EBOLA: The Emory Experience

James C Ritchie, Ph.D.
On behalf of the
Serious Communicable Diseases Unit
Emory University Hospital
DISCLOSURE STATEMENT

Speaker: James C. Ritchie, Ph.D.

Dr. Ritchie has disclosed the following financial relationships. Any real or apparent conflicts of interest related to the content of this presentation have been resolved.

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BeckmanCoulter, Inc
Roche Diagnostics
T2 Biosciences
Chromsystems
BioRad
Sebia
Objectives

• Analyze the instrumentation used, the staff preparation, and the teamwork needed
• Discuss the results for the common chemistry analytes on Ebola patients throughout their treatment course
• Explain the shipping of specimens and decontamination of equipment and the laboratory after the patients depart
Background: Ebola Virus

- Family Filoviridae
  - Two genera: marburgvirus and ebolavirus
- Enveloped RNA virus
- Five subtypes of Ebola virus
  - Zaire (EBOV)
  - Sudan (SUDV)
  - Tai Forest (TAFV)
  - Bundibugyo (BDBV)
  - Reston (RESTV)
- No vaccines/treatments approved for humans
- Case-fatality rates of up to 90%
Background:
Clinical Characteristics of EVD

- Acute infection starts as a non-specific febrile illness
  - Fever, severe headache, muscle pain, malaise; progression to include GI symptoms (diarrhea and vomiting)
  - May appear 2-21 days after exposure (8-10 days most common)
- Small vessel involvement
  - Increased permeability due to cellular damage
- Multi-organ system failure
- Hemorrhage may develop in the second week
- Poor prognosis associated with
  - shock, encephalopathy, extensive hemorrhage
Background:
Emory University Hospital

- 579 beds (93 ICU beds)
- 25,000 admission per year
- “Magnet” hospital:
  - Recognized for nursing excellence by the American Nurses Credentialing Center
- 2012 and 2013: #2 in Quality
  - #2 of 110 U.S. Academic Medical Centers by the University HealthSystem Consortium (UHC)
The Cases at Emory

• July 29th, 2014 we were informed that two humanitarians from the US had become infected with EBOV in Liberia

• During the first week of August, both were transferred by air ambulance to our hospital, 3 days apart
  • 33 yo male physician, day 11 of illness at arrival
  • 59 yo female missionary, day 15 of illness at arrival
AACC in Chicago  July 27 - 7/31/14
Clinical Pearls

• There are no proven therapeutics
  • No clear idea of the availability of any experimental agents when we started
  • Limited safety or efficacy data in humans
  • Great support and advice from CDC, FDA, and medical and scientific colleagues throughout the world

• With the help of the CDC, we monitored EBOV viral loads in blood by PCR
  • Progressive declines in viral loads that correlated with improvements in clinical condition
  • Had very low level of nucleic acid detection for several days despite resolution of symptoms
Clinical Pearls

• Our patients had marked electrolyte abnormalities and nutritional deficiency
  • Laboratory testing for chemistries was critical for patient specific care
  • Hypokalemia, hypocalcemia and hyponatremia to varying degrees
  • Required both intravenous and oral replacement
    • Both required significant potassium replacement
  • Used oral supplements including nutritional drinks high in easily absorbed proteins, minerals and vitamins
Clinical Pearls

• The ability to provide high-level nursing care and supportive care made a significant impact
  • 24/7 one-on-one nurses allowed for rapid response to changes and adjustment of care
  • Ability to support patients in nutrition, physical therapy, and self care
  • Emotional support

• Enabling safe interactions between family and patients was also beneficial
  • Glass window and intercom/phone system
SCDU CLINICAL LABORATORY

- Established in 2003 under contract with CDC
- Directed by Dr. C. Fantz until 2013
- Originally intended to treat CDC personnel only
- Provided 24/7 on-call coverage by a physician, nurse, and medical technologist
- Staff trained every six months
- Activated twice in 12 years
Clinical Laboratory: Operations

• The SCDU had previously established a small point of care lab within the anteroom
• However after the unit was activated, we realized it would become too crowded
  • Commandeered an office adjacent to anteroom
  • Facilities and Engineering built a complete point of care lab facility in less than 72 hours
• CDC: A dedicated lab is NOT required to work with blood from patients with Ebola

Laboratory Test Support for Ebola Patients Within a High-Containment Facility

Charles E. Hill, MD, PhD,¹ Eileen M. Burd, PhD,¹ Colleen S. Kraft, MD,¹ Emily L. Ryan, PhD,¹ Alexander Duncan, MD,¹ Anne M. Winkler, MD,¹ John C. Cardella,² James C. Ritchie, PhD,¹ Tristram G. Parslow, MD, PhD¹*

Advantages
- Less fear among hospital and lab staff
- Less impact on staffing and patient care
- Immediate results (really STAT)

Disadvantages
- Limited test panel
- If machine goes down, no back up
- Costs of maintaining equipment rarely used
Patient Testing Request Form – Isolation Laboratory

Patient Identification (Name, ID#, Stamp Plate)

Indicate the testing desired below. Deliver to Isolation Laboratory staff as soon as possible or page POCC on call at 63495. Laboratory staff will notify nursing when SCDU lab is up and ready for sample collection.

Date and Time testing desired:

Date: ______/_____/______ Time: ______:

Requested by:

Contact Number to call any critical results:  SCDU Ante-Room (404-712-7265)  Other ___________

Hematology: (lavender/EDTA)

- CBC (WBC, RBC, HGB, HCT, MCV, MCH, MCHC, PLT)

Chemistry: (green/heparin)

- Comprehensive Metabolic Profile
  (Na, K+, CO2, Cl-, GLU, Ca, BUN, CREAT, ALP, ALT, AST, TBIL, ALB, TP)
- Magnesium
- LD (Lactate Dehydrogenase)
- GGT
- Amylase
- Lactate
- Phosphorous

Blood Gas: (green/heparin)

- Venous (pH, pCO2, pO2, Na+, K+, Cl-, Ca++, Glu, Lac, Hct, Hbg, O2Hbg, 
  CO2Hb, MetHb, BE)
- Arterial

Urinalysis: (yellow/plain)

- Urinalysis

PCR:

- GI Panel
- BT Panel

Sample Type(s)

- Stool (Cary-Blair Medium)
- Blood (EDTA)
- Urine
- Stool (Cary-Blair medium)
- Semen

- Respiratory Panel

Sample Type

- Nasopharyngeal Swab (viral transport medium)

Parasitology: (lavender/EDTA)

- Malaria

POCT:

- INR
- Glucose

Additional Sample Needs: (list information of what/how many additional sample types and tubes are needed for sendout/CDC)

________________________

Laboratory Address and CLIA Director:

Emory Medical Laboratory at Emory University Hospital; 1394 Clifton Rd Nw; Atlanta, GA 30322; James C Mitchell, Phd – Laboratory Director

VERB:12/14
Our First Two Patients:

- Patients were admitted 10 days (A) and 12 days (B) after symptoms.
- At admission blood gases and comprehensive chemistry panel were run.
- Menu expanded to meet the needs of each patient.
- Testing done from once per day to up to Q6 hrs depending on patient care needs.
Carboxy Hb

Met Hb

Glucose

Lactate
Total Protein

Ionized Ca

Total Ca

Albumin

Days in Hospital
Clinical Laboratory:
The Impact of Electrolytes

• Our patients had MARKED electrolyte abnormalities and nutritional deficiencies
  • Hypokalemia, hypocalcemia and hyponatremia
  • Required both intravenous and oral replacement
    • Both required significant potassium replacement
  • Laboratory testing for chemistries was critical to provide supportive care
  • Used oral nutritional supplements including nutritional drinks high in easily absorbed proteins, minerals and vitamins
Clinical Laboratory: FilmArray® BioThreat Panel

- Fully automated PCR technology, combining nested and multiplex PCR with internal controls followed by melt curve analysis
- Samples are injected directly into a reaction pouch without nucleic acid extraction and the process is complete in one hour

The dried reagents in the FilmArray RP pouch are reconstituted by the addition of 1 ml distilled water to the blue port (lower right of diagram), and the diluted sample is injected into the port shown in red.

<table>
<thead>
<tr>
<th>Result Summary</th>
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<tr>
<td>Not Detected</td>
<td>Bacillus anthracis</td>
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<tr>
<td>Not Detected</td>
<td>Brucella melitensis</td>
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<tr>
<td>Not Detected</td>
<td>Burkholderia mallei/pseudomallei</td>
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<tr>
<td>Not Detected</td>
<td>Clostridium botulinum</td>
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<td>Not Detected</td>
<td>Coxiella burnetii</td>
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<td>Francisella tularensis</td>
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<tr>
<td>Not Detected</td>
<td>Ricinus communis</td>
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<tr>
<td>Not Detected</td>
<td>Rickettsia prowazekii</td>
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<tr>
<td>Not Detected</td>
<td>Staphylococcal enterotoxin gene</td>
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<tr>
<td>Not Detected</td>
<td>Yersinia pestis</td>
</tr>
<tr>
<td>✓ Detected</td>
<td>Ebola Zaire</td>
</tr>
<tr>
<td>Not Detected</td>
<td>Marburg virus</td>
</tr>
<tr>
<td>Not Detected</td>
<td>Orthopox genus virus</td>
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<tr>
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<td>Variola virus</td>
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<tr>
<td>Not Detected</td>
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<table>
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<tr>
<th>Run Details</th>
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<tbody>
<tr>
<td>Pouch</td>
<td>BioThreat Panel v2.4</td>
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<tr>
<td>Run Status</td>
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<tr>
<td>Serial No.</td>
<td>01532571</td>
</tr>
<tr>
<td>Lot No.</td>
<td>140522C</td>
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<tr>
<td>Protocol</td>
<td>BT Blood v2.0</td>
</tr>
<tr>
<td>Operator</td>
<td>Karen Jenkins (MPLJKM)</td>
</tr>
<tr>
<td>Instrument</td>
<td>ITI FA &quot;FA2702&quot;</td>
</tr>
</tbody>
</table>
Clinical Laboratory: Pre-analytical considerations

- Found that the Ebola virus result in the plasma component cleared before the whole blood component
- Ebola virus, like other filoviruses, preferentially infects certain cell types, including blood monocytes, and this discrepancy in whole blood may be due to cell associated viral nucleic acids in these blood cells

Racsa et al, Use of the FilmArray® BioThreat Panel in two patients with Ebola virus disease, *in preparation*
Clinical Laboratory:
“Rule out Ebola” testing

<table>
<thead>
<tr>
<th>Triage</th>
<th>Infectious Diseases (ID)</th>
<th>SCDU Physician</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk assessment performed in proper PPE and patient is isolated</td>
<td>Patient is evaluated by the on call infectious diseases physician</td>
<td>If testing is warranted by the ID physician, SCDU physician is notified and calls in the on-call laboratory technologist</td>
</tr>
</tbody>
</table>
# Clinical Laboratory: Interfering Substances

<table>
<thead>
<tr>
<th>Hospital Day</th>
<th>Sample Time</th>
<th>Hemolysis</th>
<th>Lipemia</th>
<th>Icterus</th>
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<tbody>
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<td>1</td>
<td>14:31</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>2</td>
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<td>3</td>
<td>9:06</td>
<td>0</td>
<td>1+</td>
<td>0</td>
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<tr>
<td>4</td>
<td>9:42</td>
<td>2+</td>
<td>1+</td>
<td>0</td>
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<td>5</td>
<td>9:40</td>
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<td>22:13</td>
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<td>3+</td>
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<td>0</td>
</tr>
<tr>
<td>14</td>
<td>6:42</td>
<td>3+</td>
<td>3+</td>
<td>0</td>
</tr>
</tbody>
</table>

**Scale:**

- 0 = Clear
- 1+ = slight
- 2+ = moderate
- 3+ = gross

Introduction of TPN
Clinical Laboratory: Shipping

- Limited staff trained in Category A shipping
- Not part of the unit team
- Reluctant to come to unit
- Emory U. safety officers trained members of our team
- Commercial couriers, even those certified in Category A shipping, refused to pick up anything from Emory destined for CDC
Clinical Laboratory: Reporting

• Division of Select Agents and Toxins (DSAT) is located in CDC's Office of Public Health Preparedness and Response (OPHPR)
• Upon viral isolation, the corresponding clinical samples also become select agents
• Documentation for all positive samples as well as their destruction
COAGULATION/TRANSFUSION
Transfusion Medicine: Blood Typing

http://www.eldoncard.com/
Transfusion Medicine: Convalescent Plasma

- Nebraska patient received convalescent plasma from recovered patient
- Underwent plasmapheresis (with albumin replacement) at their center of 1 L of plasma, and given in 2 aliquots 24 hours apart
- By definition, are ineligible donors, and this requires eIND from FDA
Coagulation: Strategies

• Can only test INR and platelet count

• Strategies
  – Supportive RBC transfusion (O negative uncrossmatched)
  – Aggressive platelet transfusion (>50,000)
  – Supportive coagulation factor replacement with FFP
MICROBIOLOGY
Blood Cultures:
Perform only if required and minimize blood draws for blood cultures. Use plastic bottles if available.

Once received in the laboratory, all specimens should be opened as described above in General Considerations: E. Wipe the outside of the bottles with bleach and inspect for any signs of breakage and positivity before loading onto the blood culture instrument or placing into an incubator for manual incubation. If the blood culture bottles are flagged as positive, or if they show any sign of positivity upon visual inspection, unload the bottles from the instrument or remove from the incubator, place the bottle(s) into a double-bag that contains absorbent pads soaked with bleach, place in a biohazard rigid plastic impervious container and process as described above in General Considerations: E.

1. Prepare slides for Gram stain examination and allow them to dry.
2. Fix the blood smear in methanol for 30 minutes, followed by dry heat at 95°C for 1 hour to inactivate the specimen. Perform testing of the gram stain QC smear in this same manner.
3. The smears can then be stained and read as usual.

**Do not perform any direct testing on positive blood cultures.**

Inoculate plates as per protocol based on Gram stain result.

1. Use shrink seal (Parafilm® or other suitable plate wrap) on all sub-cultured plates, place plates in a biohazard baggie and incubate in the AFB suite (if available) in the 35°C CO₂ incubator.
2. Examine plates for growth twice per day.
3. Perform all spot testing and inoculations of appropriate ID/AST systems from isolated colonies. **AS AN OPTION:** If any growth occurs, subculture the organism (as described above in General Considerations: E.) onto fresh plates and incubate overnight. Work only from the sub-cultured plates to minimize risk of contact with blood from the patient.
OTHER CONSIDERATIONS
Autopsy considerations

- Would contact and have CDC Pathology Branch perform the autopsy in the room of the Unit
Operations:
Staff & Environmental Safety

• Single patient room with a private bathroom
  • Maintain a log of persons entering the patient's room

• Dedicated medical equipment
  • Disposable, when possible

• Personal Protective Equipment (PPE)
  • All persons entering the patient room should wear at least:
    • Gloves
    • Gown (fluid resistant or impermeable)
    • Eye protection (goggles or face shield)
    • Facemask
  • Additional PPE might be required in certain situations depending on patient and environment, including but not limited to:
    • Double gloving
    • Disposable shoe covers
    • Leg coverings

Operations: Waste Management

• Patient 1: Admitted for 19 days
• Patient 2: Admitted for 14 days

• Autoclaved 350 bags of regulated medical waste
  • Total weight: 3,058 lbs

• Packaged 218 boxes of regulated medical waste

• 6 shipments of regulated medical waste were transported for incineration
Operations: Staff & Environmental Safety

- Team meeting everyday to review plans and protocols
  - Open forum for questions and concerns from any team member
- Only approved personnel allowed in isolation area
  - Log of everyone who entered room
- All personnel required to enter twice daily temperature and symptom review into an online registry
  - 21 day after last shift in the unit
Internal Communications

- Open forums for all physicians and staff
  - Twice a day for 3 consecutive days
  - Every other day for 1st week

- Hospital administration, nursing administration and hospital epidemiology leaders available for Q & A.

- Key leaders rounded on the floors to answer questions from staff AND patients

- Patient education video
Teamwork

• When you work in the regular lab what another tech does isn’t important to you.
• “In the SCDU you have to worry what the other person does before you, what the person does after you and what you are going to do, because one mistake can kill us all”
• That is how the Team began to think of its self as a Family
Family Rules

1. I will follow all SOP’s
2. I will ensure that others follow all SOP’s
3. I will report any new signs and symptoms
4. I will report any change in medical condition
5. I will report any incidents
Our Team

- **Emory Nursing**
  - Toni Ash
  - Chris Barnes
  - Jason Calhoun
  - Lauren Chapman
  - Tracey Daye
  - Haley Durr
  - Shunasee Evans
  - Janice Gentry
  - Jan Ginnane
  - Susan Grant
  - Chris Haynes
  - Carolyn Hill
  - Dustin Hillis
  - Crystal Johnson
  - Jessica Loomis
  - Josia Mamora
  - Laura Mitchell
  - Susan Mitchell
  - Jill Morgan
  - Nancy Osakwe
  - Jacqueline Owen
  - Sarah Piazza
  - Kristina Shirley
  - Jodi Siddens
  - Carrie Silas
  - Jason Slabach
  - Elaina Tirador
  - Donnette Todd
  - Sharon Vanairsdale

- **Health & Safety**
  - George Golston
  - Sean Kaufman
  - Patricia Olinger
  - Sean Olinger
  - Kalpana Rengarajan
  - Scott Thomaston

- **Infection Control**
  - Connie Bryant
  - Betsy Hackman
  - Regina Howard
  - Marolyn Jones

- **Pharmacy**
  - Amir Emamifar
  - Susan Rogers

- **Health & Safety**
  - George Golston
  - Sean Kaufman
  - Patricia Olinger
  - Sean Olinger
  - Kalpana Rengarajan
  - Scott Thomaston

- **Infection Control**
  - Connie Bryant
  - Betsy Hackman
  - Regina Howard
  - Marolyn Jones

- **Environmental Services**
  - Jeff Broughton
  - Brian Frisle
  - Robert Jackson
  - Jerry Lewis

- **Emory Medical Labs**
  - Jim Ritchie
  - Anne Winkler
  - Nicole Brammer
  - Juli Buchanan
  - Eileen Burd, PhD
  - John Cardella
  - Brenda Eaves
  - Crystal Evans
  - Charles Hill, MD, PhD
  - Krista Hostetler
  - Karen Jenkins
  - Maureen Lindsey
  - Jordan Magee
  - Randall Powers
  - Emily Ryan, PhD

- **Occupational Health**
  - Emily Beck
  - Paula Desroches
Our Team

**Administration**
- Robert Bachman
- Bill Bornstein
- John Fox
- Bryce Gartland
- Anne Adams
- Dee Cantrell
- Mary Beth Allen
- Nancye Feistritzer
- Jen Goodman
- Ira Horowitz
- Chad Ritenour

**Media Relations**
- Vince Dollard
- Nancy Seideman
- Holly Korschun
- Janet Christenbury

**Pastoral Care**
- Robin Brown-Haithcock
- Miranda Lynn Gartin
- Erica Geralds-Washington
- Rhonda James-Jones
- Donald Miller
- Dan Stark

**Supplies/Logistics**
- Gentrice McGee
- Porcia Jones

**EUH Security**
- Linda Scott-Harris
- James Cain
- Roderick Davis
- Tyrone Johnson
- Tyrone Pickett
- Anthony Shaw
- Tenina Truesdale

**Emory Critical Care**
- Jen Schuck
- Jim Blum
- Matthew Klopman
- Ricky Matkins
- Kathy Schwock
- Francis Wolf
- Kathy Stack
- Joel Zivot
- Laureen Hill
- Cathy Meechan
- Paul Meechan
- Jon Sevranski
- Seth Walker

**Emergency Medicine**
- Alex Isakov
- Sam Shartar

**Emory Infectious Diseases**
- Bruce Ribner
- Sonia Bell
- G Marshall Lyon
- Aneesh Mehta
- Colleen Kraft
- Jay Varkey
- Vince Marconi
- Mark Mulligan
- Carlos Del Rio
- Phyllis Kozarsky
- Rachel Friedman
- Monica Farley
- David Stephens
Thank You to Our Colleagues

• Centers for Disease Control and Prevention (CDC)
  • Timothy Uyeki
  • Anita McElroy
  • David Kuhar
  • Ute Stroehrer
  • Christina Spiropoulou
  • Jonathan Towner
  • Stuart Nichol
  • Shelley Campbell
  • Aridth Gibbons
  • Deborah Cannon
  • Paul Meechan
  • Viral Special Pathogens Branch

• National Microbiology Laboratory of the Public Health Agency of Canada
  • Dr. Gary Kobinger

• Food & Drug Administration (FDA)
  • Dr. Debra Birnkrant
  • Dr. Robert Kosko
  • Division of Antiviral Products

• SIM and Samaritan’s Purse
  • Dr. Lance Plyler
  • Dr. John Fankhauser
  • Dr. Deborah Eisenhut
  • Medical team at the ELWA hospital Liberia

• CBR International Corp
  • Dr. Miles Brennan
  • Dr. Jeanne Novak
Emory’s Experience with Ebola

TRAINING FOR THE FUTURE
Emory Ebola Protocols

www.emoryhealthcare.org/ebolaprep

Videos

This page provides videos to support the materials provided on this site.

- Donning Personal Protective Equipment
- Doffing Personal Protective Equipment Revised 11/14/14
- Taking Off Protective Gloves (Beak Method) Added 10/23/14
- Cleaning Up Spills Revised 12/4/14
- Donning Personal Protective Equipment in the Emergency Department Added 10/27/14
- Doffing Personal Protective Equipment In the Emergency Department Added 10/27/14
National Ebola Training and Education Center (NETEC) $12 million over 5 years

Activity A: Site visits and certifying facilities
- Developing verification criteria (metrics) and tool
- Performing annual site visits at the 10 Regional ETCs (and additional state ETCs)
- Performing site visits in 50 states during first two years of contract

Activity B: Training Curriculum and consensus conference
- Developing curriculum for in person, facility, and virtual training
- Holding a consensus conference and development of standard practices and drills for state health departments
- Developing an online repository for educational materials, certification materials, and exercises/drills

Activity C: Training and drills
- Holding 6 trainings at NETEC (2-Regional ETC, 2-ETCs, 2-Assessment hospitals)
- Performing unannounced drills and exercises annually at 10 Regional ETCs
- Provide technical support for facilities conducting training and drills
- Hosting Grand Round monthly webinars
- Maintaining 24-hour hotline for clinical support
Preparedness Training at Emory

• Trained 529 people for Ebola and other serious communicable diseases
• 34 states, DC and 3 US territories
  • 4 Federal agencies
  • 27 State public health departments
  • 118 different healthcare systems
• International colleagues from Canada, Singapore, South Korea, Thailand, Pan American Health Organization, World Health Organization
Their message: Help is needed in West Africa