Fighting Ebola in Sierra Leone
- a field scientist's perspective
Ed Choi

Ebola Laboratory Team Leader
Public Health England
Sierra Leone
塞拉利昂 (獅子山)
CALL FOR MICROBIOLOGISTS TO HELP FIGHT EBOLA IN SIERRA LEONE

25 November 2014

The Ebola outbreak in West Africa continues to spread, with the WHO reporting that it has caused 5,420 deaths, although deaths and cases of infection are likely to have been under-reported. The disease continues to be transmitted in Guinea, Liberia and Sierra Leone.

Earlier in the month, we spoke to Society member Professor Ian Goodfellow, who is soon to travel to Sierra Leone to work with Public Health England (PHE) to increase diagnostic capacities in the country where many areas lack access to treatment facilities or laboratories.

The UK Government has set up three diagnostic laboratories in Sierra Leone, funded by the Department for International Development (DFID) and managed by Public Health England (PHE). Sir Mark Walport, the Government Chief Scientific Adviser, and Dame Sally Davies, the Chief Medical Officer, are now calling for microbiologist volunteers to staff the laboratories in the Port Loko and Makeni districts of Sierra Leone. PHE are looking for the following volunteers:
Synopsis:

1) Introduction to Ebola
2) Emergency Outbreak Response
3) Lab
Ebola Virus EBOV
(formerly Zaire)

A filovirus
Plasma membrane
Single-stranded RNA
19Kb, 7 proteins

5 species of Ebolavirus:-
Zaire
Sudan
Bundibugyo
Reston
Tai Forest
Signs & Symptoms

Ebola Haemorrhagic Fever

Ebola Virus Disease

Fever

Flu-like

Headache

Red eye

Vomiting

Hiccups

Muscle ache

Joint pain

Diarrhoea

Bleeding

Rash

Breathing Difficulty

2-21 days incubation
Ebola virus has been identified in several animal species, including bats, chimpanzees and forest antelopes. Transmission to humans can occur directly from reservoir species, in which the virus may persist without causing active infection, or from amplifying host species, in which the virus replicates to high levels, often causing illness and death. Most infected people develop acute Ebola virus disease and are highly infectious, although some individuals survive exposure and infection without developing symptoms. There is also growing evidence\textsuperscript{3, 4} that the virus can persist in the central nervous system and reproductive organs of some survivors of the disease, with the possibility that these survivors could infect others months after resolution of their acute symptoms\textsuperscript{4}. 
Timeline

December:

Patient Zero fell ill and died in Guékédou, Guinea, near the border with Liberia & Sierra Leone
Timeline

March:

- Institut Pasteur confirmed Ebola diagnoses 15wk later
- WHO announced outbreak in Guinea, 70 deaths
- Doctors Without Border set up first isolation centre
- European Mobile Lab deployed to Guinea ground zero

Photo: European Commission
Timeline

2014
- March 31: confirmed Ebola cases in Liberia
- April 1: WHO called outbreak “relative small”
- May: first Ebola death confirmed in Sierra Leone
- June: SL nurses went on strike
- MSF distress warning, “Epidemic Unprecedented”

2015
- August: WHO declared the EVD epidemic a “Public Health Emergency of International Concern” & international aid mobilised

2016
- September: curfew & travel restriction in SL
October:
Royal Fleet Auxillary ship Argus from Cornwall arrived at Freetown
MOD-built Kerrytown ETC opened
“We worked 10-12 hour shifts everyday for 3 months. On top of that, the MOD guys have to do military exercise before and after work.”

- Helen
Timeline

2014

November:
Photo: Steve Welch
First group of NHS volunteers deployed

2015

London → Belgium → Senegal → Guinea → Sierra Leone

2016

Vaccinations: Yellow Fever, Measles, Cholera, Diphtheria, Typhoid, Polio, Hep A/B, Tetanus, Rabies, Flu, BCG
“Whatever mental or physical limits you had, you will overcome them during this deployment.” - Cristina
December: SL overtook Liberia in #Ebola cases
August: Guinea RING vaccine trial: “100%” protective
September: WHO declared Liberia ebola-free
November: WHO declared Sierra Leone ebola-free
December: WHO declared Guinea ebola-free
8 Transmission Lineages

- Freetown
- Kambia
- Port Loko
- Bombali
- Tonkolili
- Kono
- Kailahun
- Bo
- Kenema
- Moyamba
- Bonthe
- Pujeahun

Guinea
Liberia
Atlantic Ocean
District Ebola Response Centre

War against Ebola

Quarantine Houses

Ebola case

Check point

MISSING

# New mattress

# Old mattress burnt

# Old mattress burnt
Ebola Response Facilities

Holding Center

Treatment Center

Permanent P3 Lab

Mobile Lab
Makeni Ebola Treatment Centre

- Triage
- Confirmed
- Probable
- Suspected
- Convolescence
- Storage
- Canteen
- Incinerators
- Lab
- Laundry
- Research
- Medical
- Pharmacy
- Incinerators
- White Zone
- Green
- Red
Entering White / Green / Red Zone

Hand wash, Temperature

Full PPE with buddy
“The heat was exceptional. I almost drowned in sweat a number of times. I had to swallow my own sweat to avoid passing out.” - Dr Ken Soy
What we do

Diagnostics:

Ebola screening:

Live patients - in whole blood, urine, milk
Disseminated patients – buccal swabs
Survivor semen testing

Malaria & Dengue
GI & Respiratory panels
Bacterial culture
Biochemistry & Haematology analyses

Clinical trials:

Labourer
Cleaner
Laundry
Engineer
Electrician
Security guard
Social worker

Virus deep sequencing (Cambridge),
EboVac vaccine (LSHTM),
TKM small molecule treatment (Oxford),
Convalescent plasma treatment (Liverpool),
Rapid Diagnostic Tests (WHO),
GeneXpert Validation (Porton)
Containment Strategy: Space suits – China & S.Africa
Containment Strategy: Isolators – UK & Netherlands
Sample Reception
Chemical Inactivation
Heat Inactivation
RNA Extraction
PCR
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:00</td>
<td>Setting up</td>
</tr>
<tr>
<td>09:00</td>
<td>Sample Reception</td>
</tr>
<tr>
<td>09:15</td>
<td>Chemical Inactivation</td>
</tr>
<tr>
<td>10:15</td>
<td>Heat Inactivation</td>
</tr>
<tr>
<td>10:30</td>
<td>RNA extraction</td>
</tr>
<tr>
<td>11:15</td>
<td>PCR amplification of Ebola fragment</td>
</tr>
<tr>
<td>12:00</td>
<td>Results Reporting</td>
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</tbody>
</table>
Trombley Assay: Real-time PCR Polymerase-Chain Reaction for Ebola Diagnosis

1) Reverse Transcriptase: RNA → DNA

2) DNA Polymerase: Cyclical Replication of Ebola gene

30 cycles: 1 copy → $10^9$ copies
Optics

Threshold

Ct value
Results

Ebola

Internal
Control

Sample 1

Not Detected

Sample 2

Detected
**A Bad Day in the Lab...**

<table>
<thead>
<tr>
<th>Time</th>
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<th>Activity</th>
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<tbody>
<tr>
<td>16:00</td>
<td>Positive rapid tests</td>
<td>21:30</td>
<td>PCR Results</td>
</tr>
<tr>
<td>17:00</td>
<td>WHO called lab</td>
<td>21:30</td>
<td>Repeat</td>
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<td>18:00</td>
<td>Get the lab ready</td>
<td>21:30</td>
<td>Inform PHE, DMO</td>
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<td>19:00</td>
<td>Sample arrived</td>
<td>22:00</td>
<td>WHO sent helicopters</td>
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<td>19:15</td>
<td>Virus inactivation</td>
<td>22:00</td>
<td>WHO called pharma</td>
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<td>19:45</td>
<td>RNA extraction</td>
<td>22:00</td>
<td>WHO located vaccines</td>
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<tr>
<td>20:30</td>
<td>PCR</td>
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</table>
Why was this outbreak so different?

Previous Ebola #deaths
Effective Ebola Control

- Early identification
- Early case isolation
- Proper use of PPE
- Safe burial practice
- Community engagement
Early identification

Community engagement

Safe burial practice

Proper use of PPE

Early case isolation

Ebola new to country
Lack of infrastructure

Outbreak near borders
Government in denial
Low medical capacity

History of mistrust
Low literacy

People in denial
Local bereavement practice

Corruptions
Government in denial
Low medical capacity
The 2014 Ebola Perfect Storm

- Disease origin – border town
- Disease origin – new area
- Local funeral practice
- Government in denial
- Lack of infrastructure
- Low medical capacity
- Endemic corruptions
- Poverty, poor health
- Low literacy, belief in witchcraft
- History of mistrust towards Western medicine
Legacy

>10000 Ebola Survivors

- Enhanced Surveillance
- Capacity building
- Technology transfer
- Continued funding
- Political willingness
- Community acceptance
- Overcome cultural barriers
Acknowledgements

- All ETC volunteers and their employers
- PHE Porton Down
- NGOs
- DFID Funding
Sierra Leone-China Friendship Hospital 中塞友好医院
China CDC 中國疾病預防控制中心
- Sierra Leone-China Friendship Hospital
- Medical teams from the 302 Military Hospital
- Flew in mobile lab
- State-of-the-art permanent P3 lab
- 2 teams/lab
- On duty every other day
- Staff were recommended
- 6-months deployment
- Virus “outside”
- Space suit PPE
- Local government hospitals & ETC
- Medical teams from NHS trusts all across the UK
- Bought a mobile lab
- Built 3 temporary labs at ETC
- Built lab extensions at 4 hospitals
- 1 team/lab, working shifts
- Work every day
- All volunteers
- 5 weeks deployment
- Virus 'inside'
- Light PPE
- 6 months deployment
WHO Ebola Response Funding: US$460 million