Ebola diagnostic in the field, experiences from West Africa, European Mobile Laboratory - EMLab

Concetta Castilletti
INMI - National Institute for Infectious Diseases

Berlin, 27th February 2015
Main issues

• Brief description of the project
• Ebola outbreak in West Africa
• The location
• The lab
• Role in outbreak response and some activity data
• Strong and weak points
October 2010:
The EuropeAid Cooperation Office (DevCo) of the European Commission designated scientists from EMP4Lab Project to write a contract for an European mobile laboratory project.

December 2010:
Call for the European mobile laboratory project. The EuropeAid Cooperation Office (DevCo) of the European Commission has set up the collaborative project “Establishment of Mobile Laboratories up to Risk Group 4 in combination with CBRN Capacity Building in sub-Saharan Africa” (EMLab project, 2012-2015) with a budget of 3.5 Mio EUR. The EMLab consortium includes several EU Biosafety level 4 laboratories and technical partners.

15/12/2011 Project start date
The European mobile lab project: Aims

• Improve capacity to respond to outbreaks of risk group 3 and 4 pathogens in Europe and Africa
• Strengthen scientific cooperation between Europe and Africa in the field of epidemic-prone infectious diseases.
• Help African public health and research institutions to manage outbreak situations and conduct research on epidemic-prone pathogens
The European mobile lab project: specific aims

• Put three mobile diagnostic labs for pathogens up to risk group 4 into operational readiness in Europe and Africa
• Set up of infrastructure for the mobilization of equipment
• Set up of infrastructure for the supply of reagents
• Train personnel to operate lab
• Deployment in the framework of GOARN to provide laboratory support for outbreak response
• Sustainability plan
The EMLab Consortium

• **Main Partners EU BSL-4 laboratories:**
  - Bernhard-Nocht-Institute for Tropical Medicine (Hamburg, Germany)
  - „Institut für Mikrobiologie der Bundeswehr“ (Munich, Germany)
  - „Istituto Nazionale per le Malattie Infettive L. Spallanzani“ (Rome, Italy)
  - Public Health England (Salisbury, UK)
  - Institute of Virology Marburg (Marburg, Germany)
  - Laboratoire P4 Inserm (Lyon, France)
  - Spiez Laboratory (Spiez, Switzerland)

• **Additional Partners:**
  BSL4 Hungary, RKI, University Ljubljana (Slovenia), and Institut Pasteur, France
The mobile laboratory

• Developed by Bundeswehr (Medical Service of German Armed Forces)
• Stationed in EU (Munich)
• Portable equipment deployable by public airplane or two pick-ups:
  10-20 Boxes 30 kg each.
• Molecular diagnostics for viruses and bacteria
• Serology
• Portable class III cabinets
Training

• Scientists will be trained in all aspects important to the deployment and operation of these laboratories, thereby strengthening collaboration between Europe and Africa in the field of diagnostics and research on high consequence pathogens.

• Moreover, specialist training will build capacity in Africa to respond to these outbreaks and expertise will be passed on and multiplied through involved scientists and technicians.
First European Mobile Lab (EMLab) Training
Bodelsberg, 16.-20.09.2013
Transport of the EMLab unit

by small pick up trucks
European field conditions
Thinking about the Lab spatial organization and "building" the Lab
Lab Spatial separation
Looking for...in the boxes
Scenarios: samples arriving

1.
2.
3.
4.
Scenarios: samples arriving

Decontamination
Scenarios: samples processing
Repackaging: surprisingly very fast
Main issues

• Brief description of the project
• Ebola outbreak in West Africa
• The location
• The lab
• Role in outbreak response and some activity data
• Strong and weak points
Geographical distribution of new and total confirmed cases (WHO data up to 18 February 2015)
WHO – (data up to 18 February 2015)

**Cases/Deaths**

(Data up to 8 February 2015)

- **Guinea**: 3044 cases, 1995 deaths
- **Liberia**: 8881 cases, 3826 deaths
- **Sierra Leone**: 10934 cases, 3341 deaths
- **Mali**: 20 cases, 8 deaths
- **Nigeria**: 8 cases, 6 deaths
- **Senegal**: 10 cases, 0 deaths
- **Spain**: 1 case, 0 deaths
- **United Kingdom**: 1 case, 4 deaths
- **United States of America**: 1 case, 0 deaths

**Total**: 22894 cases, 9177 deaths
Figure 5: Days since last confirmed case in Guinea, Liberia and Sierra Leone

WHO
(data up to 18 February 201)

February 8 is counted as day 0.
Some characteristics of the outbreak

• High mortality rate > 50%
• Hemorrhagic signs are rare and usually late
• Several malaria coinfections
• Mainly gastrointestinal symptoms plus general symptoms (fever, headache, muscular pain, arthralgia, asthenia, ...)
• High mobility of the populations and funeral are relevant for disease spreading
Outbreak response 1

• **Integrated efforts** by: MoH and local health authorities, WHO (and EMLab), MSF, International Red Cross and Red Crescent

• **Identification of cases** (case definition, active research of cases and surveillance of contacts, laboratory confirmation, investigation of community death of unknown origin and of cluster of diseases and death)
Outbreak response 2

- **Infection control procedures**: isolation of patients (suspected and confirmed), contacts tracing and active surveillance of contacts, disinfection of patients’ home and distribution of hygienic kits (disinfectants and soaps), support for safe burial ceremonies.

- **Raising awareness and overcame resistance of the population**: (media messages, visits to communities and villages by local authorities and “the committee of wise men”)
The European mobile lab project DEVELOPMENTS: specific reached aims

• Three mobile diagnostic labs for diagnosis of ebola infections are at the moment deployed in Africa
• The infrastructure for the mobilization of equipment well worked
• The infrastructure for the supply of reagents is in place
• Trained personnel is operating in the three labs and other specialists are ready to go
• The three mobile diagnostic labs were deployed in the framework of GOARN to provide laboratory support for ebola outbreak response
• Sustainability plan
Main issues

• Brief description of the project
• Ebola outbreak in West Africa
• The location
• The lab
• Role in outbreak response and some activity data
• Strong and weak points
Figure 7: Location of laboratories in Guinea, Liberia, and Sierra Leone
Deployment of EMLab to Guinea

25 March til now
26.03.14
First team and EMLab leave Munich and go to Guinea
Figure 1. Map of Guinea Showing Initial Locations of the Outbreak of Ebola Virus Disease.

The area of the outbreak is highlighted in red. The main road between the outbreak area and Conakry, the capital of Guinea, is also shown. The map was modified from a United Nations map.
New location for EMLab in Guekedou, Guinea
New location for EMLab in Guekedou, Guinea
Liberia: Travel and location

• 1 day by car (EMLab)
or
• A flight with an elicopter

MSF compound...better than the hotels in Guinea
Main issues

• Brief description of the project
• Ebola outbreak in West Africa
• The location
• The lab
• Role in outbreak response and some activity data
• Strong and weak points
Technology and equipment: Outline of Lab

- Rapidly Deployable Biolab
  - 10-15 packages
  - Weight limit per box: max. 3 kg
  - Suitable for transport as passenger luggage
  - Tropicalized and water-tight boxes

- Modular lab equipment

Methods:
- ELISA (real-time)
- PCR (real-time)
- RT-PCR
- Light microscopy
- Immunofluorescence

Space requirement: 210 m²

Room separation using, e.g., plastic covers

Usable under limited environmental conditions

Transport and set-up by laboratory personnel

Lab Equipment & Exemplary Lab Structure
Technology and equipment

- Completely transportable by personnel
- Only small vehicle needed for transport
- Runs from car battery or small generator

<table>
<thead>
<tr>
<th>Total weight [kg]</th>
<th>397,18</th>
</tr>
</thead>
<tbody>
<tr>
<td>N01</td>
<td>31,18</td>
</tr>
<tr>
<td>N02</td>
<td>22,78</td>
</tr>
<tr>
<td>N03</td>
<td>20</td>
</tr>
<tr>
<td>N04</td>
<td>24,84</td>
</tr>
<tr>
<td>N05</td>
<td>28,1</td>
</tr>
<tr>
<td>N06</td>
<td>23,54</td>
</tr>
<tr>
<td>N07</td>
<td>23,5</td>
</tr>
<tr>
<td>N08</td>
<td>29,5</td>
</tr>
<tr>
<td>N09</td>
<td>28,44</td>
</tr>
<tr>
<td>N10</td>
<td>31,7</td>
</tr>
<tr>
<td>N11</td>
<td>26,7</td>
</tr>
<tr>
<td>N12</td>
<td>27,8</td>
</tr>
<tr>
<td>SC-box</td>
<td>31,2</td>
</tr>
<tr>
<td>act.cooling cooling box II</td>
<td>23,9</td>
</tr>
<tr>
<td>act.cooling cooling box I</td>
<td>24</td>
</tr>
</tbody>
</table>

rugged, dust and waterproof boxes
EMLab Procedures

Sample reception

Inactivation

Malaria testing

Serology
EMLab Procedures

Virus RNA Extraction

Mastermix Prep

Real-Time RT-PCR (Smartcycler)

Reporting
Main issues

• Brief description of the project
• Ebola outbreak in West Africa
• The location
• The lab
• Role in outbreak response and some activity data
• Strong and weak points
EMLab – Guéckédou, Guinea

Samples tested 15/02/2015

EBOV+ (qPCR)

5786 2238
EMLab - Foya, Liberia

Samples tested 04/12/2014

<table>
<thead>
<tr>
<th>Date</th>
<th>Team 1</th>
<th>Team 2</th>
<th>Team 3</th>
<th>Team 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>13/09/2014</td>
<td>29</td>
<td>22</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>20/09/2014</td>
<td>58</td>
<td>42</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>27/09/2014</td>
<td>29</td>
<td>34</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>04/10/2014</td>
<td>5</td>
<td>22</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>11/10/2014</td>
<td>13</td>
<td>13</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>18/10/2014</td>
<td>7</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>25/10/2014</td>
<td>10</td>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>01/11/2014</td>
<td>13</td>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>08/11/2014</td>
<td>11</td>
<td>0</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>15/11/2014</td>
<td>18</td>
<td>0</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>22/11/2014</td>
<td>12</td>
<td>0</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>29/11/2014</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

EBOV+ (qPCR)

<table>
<thead>
<tr>
<th>Date</th>
<th>Samples tested</th>
<th>EBOV+</th>
</tr>
</thead>
<tbody>
<tr>
<td>04/12/2014</td>
<td>318</td>
<td>82</td>
</tr>
</tbody>
</table>
EMLab testing of oral swab samples: decrease in community deaths in Lofa county, Liberia (first good news)
# Summary of EMLab tests to date

<table>
<thead>
<tr>
<th>EM Lab (Country)</th>
<th>EM Lab (Town)</th>
<th>1st sample tested</th>
<th>Last sample tested</th>
<th>Weeks in situ</th>
<th>Number of Teams</th>
<th>Samples tested</th>
<th>EBOV+ (qPCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guinea</td>
<td>Guéckédou</td>
<td>30/03/14</td>
<td>ongoing</td>
<td>42</td>
<td>15</td>
<td>5786</td>
<td>2238</td>
</tr>
<tr>
<td>Nigeria</td>
<td>Enugu Port Harcourt</td>
<td>20/08/14</td>
<td>01/10/14</td>
<td>1(E) 4(PH)</td>
<td>2</td>
<td>30`</td>
<td>0(E) 3(PH)</td>
</tr>
<tr>
<td>Liberia</td>
<td>Foya</td>
<td>13/09/14</td>
<td>04/12/14</td>
<td>12</td>
<td>4</td>
<td>318</td>
<td>82</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>Freetown (POW)</td>
<td>14/12/14</td>
<td>ongoing</td>
<td>4</td>
<td>3</td>
<td>999</td>
<td>182</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>Hastings</td>
<td>22/12/14</td>
<td>ongoing</td>
<td>3</td>
<td>3</td>
<td>608</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Data up to and inclusive of Feb 15, 2015</td>
</tr>
</tbody>
</table>
Key facts

• Reliable commercial filovirus RT-PCR kit used by EMLab - excellent performance in the field

• 50,000 Euro per unit per months

• Strengthening stationary labs in Conakry and Lagos (training, equipment, and reagents)
Problems / Key issues

• Response phase
  – In-country transport logistics
  – On-site infrastructures required (tent, rooms, power)
  – Biosafety and biosecurity on site (samples often not properly packaged)
  – Shipment of samples (tested positive) for safe storage outside the country
Problems / Key issues

• Response phase
  – Security of staff
    • Health security: accidents, infections, other illness
    • Repatriation difficult
Teams for Guinea 56 persons deployed (some persons went two or three times) and Joseph and Raymond.

Teams for Liberia and Sierra Leone 28 persons.

• Public Health England, Microbiology Services Salisbury, UK
• Istituto Nazionale per le Malattie Infettive „L. Spallanzani“, Rome, Italy
• Institut für Mikrobiologie der Bundeswehr, Munich, Germany (all Training)
• Philipps-Universität Marburg, Institut für Virologie, Marburg, Germany
• Laboratoire P4 Inserm Jean Merieux / Institut Pasteur, Lyon, France
• Spiez Laboratory, Spiez, Switzerland
• National Center for Epidemiology, Hungarian National Biosafety Laboratory, Budapest
• University Ljubljana, Slovenia
• Robert-Koch-Institute, Berlin, Germany
• University of Antwerp
• University of Leuven
• Tropical Institute Antwerp

Join the teams!
A big thank you to our local helpers Joseph and Raymond with whom it has been a great pleasure to work with. Joseph and Raymond are a great benefit for our lab!
Comparative evaluation of the sensitivity of Ebola virus in whole blood and plasma specimens during an outbreak emergency

<table>
<thead>
<tr>
<th>sample ID</th>
<th>WB140</th>
<th>WB50</th>
<th>plasma</th>
<th>REMARKS</th>
<th>diff WB140-50</th>
<th>diff WB50-pl</th>
<th>diff WB140-pl</th>
</tr>
</thead>
<tbody>
<tr>
<td>535</td>
<td>19,17</td>
<td>15,31</td>
<td>15,44</td>
<td>plasma prepared on day</td>
<td>hemolytic</td>
<td>3,86</td>
<td>0,13</td>
</tr>
<tr>
<td>536</td>
<td>21,11</td>
<td>19,28</td>
<td>21,72</td>
<td>plasma prepared on day</td>
<td></td>
<td>-1,83</td>
<td>2,44</td>
</tr>
<tr>
<td>537</td>
<td>16,60</td>
<td>15,97</td>
<td>14,24</td>
<td>plasma prepared on day</td>
<td></td>
<td>-0,63</td>
<td>1,73</td>
</tr>
<tr>
<td>539</td>
<td>22,39</td>
<td>21,77</td>
<td>19,35</td>
<td>plasma prepared on day</td>
<td></td>
<td>-0,62</td>
<td>2,42</td>
</tr>
<tr>
<td>540</td>
<td>19,32</td>
<td>18,07</td>
<td>15,69</td>
<td>plasma prepared on day</td>
<td></td>
<td>-1,25</td>
<td>2,38</td>
</tr>
<tr>
<td>541</td>
<td>21,11</td>
<td>nd</td>
<td>18,11</td>
<td>plasma prepared on day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>542</td>
<td>20,5</td>
<td>18,62</td>
<td>17,1</td>
<td>plasma prepared on day</td>
<td>hemolytic</td>
<td>-1,88</td>
<td>1,52</td>
</tr>
<tr>
<td>548</td>
<td>17,7</td>
<td>17,53</td>
<td>22,26</td>
<td>plasma stored 1 night</td>
<td></td>
<td>-0,17</td>
<td>4,73</td>
</tr>
<tr>
<td>549</td>
<td>19,45</td>
<td>22,23</td>
<td>21,84</td>
<td>plasma stored 1 night</td>
<td></td>
<td>2,78</td>
<td>0,39</td>
</tr>
<tr>
<td>550</td>
<td>18,10</td>
<td>20,37</td>
<td>19,02</td>
<td>plasma prepared on day</td>
<td></td>
<td>2,27</td>
<td>1,35</td>
</tr>
<tr>
<td>551</td>
<td>21,62</td>
<td>19,87</td>
<td>23,45</td>
<td>plasma prepared on day</td>
<td></td>
<td>-1,75</td>
<td>3,58</td>
</tr>
<tr>
<td>552</td>
<td>23,46</td>
<td>22,88</td>
<td>23,39</td>
<td>plasma prepared on day</td>
<td></td>
<td>-0,58</td>
<td>0,51</td>
</tr>
<tr>
<td>556</td>
<td>23,78</td>
<td>23,07</td>
<td>20,55</td>
<td>plasma prepared on day</td>
<td></td>
<td>-0,71</td>
<td>2,52</td>
</tr>
<tr>
<td>491</td>
<td>28,36</td>
<td>nd</td>
<td>24,30</td>
<td>plasma prepared on day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>492</td>
<td>26,33</td>
<td>nd</td>
<td>25,47</td>
<td>plasma prepared on day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>21,27</td>
<td>19,58</td>
<td>20,13</td>
<td></td>
<td></td>
<td>-0,69</td>
<td>-0,08</td>
</tr>
</tbody>
</table>
Internal control inhibition by competition
Internal control added in the AVL: CT variations, RNA degradation?
RT-PCR inhibition
Removal of inhibiting factors: freezing better than re-extraction!
Repetition of the run
Samples preparation and RNA extraction

- Whole blood vs plasma
- Carrier RNA amount
- RNA extraction: washing!!!
- RNA freezing
Reception of samples from unknown senders
Reception of samples
INMI - Emergency ETC Laboratory
Acknowledgements

**EMLab**
- Martin Gabriel (Hamburg)
- Roman Wölfel (Munich)
- Miles Carroll (Porton Down)
- Antonino Di Caro (Rome)
- Raymond & Joseph (Gueckedou)

**Field work and deployment**
- MSF
- WHO

Funding
Thank you for your attention!!