health* was devoted to smallpox eradication at the time of the Thirty-third World Health Assembly's formal declaration that eradication had been achieved.



Peter Brughel, “The Triumph of Death”, 1562

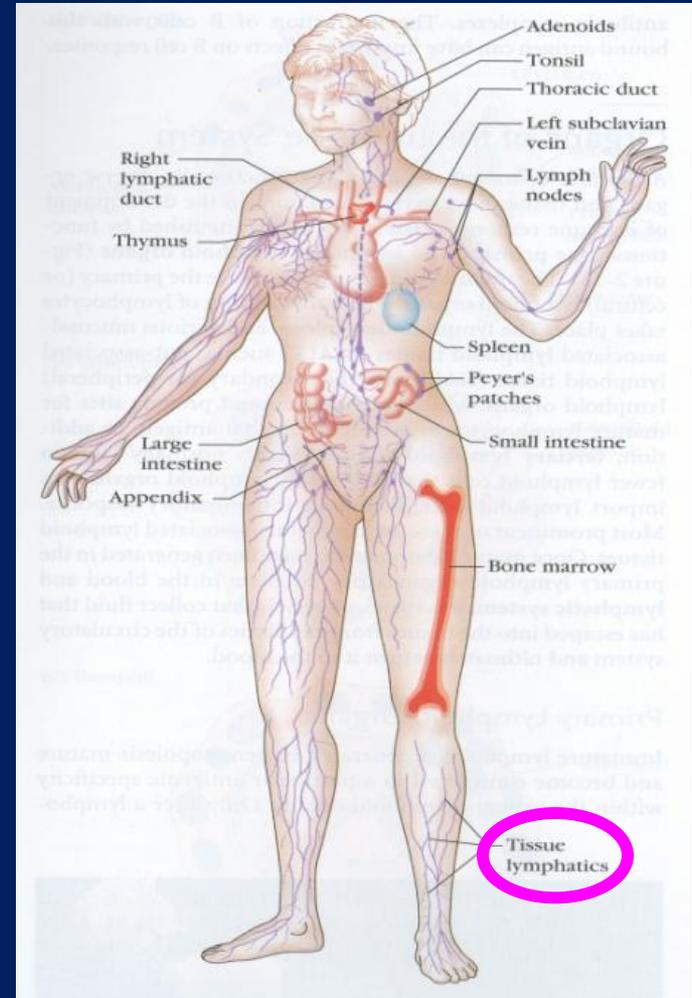
The Organism (*Yersinia pestis*)

- A rod-shaped bacterium, gram stain negative, related to *Escherichia coli*, *Shigella*, others
- Named after Alexandre Yersin who isolated the organism in Hong Kong, 1894
- 11 Species of *Yersinia*, of which 3 cause disease in humans
 - *Y. enterocolitica*
 - *Y. pseudotuberculosis*
 - *Y. pestis*
- It is an **obligate pathogen**. Incapable of long term existence outside a host



Clinical Manifestations

- Bite of an infected flea, organism replicates locally
- Migration via lymphatics to regional lymph nodes
- Bubonic disease most common
 - 2-6 days incubation
 - Sudden onset of high fevers, chills, headache
 - Gastrointestinal complaints common. Nausea, vomiting, diarrhea, severe abdominal pain
 - Simultaneously or within a short time exquisite pain over the affected lymph node. Bubo becomes enlarged





Other Forms of Illness

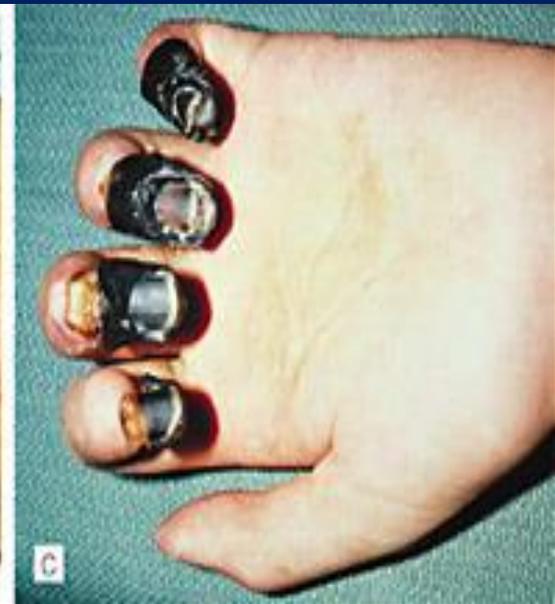
- Bacteremia and sepsis is common with bubonic disease
- Primary septicemic plague with no obvious lymph node involvement
- Pneumonic disease
 - Bacteremic spread to the lungs
 - Inhalation disease. Shorter incubation, more fulminant course
- Meningitis
- Pharyngitis

Digital gangrene



Bubo

Septicemic plague With ecchymosis



Journal of the American Medical Association 1999;283:2281-2290

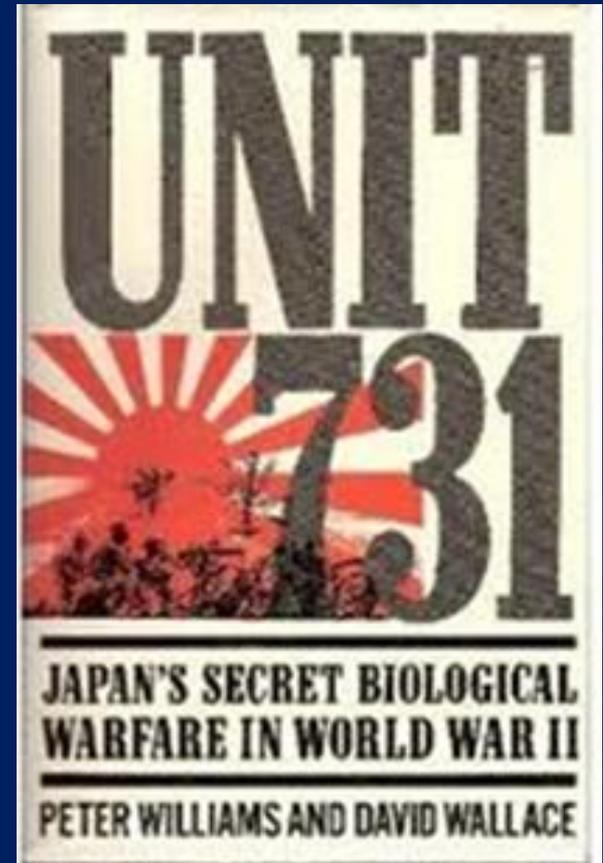
Plague as a Biological Weapon

- Kaffa, Black Sea, 1346
- Reval, Estonia, 1710.
Russians against the Swedes
- During WW II the Japanese Army establishes the secret Unit 731 in Ping Fang, Manchuria under the direction of Dr. Shiro Ishii



Unit 731

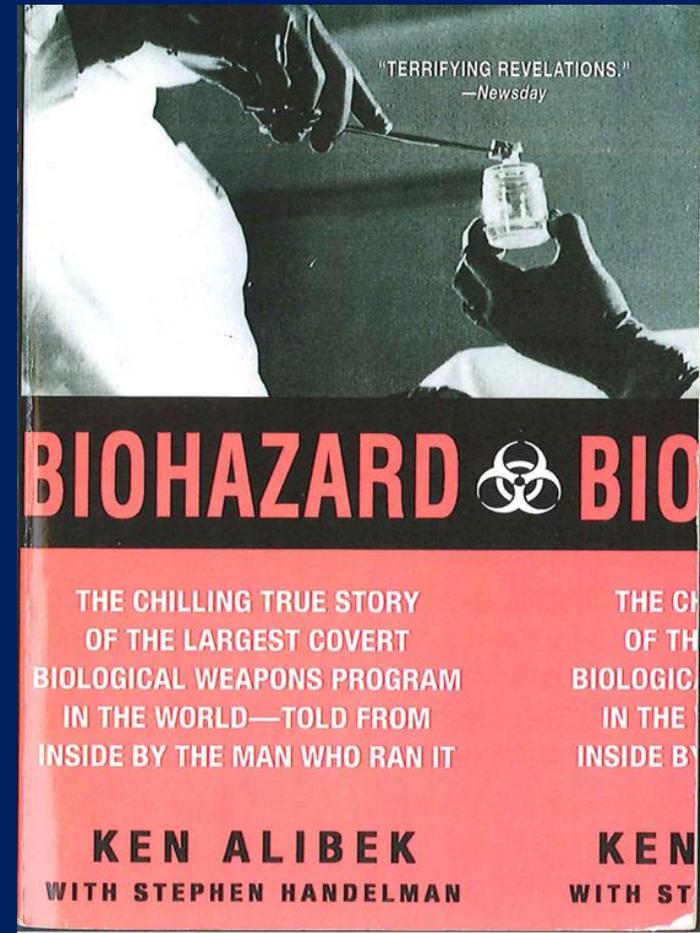
- Aerial bombing- unsuccessful due to pressure and temperature
- Discovered *Pulex irritans* could be a vector
- Infected lice placed in clay bombs and dropped over targets. 80% of lice survive
- At least 3 incidents of plague outbreaks in previously plague free areas
 - October 4, 1940 Chuhsien. 21 deaths
 - October 27, 1940 Ningpo . 99 deaths
 - November 1941 Changteh. Number of deaths unknown
- 3,000 POWs killed in experiments involving plague



Source: Worsham et. al., *Medical Aspects of Biological Warfare*, 2007

Plague as a Biologic Weapon

- 1980's: Soviets develop aerosolized *Y. pestis* and load it onto bombs, rocket warheads, artillery shells
- State Department Report, August 30, 2005. Russia, Iran, North Korea, Syria all continue to maintain biological weapons programs.
 - China maintains “some elements”
 - Cuba: experts divided



Being Prepared for the Unexpected

- Importance of the basics
 - Intake history: must include travel, risk factors, and clinical complaints
 - Thorough knowledge of Standard and Transmission based Isolation Guidelines
- Prompt implementation of appropriate isolation
- Dialogue with Public Health
 - New diseases being seen?
- Diagnostic testing. State and CDC

CDC Develops New Isolation Guidelines: 1996

- Rival guidelines had developed due to confusion over multiple CDC and OSHA guidelines, revisions and requirements, primarily dealing with HIV
- CDC attempts to resolve the problem by synthesizing the best of all the previously used systems, with extensive input from practitioners in the field. The new guidelines were designed to
 - Be epidemiologically sound
 - Recognize the importance of all body fluids, secretions and excretions in the potential to transmit one thing or the other
 - Be as simple and user friendly as possible
- Uses new terms to avoid confusion with existing systems

Simplification

- Standard Isolation Guidelines
 - Replaces the term “Universal Precautions”
 - Melds the best components of Universal Precautions and Body Substance Isolation
- Three categories of Transmission Based Guidelines
 - Contact isolation
 - Droplet isolation
 - Airborne isolation

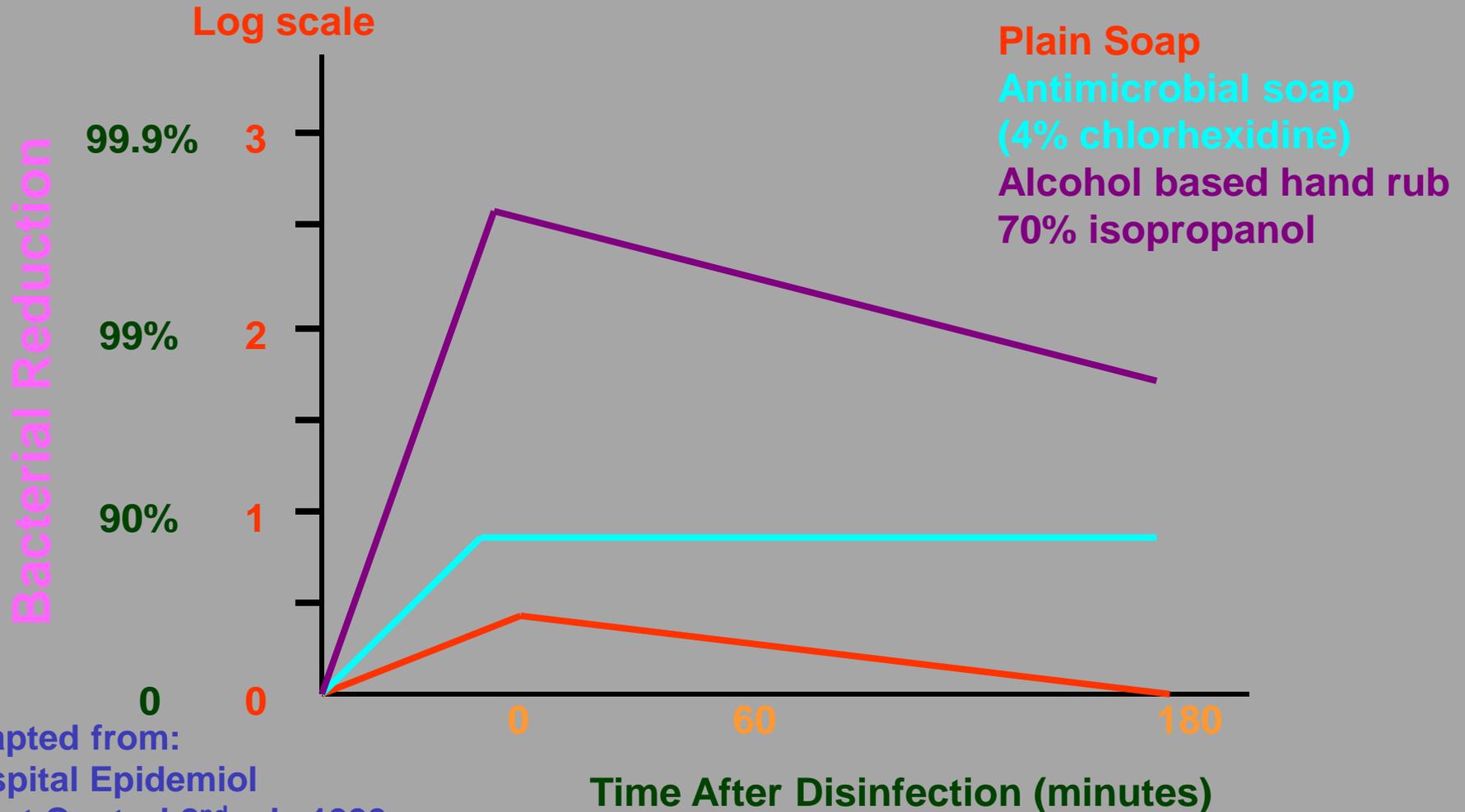
Standard Precautions

- Based on the principle that all blood, body fluids, secretions, excretions except sweat , non-intact skin and mucous membranes may contain transmissible infectious agents
- Designed to reduce the risk of transmission of disease from both recognized and unrecognized sources
- To be used on **all** patients at **all** times

Standard Precautions

- Hand hygiene. Preferred method is an alcohol based rub unless hands visibly soiled
- When to perform hand hygiene
 - Before and after any direct contact with patients or inanimate objects in the immediate vicinity of the patient
 - After removing gloves
- Gloves are to be worn
 - Whenever touching mucous membranes, non-intact skin, blood, body fluids, secretions or excretions
 - Intact skin contact if skin may be contaminated (i.e., a patient with diarrhea)
 - Any items that have come in contact with body fluids

Ability of Hand Hygiene Agents to Reduce Bacteria on Hands



Adapted from:
Hospital Epidemiol
Infect Control 2nd ed., 1999

Standard Precautions

- Use masks, eye protection, or gowns appropriate to the procedure when splashes, generation of aerosols etc. are expected
- Careful handling of linen and contaminated items
- Avoidance of sharps injuries
- Use of mouthpieces for CPR
- Use of a private room if hygiene cannot be maintained for any reason

PPE Has Improved Over Time



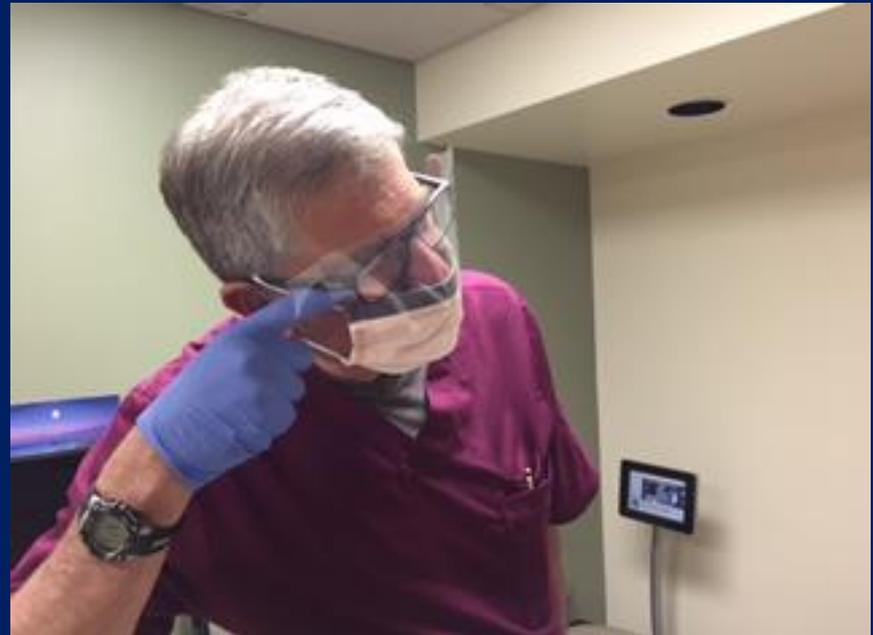
HOWEVER...

Cluster of SARS Cases Among Protected Health-Care Workers: Toronto, 2003

- During care of a 54 year old physician with advanced SARS in an ICU, 11 HCW's developed suspected or confirmed illness.
- Analysis of the cases revealed
 - No formal respiratory protection program existed at the hospital. Individual workers had not been fit tested
 - Understanding of the correct sequence of PPE removal varied among HCW's
 - Primary nurse for the patient had a beard, he could feel air entering around the sides of the mask

SARS Leads to Changes in Standard Isolation Guidelines

- Implementation of respiratory etiquette at first point of contact with the patient
- Emphasis on training



How to contract Ebola, SARS, influenza, monkeypox.....

Isolation in 2007: Updated

- Affirmation of the fundamental soundness of the 1996 approach
- A broader scope of issues needed to be addressed
- Some updates and modifications
 - Expansion of alternative sites for health care has resulted in a blurring of the distinction between community acquired and hospital acquired infections.
 - Nosocomial is retained but the new term “Healthcare Associated Infection” or HAI is introduced
 - **Respiratory hygiene/cough etiquette**
 - Safe injection practices
- A new emphasis placed on the importance of administrative involvement in the development and support of infection control programs
 - Nurse staffing levels
 - Establishment of a culture of safety

Respiratory Hygiene/Cough Etiquette

- Prompt implementation at the first point of encounter
- Applies to anyone with signs of cough, congestion, rhinorrhea or increased production of respiratory secretions
- Key elements
 - Education of healthcare facility staff, patients and visitors
 - Posted signs (in appropriate language or languages)
 - Source control measures
 - Covering mouth or nose with a tissue when coughing/sneezing
 - Prompt disposal of used tissues
 - Use of a surgical mask if the patient is able to tolerate one
 - Hand hygiene after contact with respiratory secretions
 - Spatial separation from other patients and healthcare staff (> 3 feet desirable)
- HCW should use **droplet precautions**

Contact Precautions

- For epidemiologically important organisms transmitted by direct or indirect contact with a patient
- Examples- (see guidelines for complete list)
 - Draining major abscess or pressure ulcer (any organism)
 - Multidrug resistant organisms of GI or respiratory tract, surgical site infections/wounds etc. of any size
 - Acute respiratory virus infections in infants and young children (examples RSV, metapneumovirus, adenovirus, parainfluenza)
 - Skin infections that may occur even on dry skin (cutaneous diphtheria, HSV, impetigo, scabies, dried stool from a patient with diarrhea)
 - Stool
 - Fecal incontinence (any age)
 - Acute infectious diarrhea of any cause in a diapered or incontinent patient (any age)
 - Diarrhea caused by *Clostridium difficile* (whether incontinent or not)
 - Hemorrhagic Fever Viruses

Droplet Precautions

- Organisms that transmit infection by coming in contact with susceptible mucosal surfaces
 - Nasal mucosa
 - Conjunctiva
 - Less commonly oral mucous membranes
- Infectious respiratory droplets are generated by
 - Coughing, sneezing, talking
 - Iatrogenic: suctioning, breathing treatment, BAL



Droplets: How Big and How Far?

- Traditionally defined as large particles i.e. $> 5 \mu\text{m}$ that do not remain suspended on air currents
- Propelled a short distance through the air (usually < 3 feet) and impact on mucous membranes
- Particles of this size do not gain access to the distal airways
- Newly appreciated that at times droplets may travel greater distances, up to 6-10 feet
- New CDC guidelines: “it may be prudent to don a mask when within 6-10 feet of a patient or upon entry into a patient’s room, especially when exposure to emerging or highly virulent pathogens is likely.”

Airborne Transmission

- Microorganisms that can infect by means of very small particles (5 μm or less)
- Particles of this size bypass the upper airway defenses and gain access to the terminal airways
- Three categories of organism can be responsible
 - **Obligate.** Under natural conditions disease occurs only through inhalation of small particle aerosols. *Mycobacterium tuberculosis*
 - **Preferential.** Natural infection results from transmission through multiple routes, but small particle aerosols are the predominant route (measles, varicella)
 - **Opportunistic.** Agents that normally and naturally cause disease through other routes but under special circumstances may be transmitted by small particle aerosols. SARSCoV, smallpox, influenza

Summing Up

- Infectious Diseases will never be eliminated
- Exotic diseases can get to anywhere in MT
- HCW's must always be on the alert for the unexpected
- Isolation guidelines work if used correctly
- Thorough knowledge of proper use of PPE will protect against the acquisition of even the most exotic of pathogens