The potential impact of different vaccination policies

John Edmunds, Anton Camacho, Roz Eggo, Adam Kucharski, Sebastian Funk, Alexis Robert, Conall Watson, Stefan Flasche

London School of Hygiene and Tropical Medicine

john.edmunds@lshtm.ac.uk
Ring vaccination

- Randomised clinical trial gives clearest evidence of effectiveness of ring vaccination policy
- Are there conditions when it might fail to control an outbreak?

Ring vaccination

Transmission model

Vaccination delays

80% efficacy and 70% vaccinated means:
\[ R_v = (1-0.7\times0.8)R_w = 0.44R_w \]
• Initial (i.e. missed) cases have $R=7$
• Or $R=2.5$ if individuals with funeral and hospital transmission omitted
• Other cases have $R=0.66$
If no funeral or hospital superspreading events, ring vaccination can prevent large outbreaks even if ~40-50% cases missed

0= No vaccination
1= Ring vaccination
2= Mass vaccination

If missed cases associated with superspreading, ring vaccination might fail to stop large outbreak (i.e. >500 clusters) even if small proportion of cases missed.
- Mass vaccination at the regional level
  - Liberia: county
  - Sierra Leone: district
- Meta-population model
- Importations from neighbouring regions
- Rate dependent on size & proportional to cases
Base case results

Vaccination (base case)
80% efficacy
Trigger: 10 cases per region
2 week delay to start
100,000 doses per region per week
70% coverage
Delay in vaccine availability

Liberia

- Incidence
- Cases Averted
- Doses Deployed

Sierra Leone

- Incidence
- Cases Averted
- Doses Deployed

Graphs show the impact of immediate vaccination and delayed availability on incidence, cases averted, and doses deployed in Liberia and Sierra Leone from 1 Aug 2014 to 1 Oct 2014.
HCW: questions

- Do HCW play an active role in driving the transmission during the increasing phase of the epidemic?
- What would have been the benefit (direct and indirect) of vaccinating HCW before this epidemic?

<table>
<thead>
<tr>
<th>Location</th>
<th>Population size</th>
<th>Confirmed &amp; probable cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Community</td>
<td>HCW</td>
</tr>
<tr>
<td>Kikwit (1995)</td>
<td>200,000</td>
<td>900</td>
</tr>
<tr>
<td>Liberia (2014)</td>
<td>4.3 m</td>
<td>11.7 k</td>
</tr>
<tr>
<td>Sierra Leone (2014)</td>
<td>6.3 m</td>
<td>6.2 k</td>
</tr>
<tr>
<td>Guinea (2014)</td>
<td>10.5 m</td>
<td>1.7 k</td>
</tr>
</tbody>
</table>
Transmission tree (Kikwit)

1 HCW
39 secondary cases
25 (69%) are HCW

1 COM
21 secondary cases
100% are COM

262/316 (83%) known index cases
Vaccination

- Vaccine type: single dose.
- Vaccine efficacy: 70, 80 or 90%.
- Protective 1 week post vaccination.
- All-or-nothing immunity.
- Immunity lasts for 1 year.
- Scenario 1: vaccinate all health-care workers before the epidemic.
- Scenario 2: vaccine campaign in the community:
  - 100,000 doses per week (2 weeks to vaccinate all Kikwit area)
  - Starts on 20 April (2 weeks after the initial case in Kikwit General Hospital) or on 10 May (arrival of international response team)
- Scenario 3: scenario 1 + 2
Proportion of cases averted

Comparing Scenario 1 and Scenario 3, Timing of campaign

Community cases can be averted

- Later starts to the campaign (>34 days) result in little additional benefit to vaccinating only HCW before the epidemic
Summary

General approach
– Impossible to tell what next epidemic will be like
– What if vaccine had been available in past outbreaks

Ring vaccination
– Trial demonstrates the effectiveness of this strategy
– Least effective if cases who “escape detection” have high reproduction number
– May need to widen ring &/or supplement with more widespread vaccination
  • Stockpile implications

Mass vaccination (district, country, etc)
– Effectiveness of vaccination depends on timing
  • Late vaccination has little impact

HCW vaccination (prophylactic)
– HCW at very high risk, particularly at the outset of Ebola epidemics
– May also play a role in amplifying initial spread
  • Vaccination of HCW has potential population-level effects
    General approach
Acknowledgements & further details

More detailed weekly assessments and district-level forecasts at: http://cmmid.lshtm.ac.uk/research/ebola/

Data:
• MoHs
• WHO
• MSF

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