



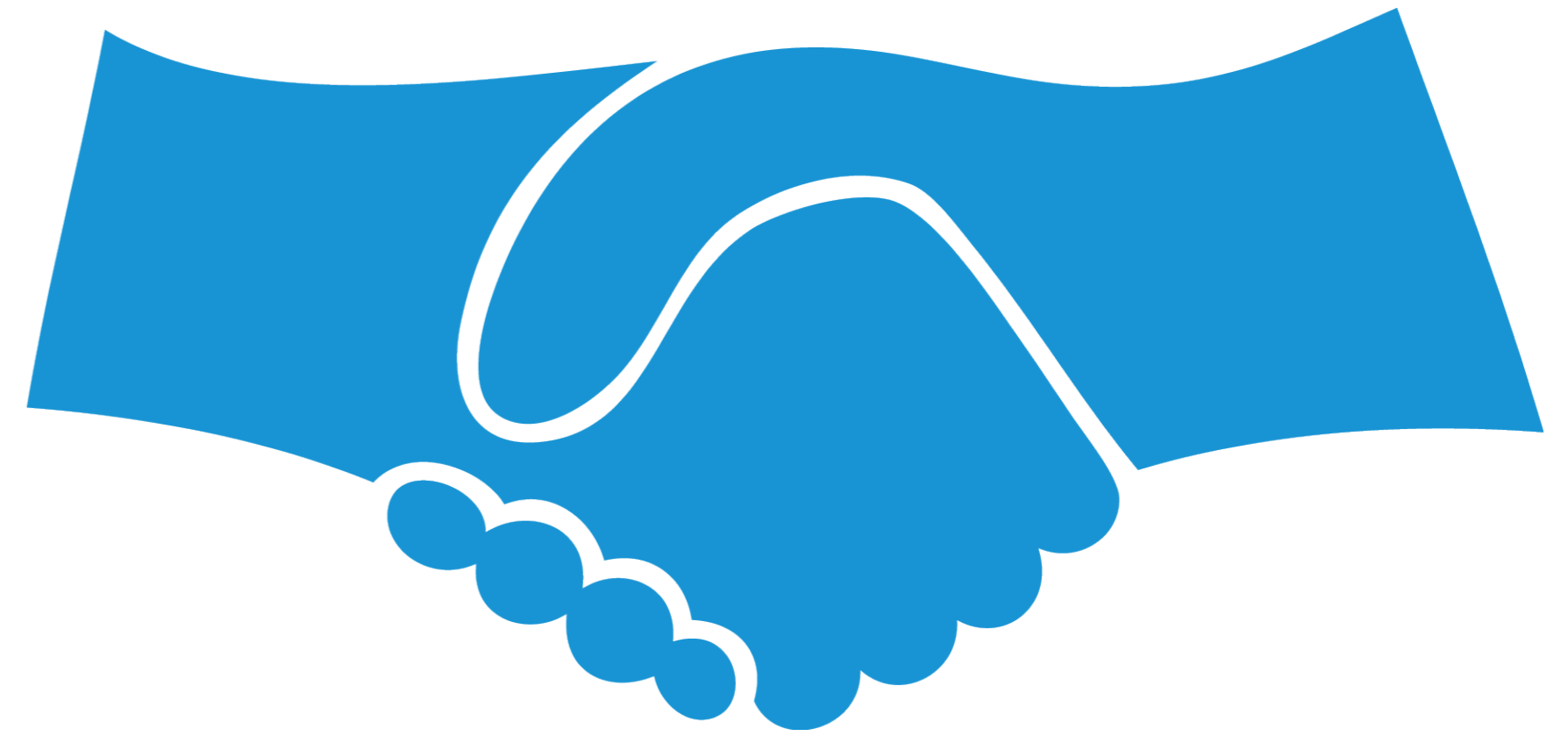
# Medical Personnel Preparedness for Ebola in the U.S.

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# Medical Personnel and CDC: A Partnership for Healthcare Quality and Safety

- Our mission at CDC and health departments is to work closely with you to ensure you have the latest information and the best strategies to do your jobs safely and effectively



**Healthcare is a team sport**

# Lessons Learned About Ebola and the U.S. Healthcare System

- The care of patients with Ebola virus disease (EVD) in U.S. hospitals is complex and challenging
- It can be done safely and effectively
- It takes really strong quality and safety systems



# Key Points: Healthcare Facility Safety

- **Facility leadership** provides resources and support for effective prevention precautions
- **Designated on-site Ebola site manager** oversees precautions
- Make sure there are **clear, standardized procedures**
- **Practice, practice, practice** with the personal protective equipment (PPE) you will use
- Make sure there is **oversight of practices** and putting on and taking off of Personal Protective Equipment

# The Current Ebola Outbreak

# Current Ebola Outbreak in Countries with Widespread Transmission

- 13,241 total cases
- 4,950 confirmed deaths

As of November 7, 2014



Guinea, Sierra Leone, Liberia

# Containing the West African Outbreak

- Without interventions CDC estimates that by January 20, 2015, there could be 550,000 to 1.4 million Ebola cases in West Africa
- Controlling Ebola in Africa is critical to protecting the rest of world



# Ebola in the U.S.

- Four Americans with Ebola have been medically evacuated to the United States for treatment
- All recovered and were discharged





# Ebola in the U.S.

- Two patients who had travelled to the endemic area have been diagnosed with Ebola virus disease following their return to the U.S.
- Two nurses who cared for one of the patients were diagnosed with Ebola virus disease



# CDC's Ebola Response

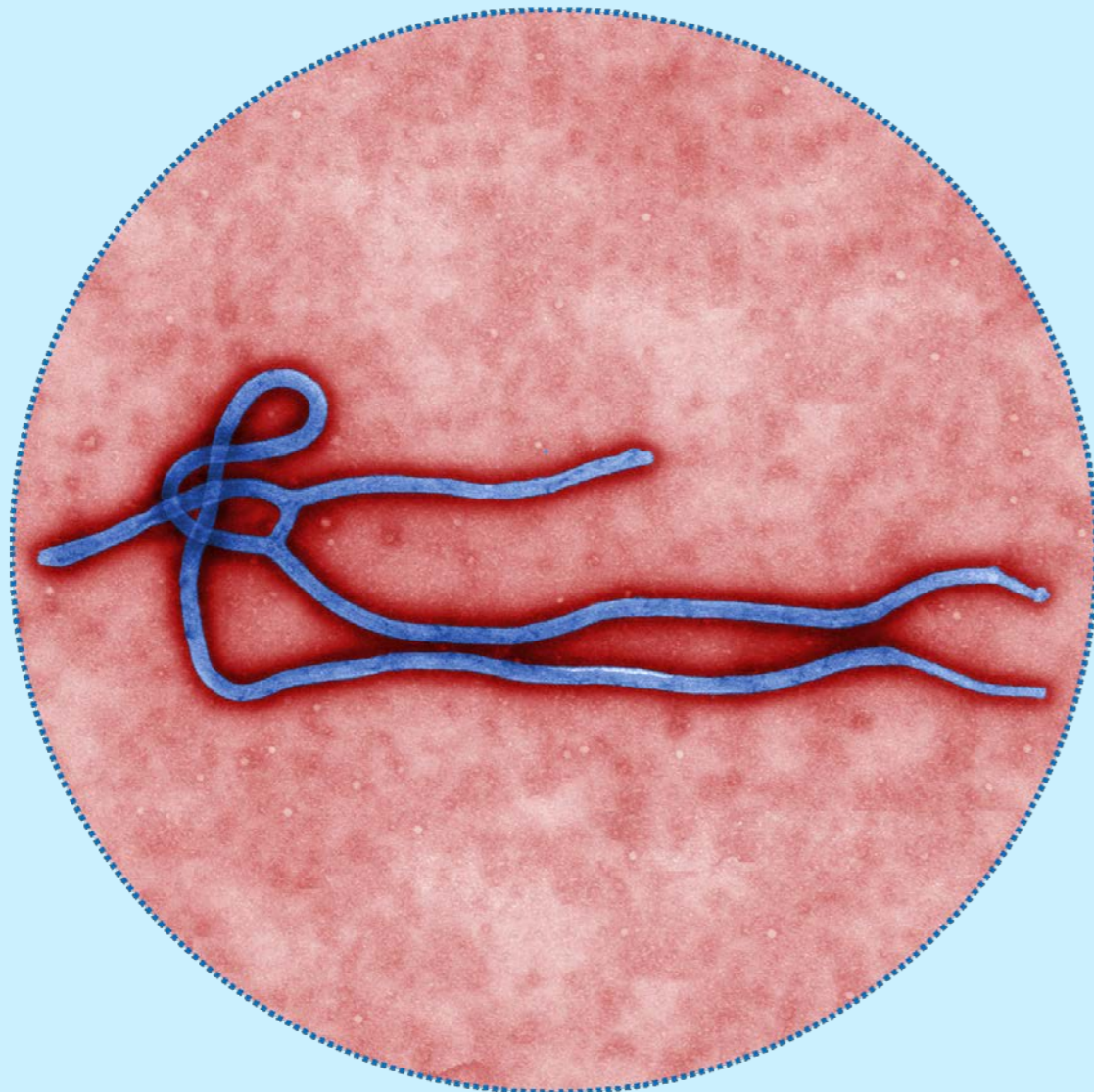
- Activated since July 9, 2014
- More than 250 CDC staff currently deployed to 13 countries and several states
- More than 1,500 CDC staff have been activated
- 30,000 calls to CDC-INFO line from the public



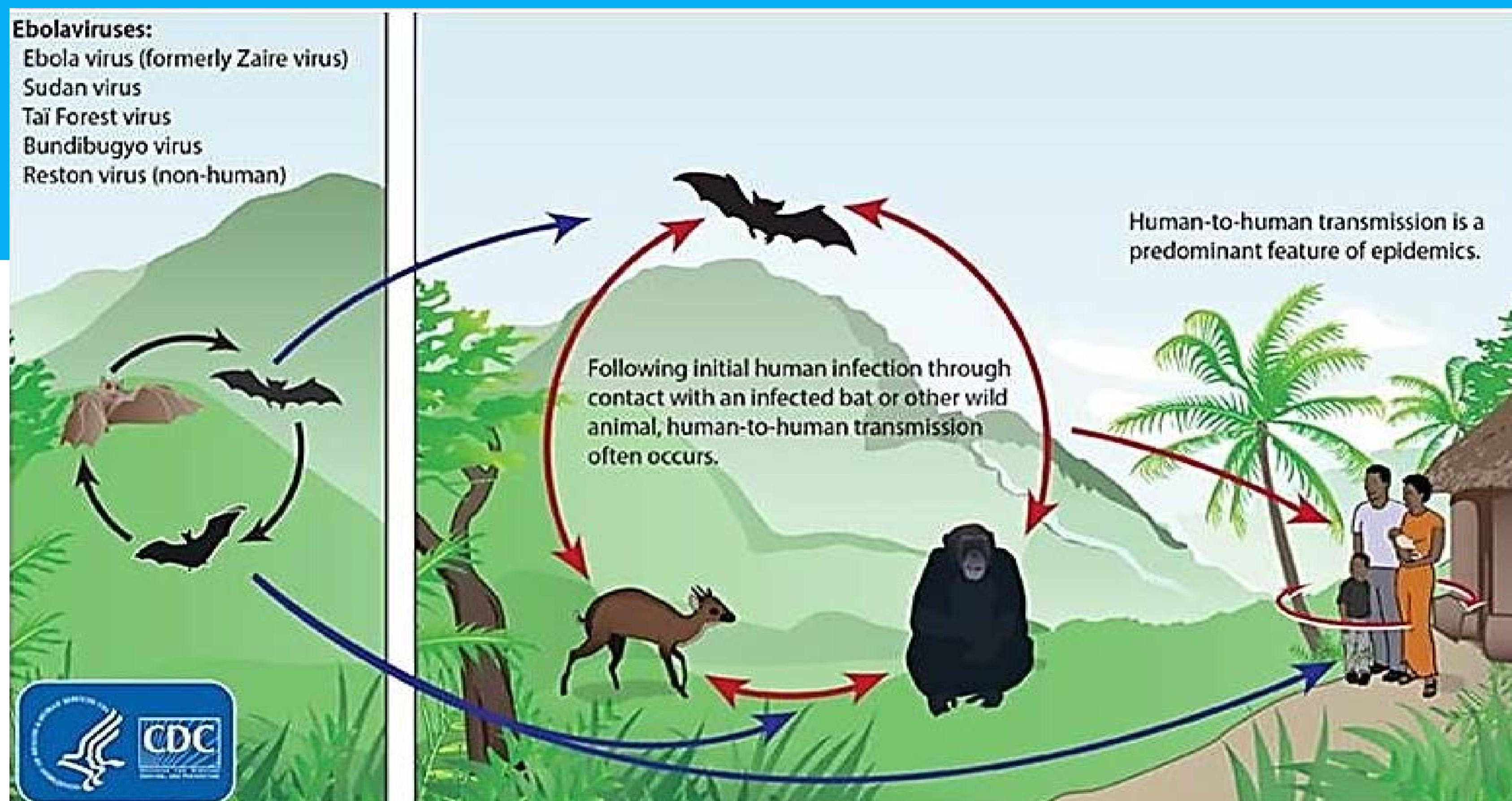
# Ebola: Background and Transmission

## Ebola Virus

- Prototype Viral Hemorrhagic Fever Pathogen
  - Filovirus: enveloped, non-segmented, negative-stranded RNA virus
  - Severe disease with high case fatality
  - Absence of specific treatment or vaccine
- >20 previous Ebola and Marburg virus outbreaks since its 1976 discovery near the Ebola River
- 2014 West Africa Ebola outbreak caused by Zaire ebolavirus species (five known Ebola virus species)



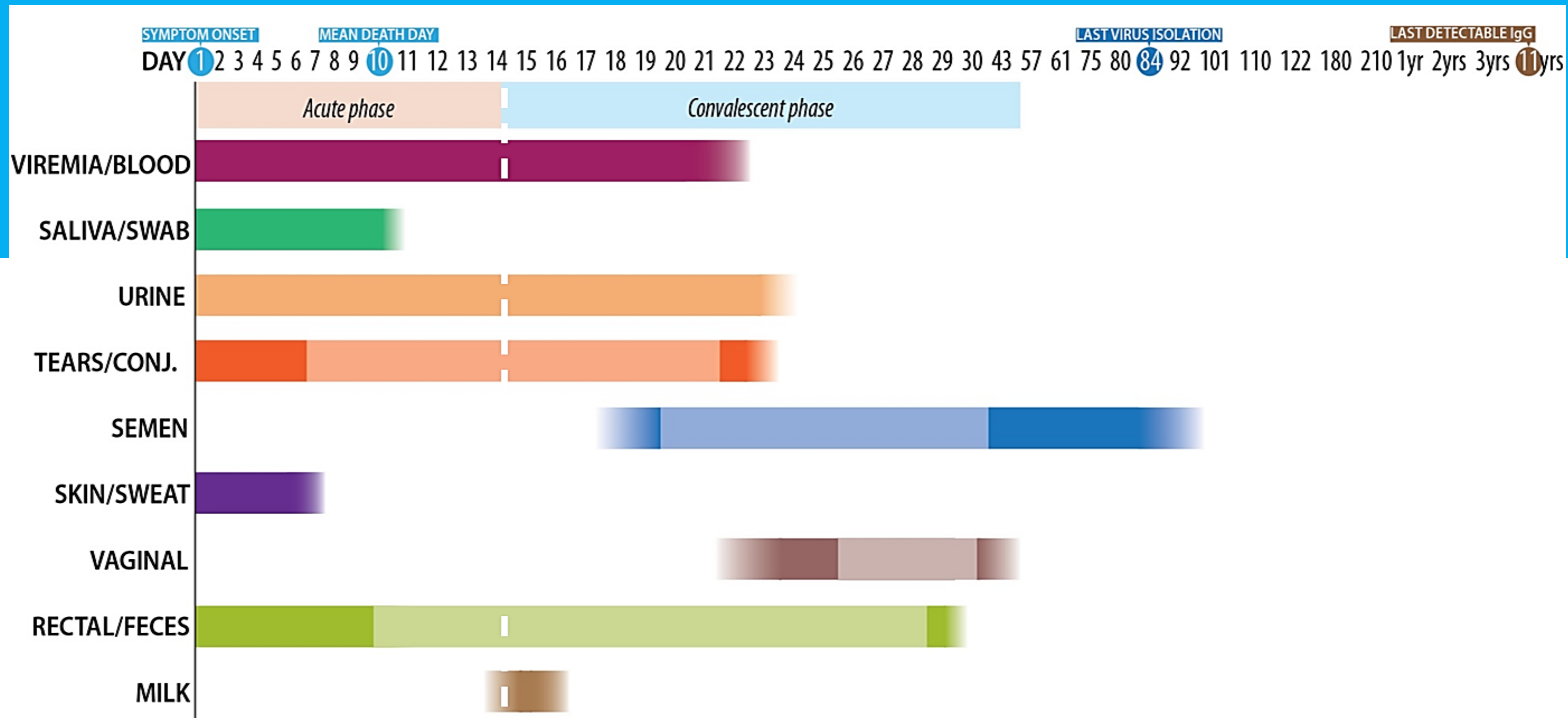
- Zoonotic virus – bats the most likely reservoir, although species unknown
- Spillover event from infected wild animals (e.g., fruit bats, monkey, duiker) to humans, followed by human-human transmission



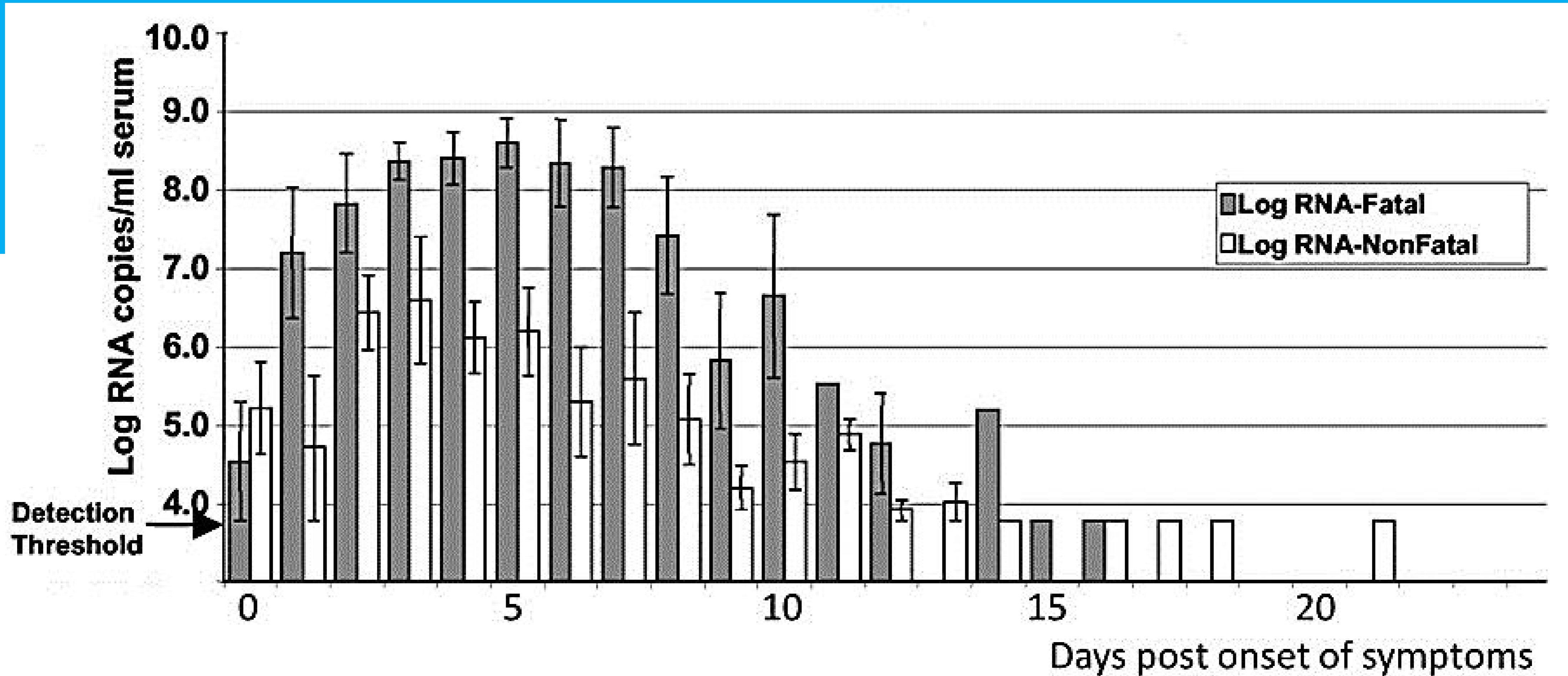
# Ebola Virus Transmission

- Virus present in high quantity in blood, body fluids, and excreta of *symptomatic* EVD-infected patients
- Opportunities for human-to-human transmission
  - Direct contact (through broken skin or unprotected mucous membranes) with an EVD-infected patient's blood or body fluids
  - Sharps injury (with EVD-contaminated needle or other sharp)
  - Direct contact with the corpse of a person who died of EVD
  - Indirect contact with an EVD-infected patient's blood or body fluids via a contaminated object (soiled linens or used utensils)
- Ebola can also be transmitted via contact with blood, fluids, or meat of an infected animal
  - Limited evidence that dogs become infected with Ebola virus
  - No reports of dogs or cats becoming sick with or transmitting Ebola

# Detection of Ebola Virus in Different Human Body Fluids over Time



# Ebola Virus Levels in Serum





# Human-to-Human Transmission

- Infected persons are not contagious until onset of symptoms
- Infectiousness of body fluids (e.g., viral load) increases as patient becomes more ill
  - Remains from deceased infected persons are highly infectious
- Human-to-human transmission of Ebola virus via inhalation (aerosols) has not been demonstrated

# Household Transmission Data

- 1995 outbreak in Kikwit, Democratic Republic of the Congo
- 28 of 173 household contacts of 27 primary patients developed Ebola
- All 28 reported direct physical contact with a known patient
  - Other studies with similar findings
- Several studies show people who shared confined space with a patient with Ebola, but did not have direct contact, did not develop Ebola

# Transmission to Healthcare Personnel

- The risk is high
- Late stage illness with high viral loads and severe gastrointestinal symptoms increase the risk
- Limited experience with some invasive procedures (blood draws) can increase risk
- No data on risks during aerosol generating procedures

# Transmission to Healthcare Personnel

- 1995 Kikwit outbreak- 80 cases of HCP contracting Ebola before implementation of proper precautions.
- Only 1 case after implementation of precautions (nurse who reported inadvertently rubbing her eyes with soiled gloves).
- 2007-2008 outbreak in Bundibugyo district, Uganda- 14 HCP infected before implementing precautions, none after.

# Data on Airborne Transmission

- Has not been demonstrated in humans
- No evidence of airborne transmission in hospitals or home settings in past Ebola outbreaks
  - People have shared air space with patients and not become infected
  - In Kikwit study, presence of cough in case patients did not predict spread
- Some conflicting animal data

# Is This Outbreak Consistent with Others?

- Clinical course of infection similar to past outbreaks
  - Incubation period
  - Duration of illness
  - Case fatality rate
- Reproductive number ( $R_0$ ) similar to past outbreaks (1.38-1.81)

# Ebola: Clinical and Lab Findings

# Early Clinical Presentation

- Acute onset; typically 8–10 days after exposure (range 2–21 days)
- Signs and symptoms
  - Initial: Fever, chills, myalgias, malaise, anorexia
  - After 5 days: GI symptoms, such as nausea, vomiting, watery diarrhea, abdominal pain
  - Hemorrhagic symptoms in 18% of cases
- Other possible infectious causes of symptoms
  - Malaria, typhoid fever, meningococemia, Lassa fever and other bacterial infections (e.g., pneumonia) – all very common in Africa





# Clinical Manifestations by Organ System in West African Ebola Outbreak

Organ System	Clinical Manifestation
General	Fever (87%), fatigue (76%), arthralgia (39%), myalgia (39%)
Neurological	Headache (53%), confusion (13%), eye pain (8%), coma (6%)
Cardiovascular	Chest pain (37%)
Pulmonary	Cough (30%), dyspnea (23%), sore throat (22%), hiccups (11%)
Gastrointestinal	Vomiting (68%), diarrhea (66%), anorexia (65%), abdominal pain (44%), dysphagia (33%), jaundice (10%)
Hematological	Any unexplained bleeding (18%), melena/hematochezia (6%), hematemesis (4%), vaginal bleeding (3%), gingival bleeding (2%), hemoptysis (2%), epistaxis (2%), bleeding at injection site (2%), hematuria (1%), petechiae/ecchymoses (1%)
Integumentary	Conjunctivitis (21%), rash (6%)

# Laboratory Findings

- Thrombocytopenia (50,000–100,000/mL range)
- Leukopenia followed by neutrophilia
- Transaminase elevation: elevation serum aspartate amino-transferase (AST) > alanine transferase (ALT)
- Electrolyte abnormalities from fluid shifts
- Coagulation: PT and PTT prolonged
- Renal: proteinuria, increased creatinine

# Ebola Virus Diagnosis

- Real Time PCR (RT-PCR)
  - Used to diagnose acute infection
  - More sensitive than antigen detection ELISA
  - Identification of specific viral genetic fragments
  - Performed in select CLIA-certified laboratories
- RT-PCR Interpretation
  - Test negative >3 days after symptom onset- Ebola very unlikely
  - Test negative <3 days after onset- repeat test >72 hours after symptom onset.

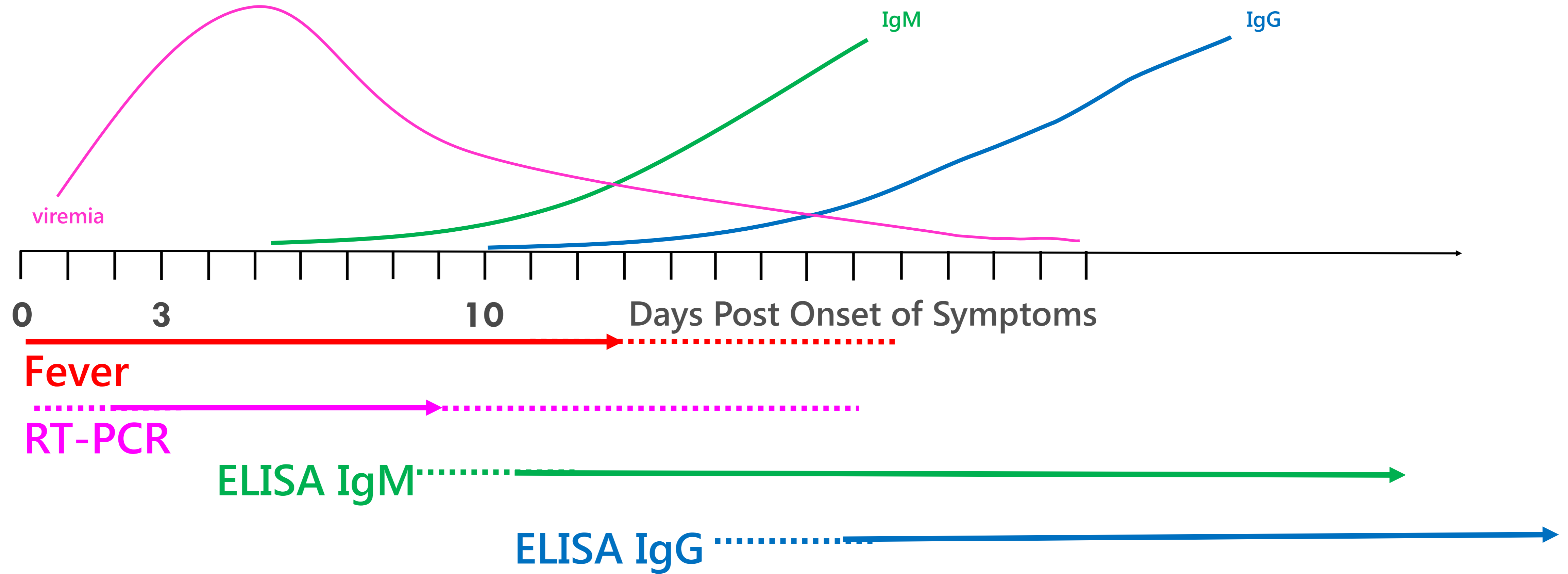
# Other Ebola Virus Diagnostics

- Virus isolation
  - Requires Biosafety Level 4 laboratory
  - Can take several days
- Immunohistochemical staining and histopathology
  - On collected tissue or dead wild animals localizes viral antigen
- Serologic testing for IgM and IgG antibodies (ELISA)
  - Detection of viral antibodies in specimens, such as blood, serum, or tissue suspensions
  - Monitor the immune response in confirmed EVD patients



# EVD: Expected Diagnostic Test Results Over Time

Critical information: Date of Onset of Fever/Symptoms



IgM: up to 3 – 6 months

IgG: 3 – 5 years or more (life-long persistence?)

# Clinical Course

- Nonspecific early symptoms can progress to:
  - Hypovolemic shock and multi-organ failure
  - Hemorrhagic disease
  - Death
- Fatal disease associated with more severe early symptoms
  - Fatality rate of ~70% in current outbreak
- Intensive care, especially early intravenous and electrolyte management, can increase the survival rate

# Patient Recovery

- Patients who survive often have signs of clinical improvement by the second week of illness
  - Associated with the development of virus-specific antibodies
  - Antibody with neutralizing activity against Ebola persists greater than 12 years after infection
- Prolonged convalescence
  - Includes arthralgia, myalgia, abdominal pain, extreme fatigue, and anorexia; many symptoms resolve by 21 months
  - Significant arthralgia and myalgia may persist for >21 months
  - Skin sloughing and hair loss has also been reported

References: <sup>1</sup>WHO Ebola Response Team. *NEJM* 2014; <sup>2</sup>Feldman H & Geisbert TW. *Lancet* 2011; <sup>3</sup>Ksiazek TG et al. *JID* 1999; <sup>4</sup>Sanchez A et al. *J Virol* 2004; <sup>5</sup>Sobarzo A et al. *NEJM* 2013; and <sup>6</sup>Rowe AK et al. *JID* 1999.

# Clinical Management of EVD: Supportive, but Aggressive

- Hypovolemia and sepsis physiology
  - Aggressive intravenous fluid resuscitation
  - Hemodynamic support and critical care management if necessary
- Electrolyte and acid-base abnormalities
  - Aggressive electrolyte repletion
  - Correction of acid-base derangements
- Symptomatic management of fever and gastrointestinal symptoms
  - Avoid NSAIDS
- Multisystem organ failure can develop and may require
  - Oxygenation and mechanical ventilation
  - Correction of severe coagulopathy
  - Renal replacement therapy



# Investigational Therapies for EVD Patients

- No approved Ebola-specific prophylaxis or treatment
  - Ribavirin has no *in-vitro* or *in-vivo* effect on Ebola virus
  - Therapeutics in development with limited human clinical trial data
    - Convalescent serum
    - Therapeutic medications
      - Zmapp – chimeric human-mouse monoclonal antibodies
      - Tekmira – lipid nanoparticle small interfering RNA
      - Brincidofovir – oral nucleotide analogue with antiviral activity
- Vaccines – in clinical trials
  - Chimpanzee-derived adenovirus with an Ebola virus gene inserted
  - Attenuated vesicular stomatitis virus with an Ebola virus gene inserted

References: <sup>1</sup>Huggins, JW et al. *Rev Infect Dis* 1989; <sup>2</sup>Ignatyev, G et al. *J Biotechnol* 2000; <sup>3</sup>Jarhling, P et al. *JID* 2007 S400; <sup>4</sup>Mupapa, K et al. *JID* 1999 S18; <sup>5</sup>Olinger, GG et al. *PNAS* 2012; <sup>6</sup>Dye, JM et al. *PNAS* 2012; <sup>7</sup>Qiu, X et al. *Sci Transl Med* 2013; <sup>8</sup>Qiu, X et al. *Nature* 2014; <sup>9</sup>Geisbert, TW et al. *JID* 2007; <sup>10</sup>Geisbert, TW et al. *Lancet* 2010; <sup>11</sup>Kobinger, GP et al. *Virology* 2006; <sup>12</sup>Wang, D *JV* 2006; <sup>13</sup>Geisbert, TW et al. *JID* 2011; and <sup>14</sup>Gunther et al. *JID* 2011.

# Ebola Infection Control

# Early Identification is Essential

- Both for infection control and for patient care
- Need to screen for Exposure risk:
  - Contact in the past 21 days with either confirmed or suspect Ebola patients
  - Residence in—or travel to—an area where Ebola transmission is currently active including Liberia, Sierra Leone and Guinea
- AND symptoms:
  - Fever or any Ebola-compatible symptoms: fatigue, headache, weakness, muscle pain, vomiting, diarrhea, abdominal pain, or hemorrhage



# Entry Screening and Education

- People travelling from areas where there is transmission are being evaluated and educated on arrival to the U.S.
- Travelers are being given detailed instructions on symptom monitoring and are instructed to call their state health department on arrival to their final destination
- State health departments then conduct direct active monitoring or active monitoring of all returned travelers for 21 days
  - Same applies to healthcare providers caring for patients in U.S. hospitals



# Monitoring

- Direct active monitoring: public health official observes the individual at least once daily to assess symptoms and check temperature
- Active monitoring: the individual is required to report daily to the health department on temperature and any potential symptoms
- Level of monitoring depends on exposure risks



# Monitoring and Movement for Healthcare Personnel- Risk Categories

- Healthcare personnel can fall into different risk categories
  - High risk: known breach of PPE or HCP in a facility with transmission of unknown source (i.e. transmission to HCP without known PPE breach)
  - Some risk: patient contact in endemic area while wearing PPE (no known breaches)
  - Low risk: HCP in endemic areas with no patient exposure and HCP with patient contact in the US while wearing PPE (no known breaches)

# Interim Guidance for Monitoring and Movement of Persons with EVD Exposure

CDC has created guidance for monitoring people exposed to Ebola virus but without symptoms

RISK LEVEL	PUBLIC HEALTH ACTION		
	Monitoring	Restricted Public Activities	Restricted Travel
HIGH risk	Direct active monitoring	Yes	Yes
SOME risk	Direct active monitoring	Case-by-case assessment	Case-by-case assessment
LOW risk	Active monitoring for some; Direct active monitoring for others	No	No
NO risk	No	No	No

# Healthcare Activities in US Hospitals

- HCP providing care to patients with Ebola virus disease in the US with no known breaches in PPE (low risk category) and who are asymptomatic can provide care as usual, i.e. can see other patients
  - Must undergo direct active monitoring
  - No restrictions on travel and other activities
- HCP caring for a patient in facility with transmission of unknown source or a PPE breach are in high risk category and should not care for other patients

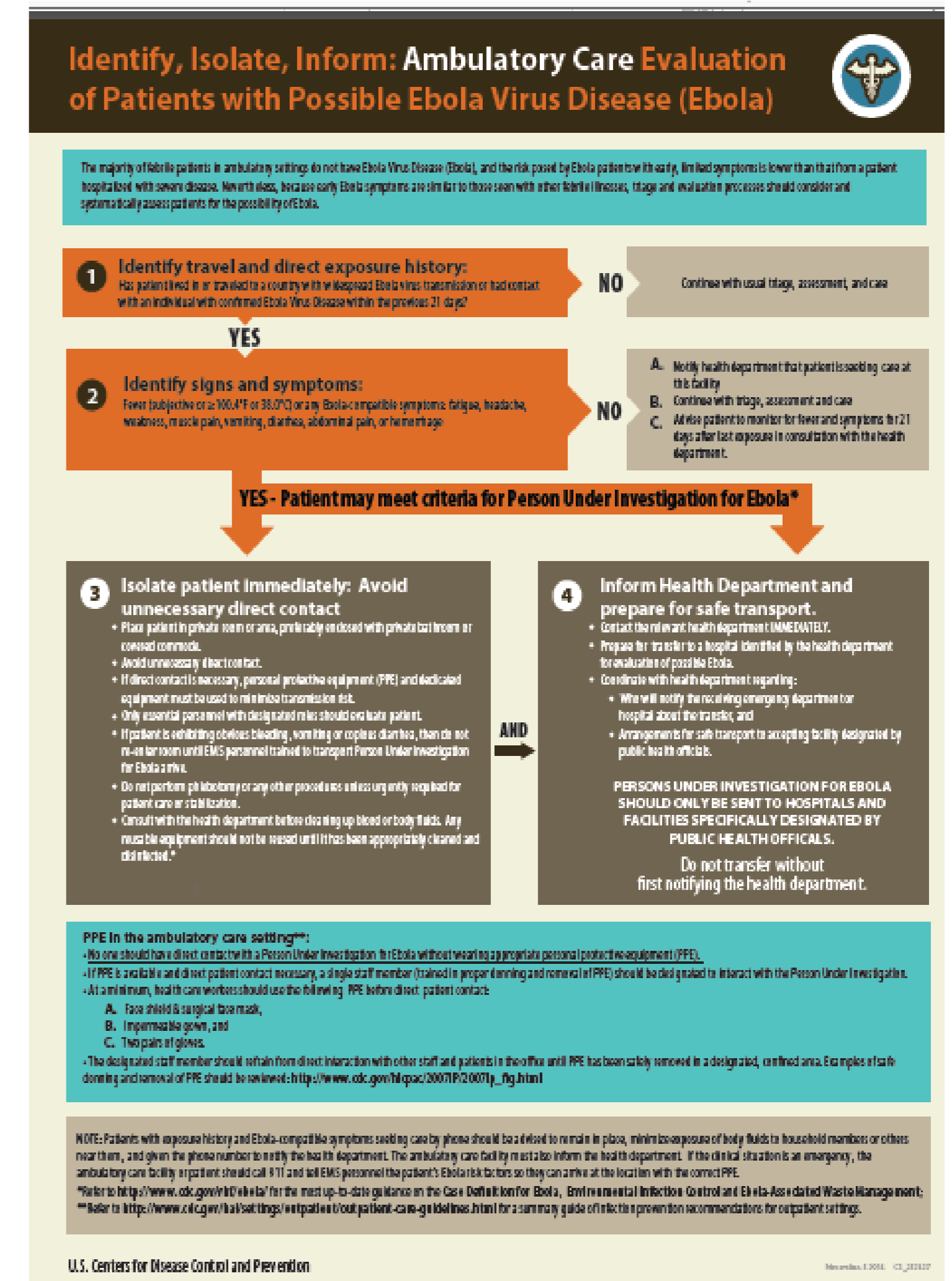


# Ebola Infection Control Setting-Specific Guidance

# Identify, Isolate and Inform:

## Ebola Guidance for Ambulatory, Non-Emergency Department Settings

- Patients should generally not be evaluated for possible Ebola infection in these settings
- Telephone screening can help ensure that symptomatic patients with exposure risks do not unexpectedly come to these settings
- Chances that a patient with Ebola risks will unexpectedly present to one of these clinics is even lower with daily monitoring by health department



# Identify, Isolate and Inform:

## Ebola Guidance for Ambulatory, Non-Emergency Department Settings

- Ensure that mechanisms are in place to identify patients who have exposure risk and symptoms – preferably before they arrive
- If a patient with an exposure risk and symptoms does come unexpectedly to an ambulatory clinic:
  - Immediately place the patient in a private room
  - Inform the health department to arrange for transfer to a facility where further evaluation can be done



# Identify, Isolate and Inform:

## Ebola Guidance for Ambulatory,

## Non-Emergency Department Settings

- Avoid direct patient contact, especially if the patient is bleeding, vomiting, or has diarrhea
  - Call EMS
- If contact is required, staff should wear:
  - Eye protection- e.g. face shield
  - Mouth protection- surgical mask
  - Clothing protection- gown
  - Hand protection- 2 pairs of gloves

# Guidance for EMS

- EMS call centers have incorporated screening questions into 911 calls.
- When there is a potential patient with Ebola, EMS crews are deployed with personal protective equipment (PPE).
  - Following PPE guidance for care of hospitalized patients.

# Identify, Isolate and Inform:

## Ebola Guidance for Emergency Department Settings

- Every Emergency Department does have to be prepared to provide initial evaluation and care for a patient with potential Ebola virus disease
- Several already have

**IDENTIFY**

**ISOLATE**

**INFORM**

# Identify, Isolate and Inform:

## Ebola Guidance for Emergency Department Settings

- Point of entry screening for exposure risks and symptoms is an essential key to safety
  - Signs on entry points asking patients/family to self-identify
  - Triage questions at first interaction

**IDENTIFY**

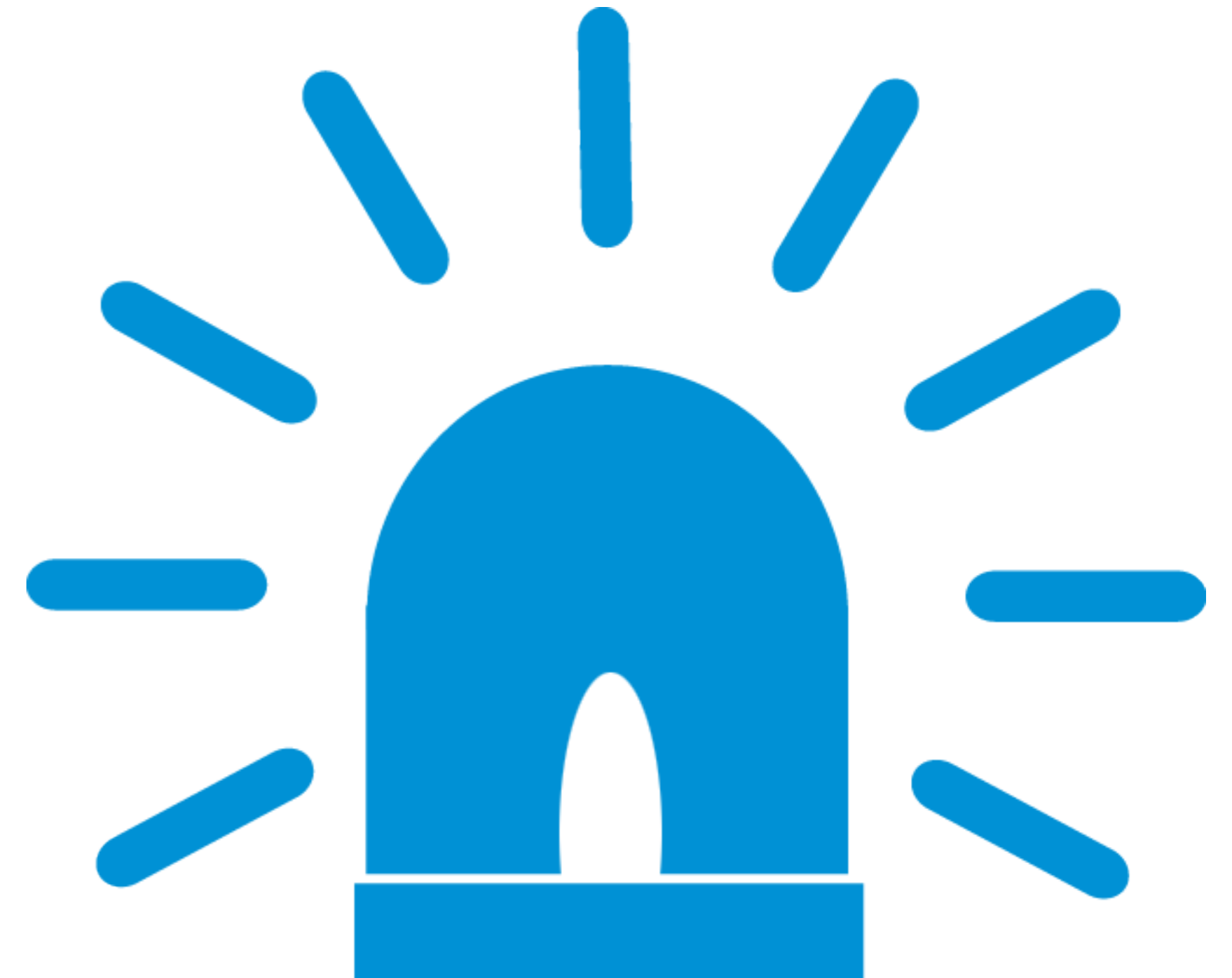
**ISOLATE**

**INFORM**

# Identify, Isolate and Inform:

## Ebola Guidance for Emergency Department Settings

- For a patient with exposure risks AND symptoms: activate the Emergency Department Ebola management plan
- Immediately put the person in a private room with a bathroom or portable commode
- Notify the health department and infection control
- Implement recommended personal protective equipment





# Ebola Emergency Department Management Plan Key Considerations

- Facility manager who develops the plan and oversees implementation and readiness
- Plan for patient placement- identifying a room that allows for separate space to put on and remove PPE
- Plan for very limited staff who will provide care
- Plan for training of healthcare personnel to put on and take off PPE
- Plan for necessary supplies, especially PPE
  - Limited supply needed for training and evaluation
  - Likely only will be used for very small number of patients
- Plan for lab testing
- Plan for environmental cleaning
- Plan for waste management- special considerations for confirmed cases

# **Personal Protective Equipment for ED Evaluation of Patients With Possible Ebola**

- Patient stable and without bleeding, vomiting or diarrhea:
  - Face shield & surgical face mask
  - Impermeable gown
  - 2 pairs of gloves
- Patient not stable or has bleeding, vomiting or diarrhea:
  - Follow PPE guidance for hospitalized patients with known Ebola virus disease

# Emergency Department: Lab Considerations

- Clinical labs can safely handle specimens from patients under investigation for Ebola
- Specific guidance is available for labs
- Lab staff handling specimens should wear recommended PPE and should use a biosafety cabinet or splash guard
- Samples can be run on routine lab equipment following manufacturer recommendations for safety features and decontamination protocols for enveloped viruses, such as HIV



# Emergency Department: Key Points

- Important to remember that of roughly 400+ patients in the US who have been evaluated for Ebola, only 1 case has been confirmed in an ED
- Most patients will be found not to have Ebola
- If Ebola is ruled out, all aspects of care, including lab testing, environmental cleaning, and waste management can proceed per normal protocols

# Management of Patients with Confirmed Ebola Virus Disease in US Hospitals

# Hospital Management of Patients with Ebola in the U.S.

- Experience in the U.S. indicates that care of patients with confirmed Ebola virus disease is best done in hospitals that are well prepared, equipped and supplied to do this
- This is not every US hospital, but a select group of hospitals
- Federal partners are currently collaborating with state and local public health officials to determine where Ebola care can be most effectively and safely delivered
- Will focus training and support



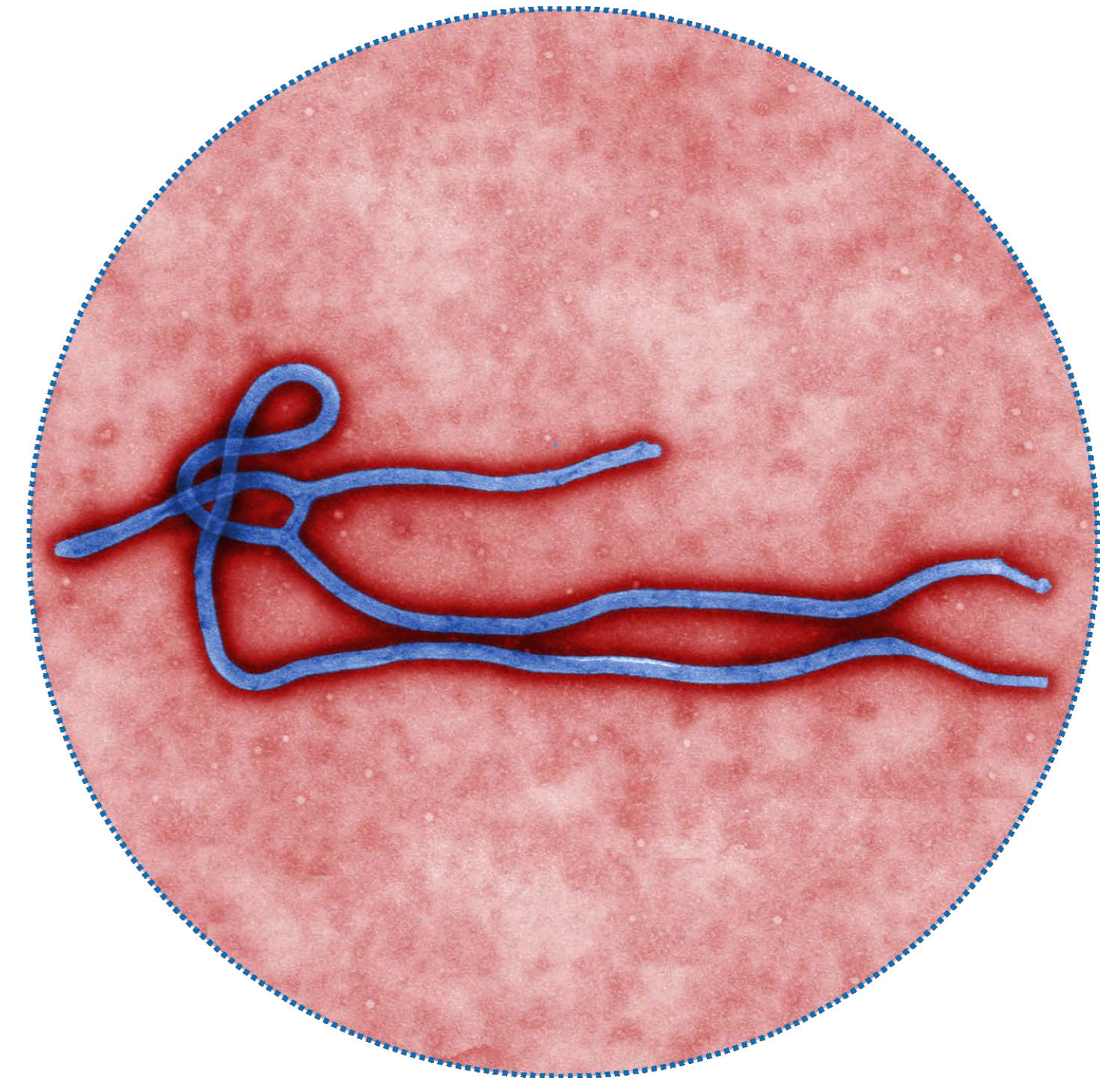
# Assisting Interested Hospitals

- CDC, the Office of the Assistant Secretary for Preparedness and Response and state/local health departments are sending teams to collaborate with hospitals that are preparing to care for patients with confirmed Ebola virus disease
  - Share lessons learned from other hospitals
  - Understand barriers and solutions
- CDC will collaborate with state/local health departments to send a rapid-response team to assist any hospital where a patient is admitted



# Stating the Obvious

- Safe and effective care for a patient hospitalized with Ebola is tremendously complex and requires extensive advanced planning and training
- Fortunately, there is experience with doing this in the US





# Ebola Hospital Management Plan

## Key Considerations

- Facility manager who develops the plan and oversees implementation and readiness.
- Plan for patient placement- identifying a room that allows for separate space to put on and remove PPE.
- Plan for very limited staff who will provide care.
- Plan for training of healthcare personnel to put on and take off PPE.
- Plan for necessary supplies, especially PPE.
- Plan for lab testing
- Plan for environmental cleaning
- Plan for waste management



# Personal Protective Equipment for Care of Patients Hospitalized with Ebola

## PPE for Management of Hospitalized Ebola Patients:

- 1 Single use, disposable face shield, surgical hood extending to shoulders, and N95 Respirator OR PAPR with a full face shield, helmet, or headpiece (not shown)
- 2 Single use, disposable, fluid-resistant or impermeable gown that extends to at least mid-calf OR coverall without integrated hood (not shown)
- 3 Two pairs of single use, disposable gloves w/ extended cuffs
- 4 Single use, disposable, fluid-resistant or impermeable apron that covers the torso to the level of the mid-calf (optional)
- 5 Single use, disposable, fluid-resistant or impermeable boot covers that extend to at least mid-calf

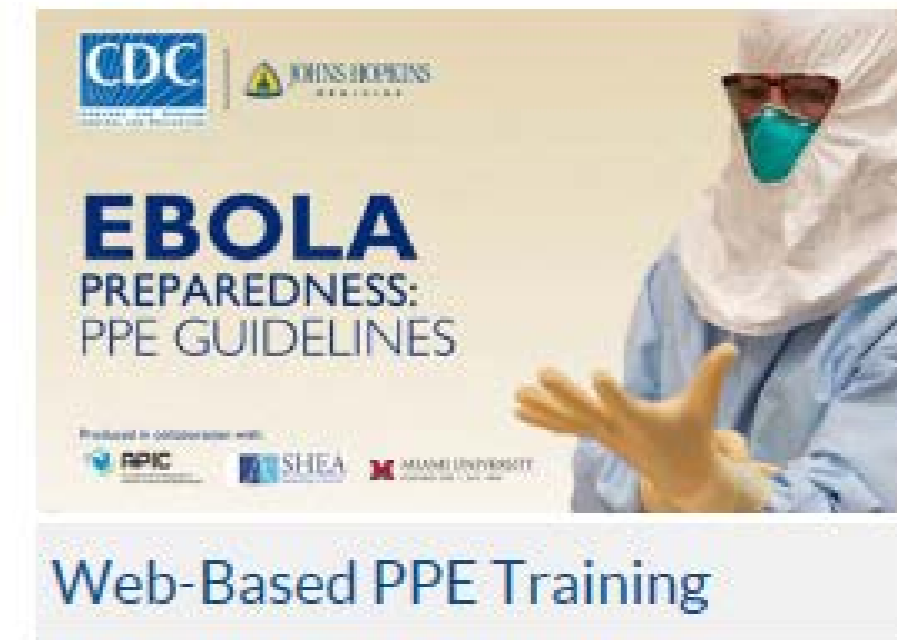


# Personal Protective Equipment (PPE)

- This is PPE that most staff are not accustomed to using, especially the more extensive PPE
- Putting on PPE properly is challenging
- Taking it off without contaminating yourself is very challenging
- Staff will need training and practice, practice, practice
- CDC recommends that putting and taking off PPE always be supervised by an observer who is experienced in PPE and well trained on the facility's PPE

# Personal Protective Equipment

- Guidance and videos for putting on and taking off PPE are available to help with training
- No substitute for hands-on practice
- Videos are guides. You might have differences in your procedures based on your experience and practice



# Why A Respirator?

- Ebola is NOT transmitted via an airborne route
- However, experience in caring for patients with Ebola in the US indicates that patients might require aerosol generating procedures (e.g. intubation) and the need for these procedures could develop unexpectedly
- Because Ebola PPE is time-consuming and challenging to put on and remove, the guidance recommends that people entering the room wear PPE that would protect them even if an aerosol generating procedure had to be done

# Respiratory Protection

- **Two options:**
  - Fit-tested, NIOSH certified N95 respirator
  - Powered air purifying respirator (PAPR)
- **Both have been used to safely care for Ebola patients in the US.**
- **Both have been used for decades to safely care for patients with true airborne diseases (e.g. tuberculosis).**
  - Including during aerosol generating procedures

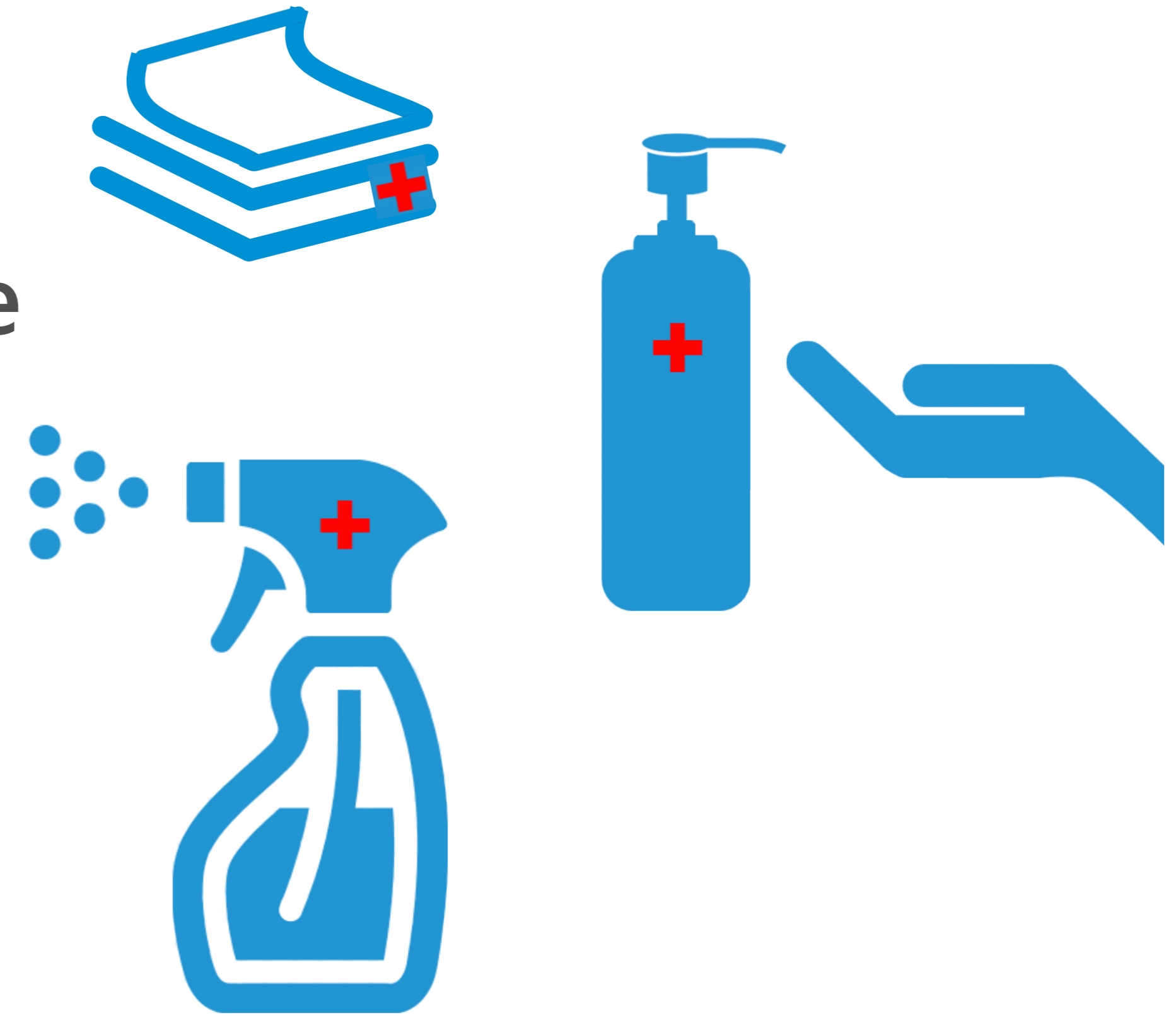
# Some Key Lessons Learned About PPE for Ebola

- Critical to have a trained observer monitor all steps of putting on and removing PPE
  - Can also be helpful to have an assistant to help with removal, especially with the PAPR
- Important to inspect and decontaminate PPE before removal
- Frequent hand hygiene during removal reduces risks of contamination
- More PPE is not always better
  - Adding extra layers or taping PPE can actually increase the risk of contamination during removal



# Disinfection of the Patient Care Area

- Daily cleaning of high-touch surfaces (e.g. bed rails) should be done by the clinical care team to minimize the number of people who must enter the room
- Terminal cleaning should be done by staff with training and experience in environmental services and who are trained to wear the same PPE that patient care staff wear





# Effective Agents for Disinfection

- Ebola is an enveloped virus and many products are highly effective against it
- Alcohol based hand rubs.
- Any EPA registered disinfectant or wipe with a label claim against “non-enveloped viruses” (e.g. norovirus)
  - Recommend using a disinfectant that’s one level higher than those effective against enveloped viruses



# Special Considerations for Waste Handling

- Packaging and transport of Ebola waste is governed by federal (Department of Transportation, DOT) regulations, but the disposal is governed by state and local law
- Ebola waste that has been appropriately incinerated, autoclaved, or otherwise inactivated is **NOT** infectious



# Conclusions

- The current Ebola epidemic poses huge challenges around the world
- Ultimately, the best way to protect the US is to work to stop the outbreak in Africa
- Until the outbreak is controlled, US healthcare facilities should follow relevant guidance to be prepared for the role they might have to play
- We are eager to collaborate with you to help healthcare facilities and personnel understand and prepare