10th International Global Virus Network (GVN) meeting:
Eradication and control of (re-) emerging viruses

Marburg and Ebola viruses

Stephan Becker
Philipps-Universität Marburg

Les Pensières Center for Global Health
Veyrier-du-Lac - France
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Filoviridae (order Mononegavirales)

- **Ebola**
  - Tai Forest Ebola Virus
  - Sudan Ebola Virus
  - Zaire Ebola Virus
  - Bundibugyo Ebola Virus
  - Reston Ebola Virus

- **Marburg**
  - Marburg Virus
  - Ravn Virus

- **Cuevovirus**
  - Lloviu Cuevovirus

Structural components:
- Surface glycoprotein (GP)
- Ribonucleoprotein complex (vRNA, NP, VP35, VP24, L, VP30)
- Matrix (VP40)
- Lipid envelope
First documented outbreak of a filovirus, Germany 1967

- Marburg, Frankfurt, Belgrade.
- Primary cases: Lab workers with contact to tissue of imported monkeys (Uganda).
- Secondary cases: relatives, health care workers.
- 32 cases, CFR: 25%.
1976: Outbreak of Ebola Virus in DR Kongo and Sudan
Ebola virus epidemiology

Mononegavirales
Filoviridae

Ebola virus
Marburg virus

- Zaire EBOV
- Sudan EBOV
- Tai Forest EBOV
- Bundibugyo EBOV

Map of Africa showing outbreaks of Ebola virus (EBOV) and Marburg virus (MARV) from 1976 to 2019, with specific dates and locations of outbreaks in countries such as Gabon, Republic of the Congo, South Sudan, and Uganda.
Ebola virus
West Africa 2014/16
Ebola virus West Africa 2014/16

Socio-economic impact

- schools closed for > 6 months,
- agricultural output (including domestic food production) dropped dramatically,
- activities in mining were scaled back,
- cross-border trade stopped completely.

GDP dropped by 7 – 20%
May 2015: Finally…..!? 
How has this been achieved?

Unprecedented international help:
- People
- Infrastructure
- Money

Education

Behavioral changes
Lessons learned

- **Health Infrastructure** needs to be strengthened in many countries facing outbreaks of emerging pathogens (not only Ebola virus)
- **Building trust** between the national/international help teams and the local population at risk is most important.
- **Community engagement** is key to contain outbreaks
- **Preparedness** for known emerging viruses needs to be improved (vaccines, antivirals)
- Be prepared for **the unexpected**
What about anti-Ebola virus vaccines?
The surface glycoprotein GP is the primary vaccine target.
Ebola virus Vaccine Candidates

- Replication-competent virus
- 1 dose protected macaques from lethal challenge
- Treatment 1h after infection protected 50% of animals
- No pre-existing immunity in humans

⇒ Ideal candidate in an epidemic scenario!? 

Clinical trials testing VSV-ZEBOV GP

Studies conducted November 2014 – January 2015
Ring Vaccination: Who is offered the Ebola vaccine in a ring vaccination?

- Family members and persons who live in the same household
- High risk contact: close contact with patient body or body fluids, linen, or clothes
- Lab confirmed EVD case
- Neighbours
- Persons who visited the symptomatic patient
- Local & international HCWs & FLWs in the affected areas and those working in areas at risk of expansion of the outbreak

Adapted from WHO
Ebola outbreak in DRC, 2018 (Equateur Province)

March 2018: First cases reported, outbreak declared
Jul 2018: 53 cases including 29 deaths

3,330 people have been vaccinated against Ebola virus
Ebola outbreak in **North Kivu/Ituri** provinces, DRC, August 2018

- Densely populated province, borders with Uganda and Rwanda
- Intense insecurities, humanitarian crisis
- 1 Mio internally displaced people
- Outbreaks of cholera, measles, monkey pox
Population densities in DRC
Ebola outbreak in **North Kivu/Ituri** provinces, DRC

**Latest numbers as of 26 November 2018**

<table>
<thead>
<tr>
<th>Total cases: 421</th>
<th>Deaths: 241</th>
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<tbody>
<tr>
<td>- Confirmed cases: 374</td>
<td>- Confirmed: 194</td>
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<tr>
<td>- Probable cases: 47</td>
<td>- Probable: 47</td>
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Ebola outbreak in **North Kivu/Ituri** provinces, DRC
Cases from unknown chains of transmission

![Graph showing % of cases from unknown chains of transmission over time]

*Data as of October 23, 2018

Source: World Health Organization
Ebola outbreak in **North Kivu/Ituri** provinces, DRC
Ebola outbreak in North Kivu province
Anti-Ebola virus vaccination

36,612 people consented and were vaccinated (Nov 26, 2018)

- Contacts of patients (ring vaccination)
- Health Care Workers
- Burial Teams
Clinical trial testing anti-Ebola virus treatment options during the North Kivu outbreak

- Randomized controlled clinical trial
- Compare 3 different antibody treatments and an antiviral drug, no placebo included

- Sponsor: INBR of the Congo

**Study arms:**
- **Remdesivir** (Gilead)
- **Zmapp** (Mapp Biopharmaceuticals)
- **REGN 3470-3471-3479** (Mabs, Regeneron)
- **mAb 114**, (National Institutes of Health and DRC's National Institute of Biomedical Research)
Outbreaks of Emerging Viruses

• Unpredictable
• Impact on all aspects of life
  – Individual health
  – Public health
  – Social networks
  – Economy
Outbreaks of Emerging Viruses

Public Health authorities

- Quarantine measures
- Epidemiological investigations
- Risk assessment
- Scientific policy advice
- Information of the public
- …

Academic research

- Identification and characterization of novel pathogens
- Rapid development of diagnostic tools
- Patient management (University Medical Centers)
- Rapid development of vaccine candidates
- Antivirals
- Promote investigator initiated clinical studies + industrial development, production and marketing