The potential impact of different vaccination policies

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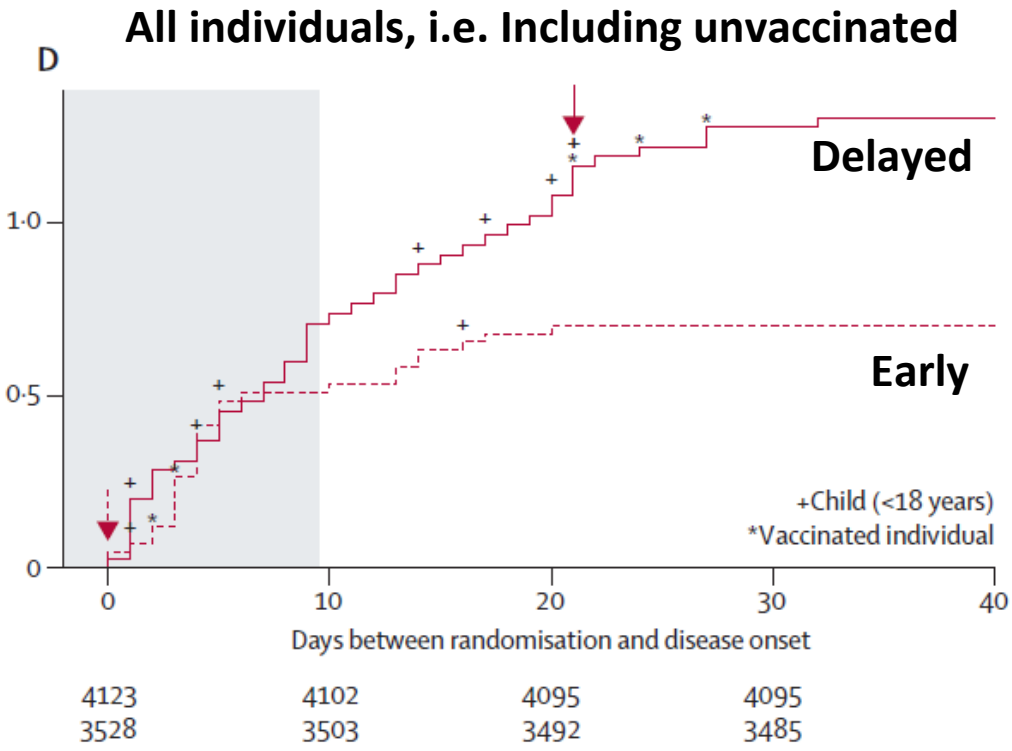
Ring vaccination

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



Henao-Restrepo *et al.* Lancet (2015)

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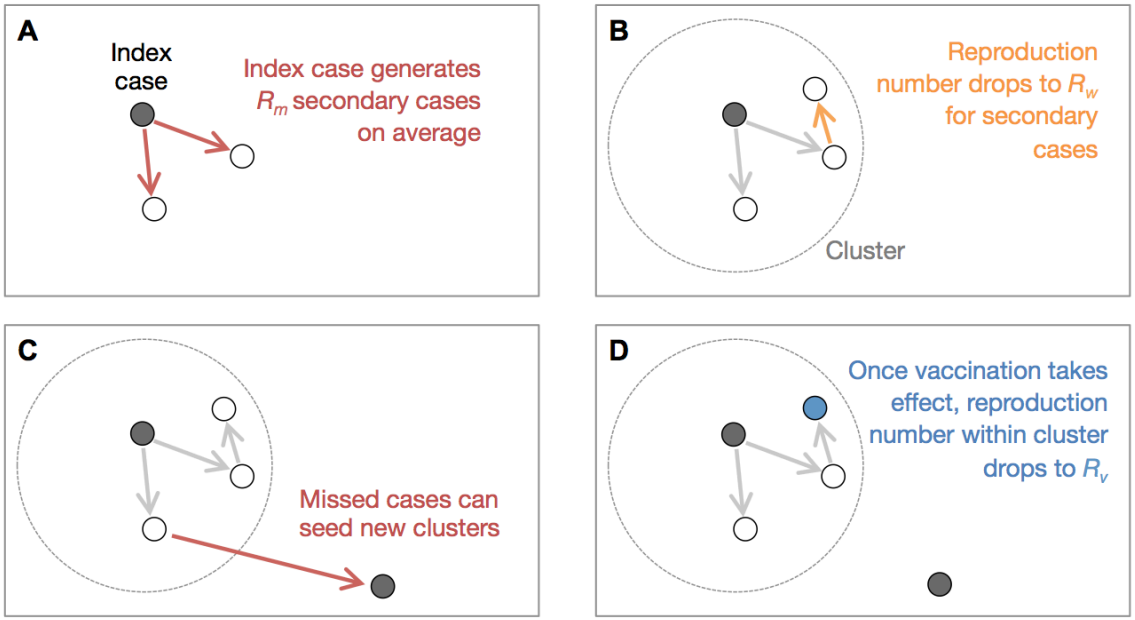
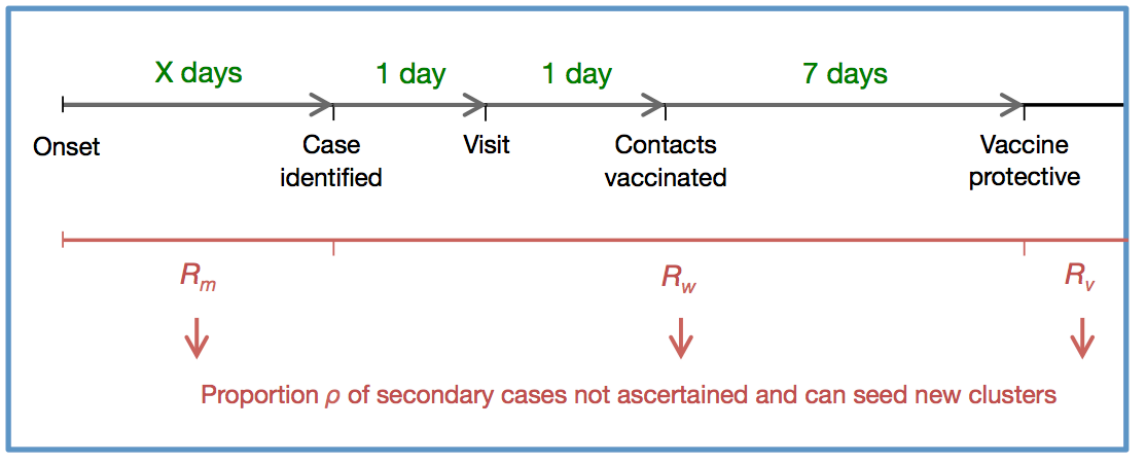
Ring vaccination



Transmission model

Vaccination delays



80% efficacy and 70% vaccinated means:
$R_v = (1\text{-}0.7*0.8)R_w = 0.44R_w$

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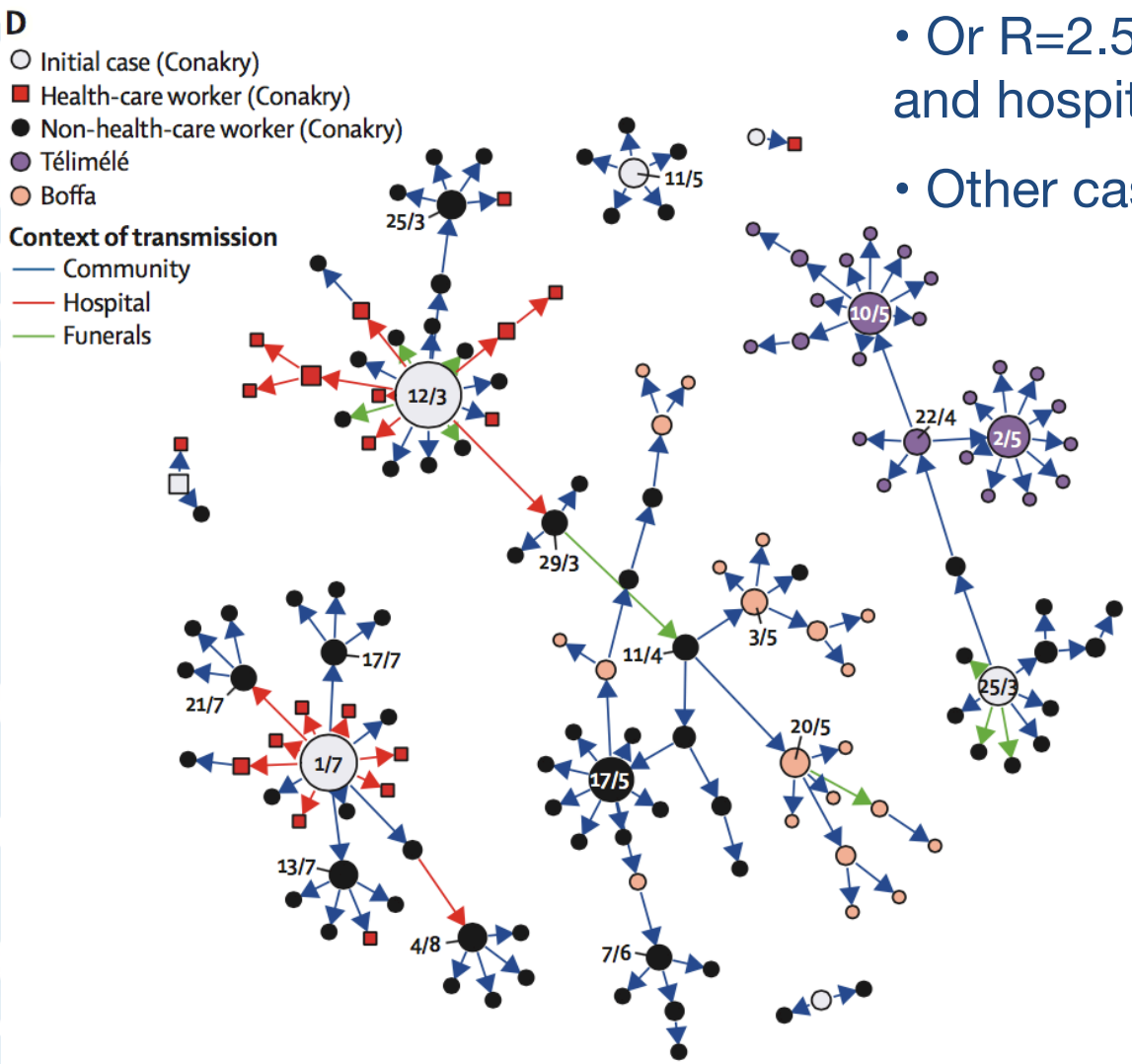
- Initial (i.e. missed) cases have R=7
- Or R=2.5 if individuals with funeral and hospital transmission omitted
- Other cases have R=0.66



Faye et al (2015) *The Lancet Infectious Diseases*

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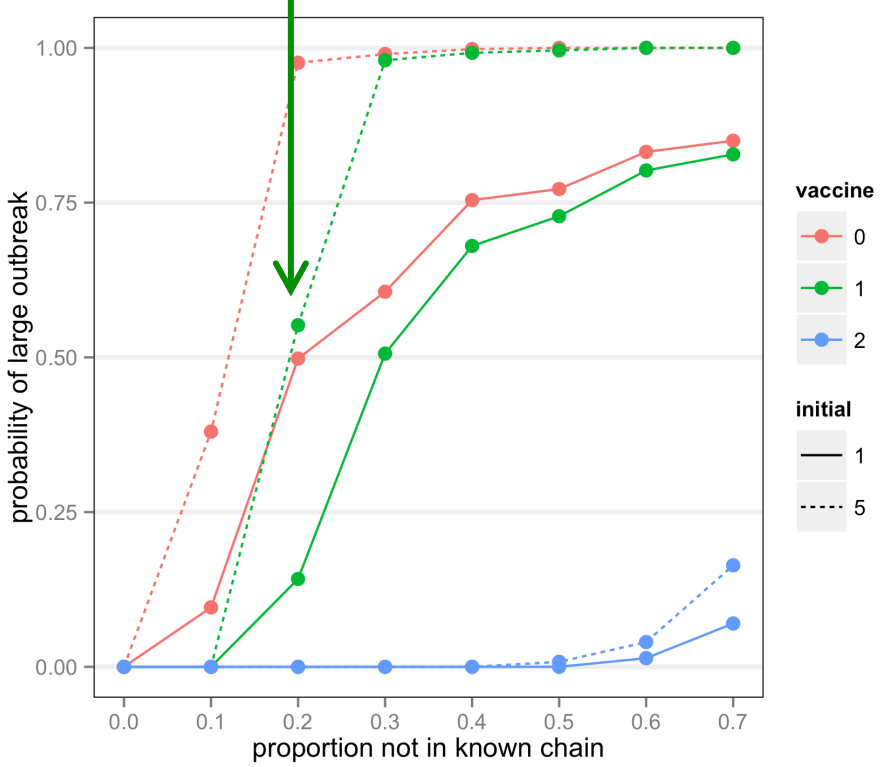
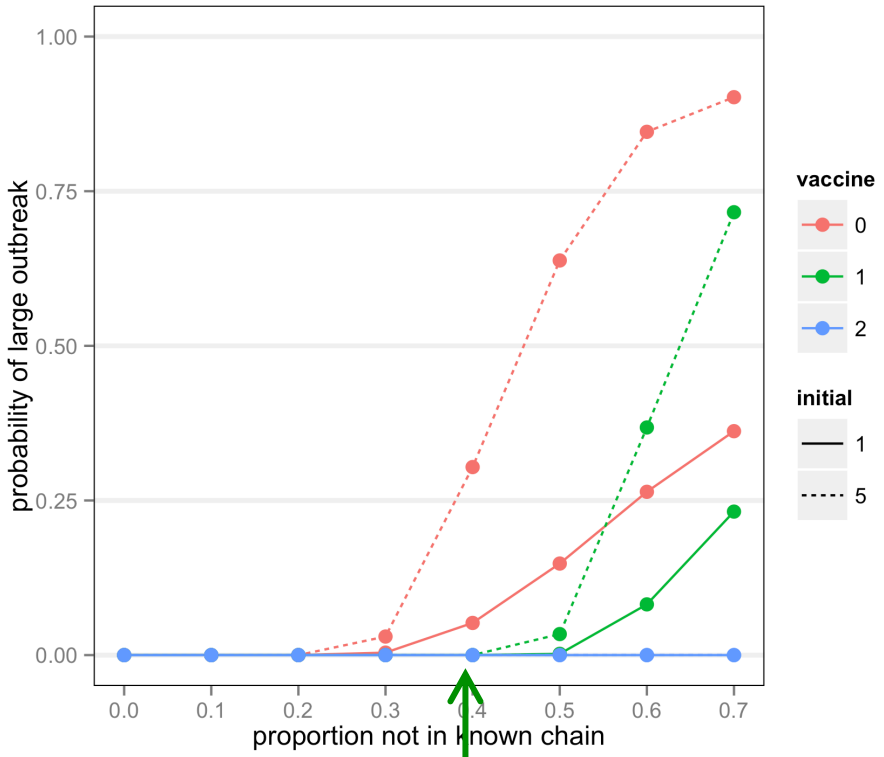
If missed cases associated with superspreading, ring vaccination might fail to stop large outbreak (i.e. >500 clusters) even if small proportion of cases missed

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





If no funeral or hospital superspreading events, ring vaccination can prevent large outbreaks even if ~40-50% cases missed

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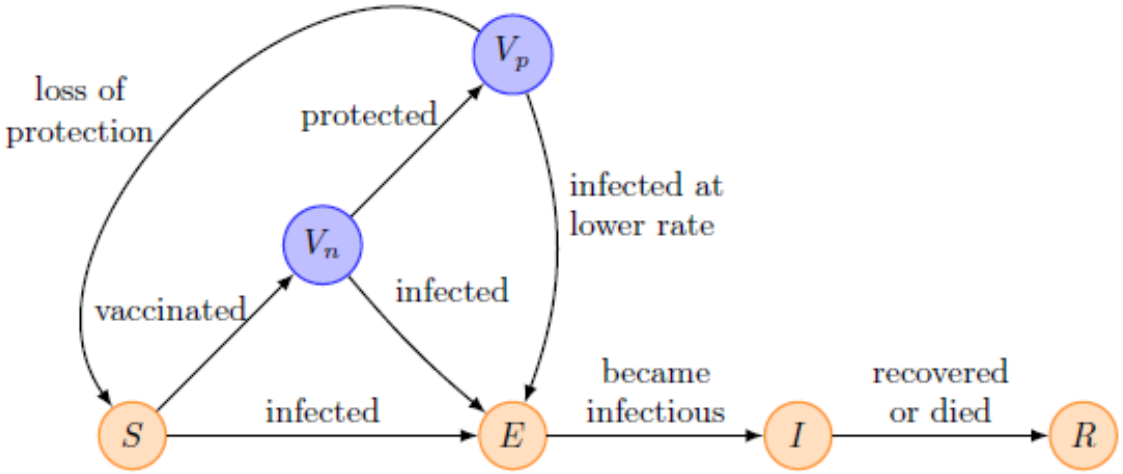
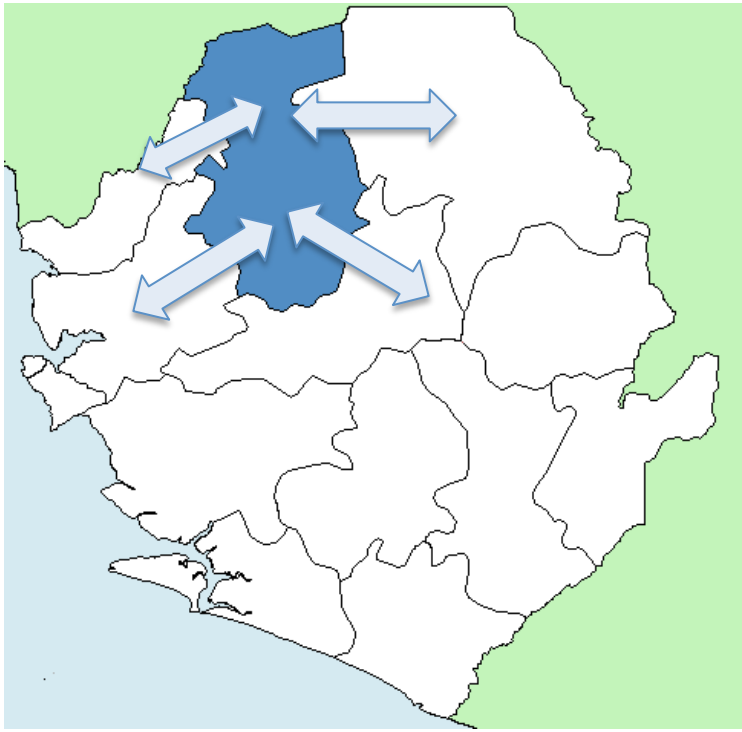
Model for mass vaccination





- 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

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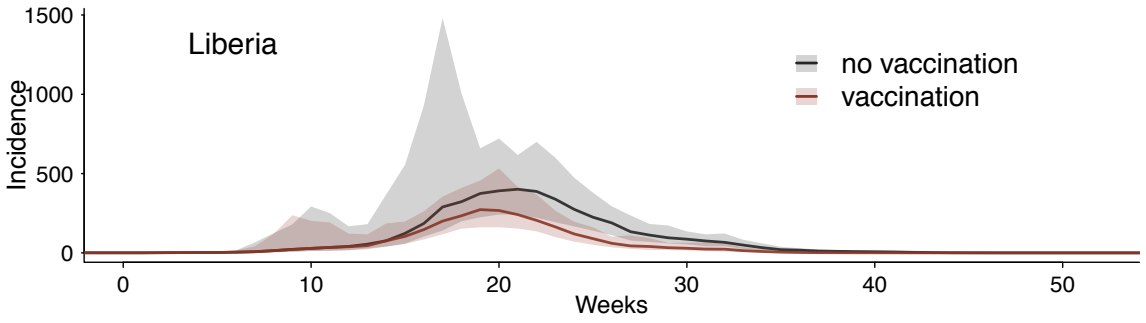
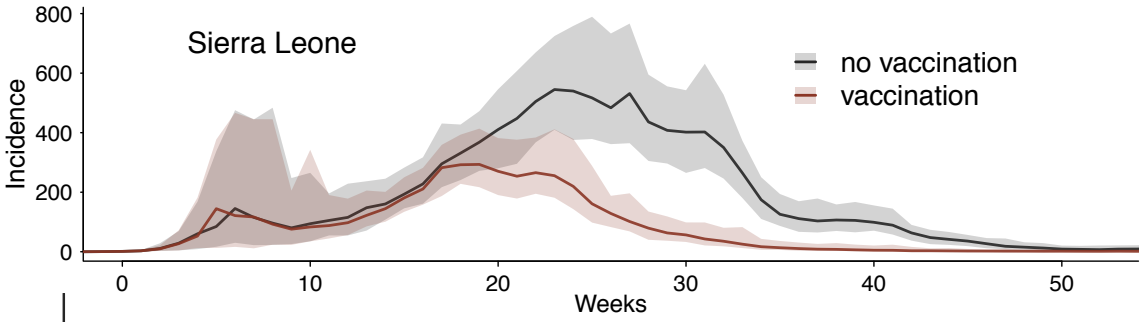
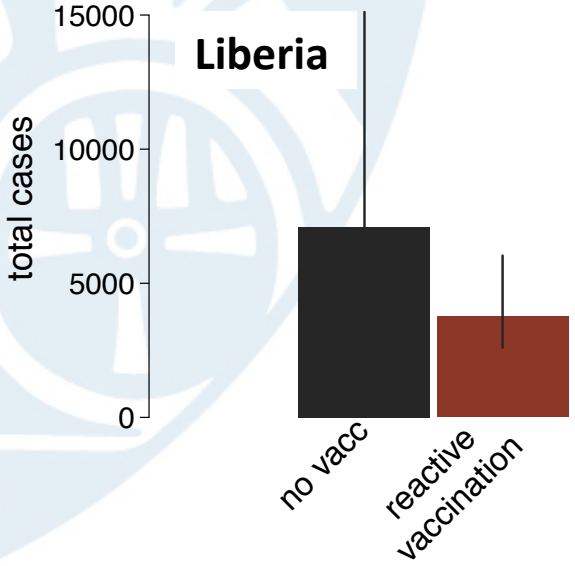
Base case results

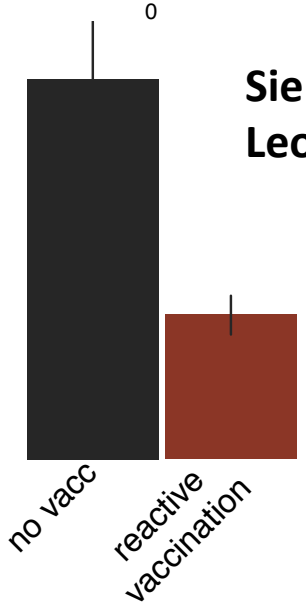
Vaccination (base case)

- 80% efficacy
- Trigger: 10 cases per region
- 2 week delay to start
- 100,000 doses per region per week
- 70% coverage









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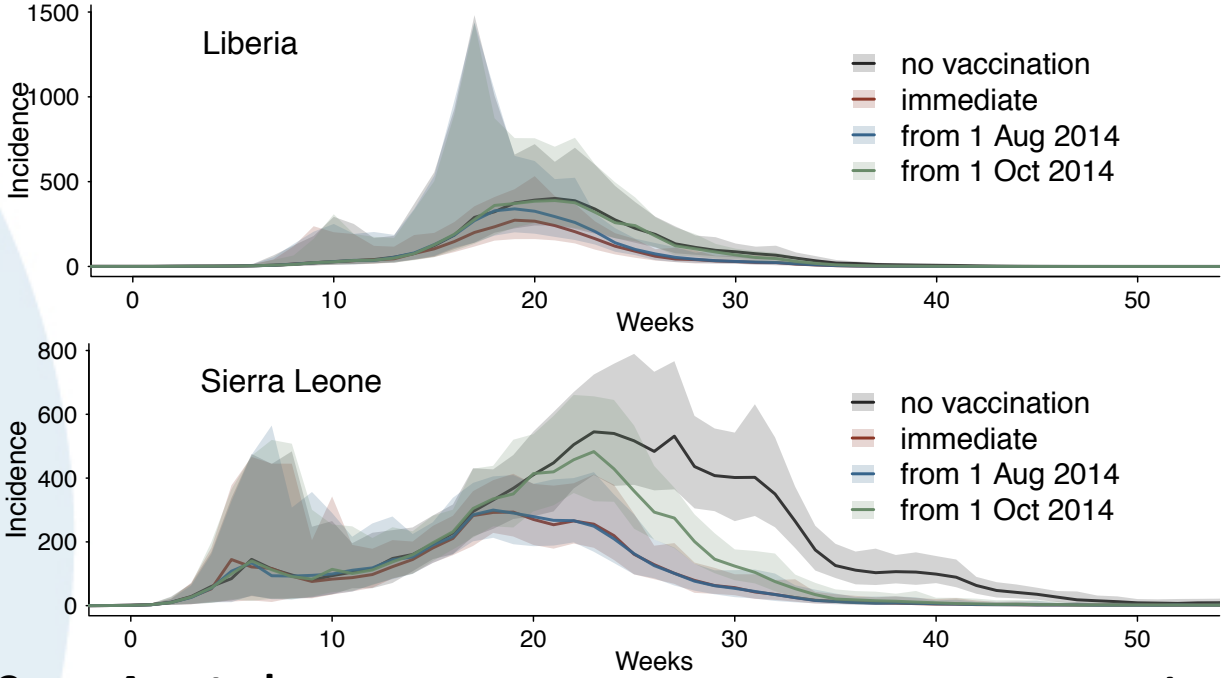
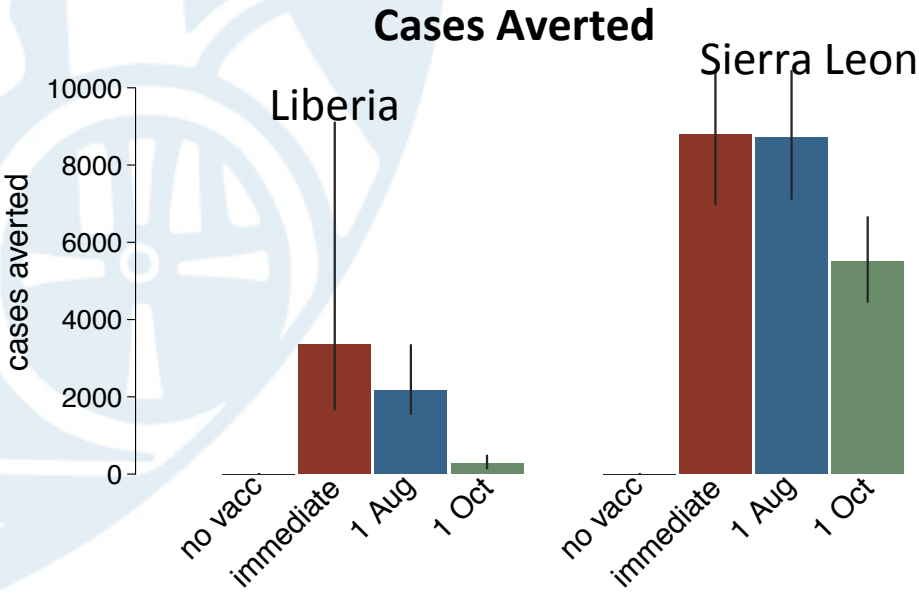
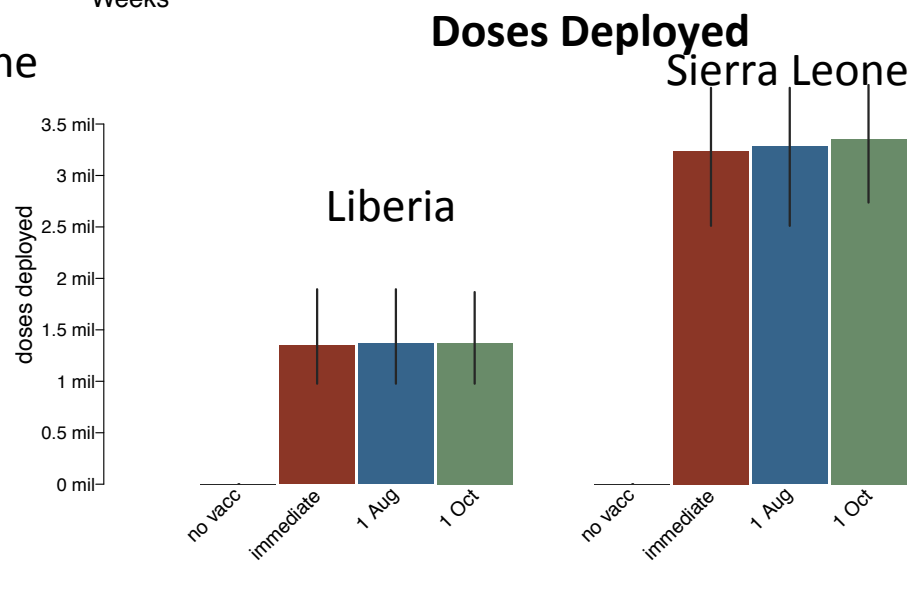
Delay in vaccine availability







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?

Location	Population size		Confirmed & probable cases	
	Community	HCW	Community	HCW
Kikwit (1995)	200,000	900	241	76
Liberia (2014)	4.3 m	11.7 k	5 k	378
Sierra Leone (2014)	6.3 m	6.2 k	9 k	307
Guinea (2014)	10.5 m	1.7 k	3.7 k	195

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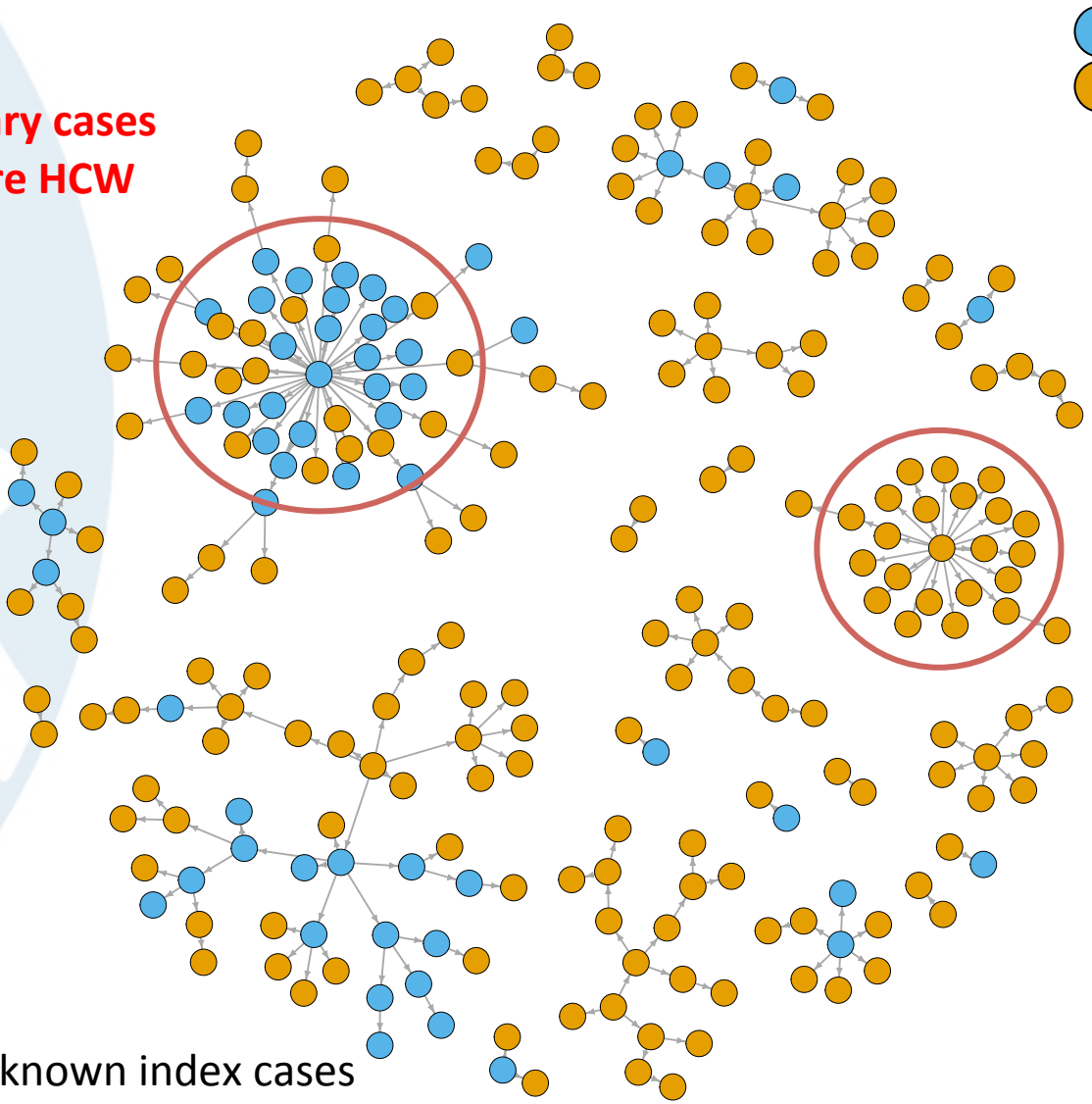
Transmission tree (Kikwit)



262/316 (83%) known index cases

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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

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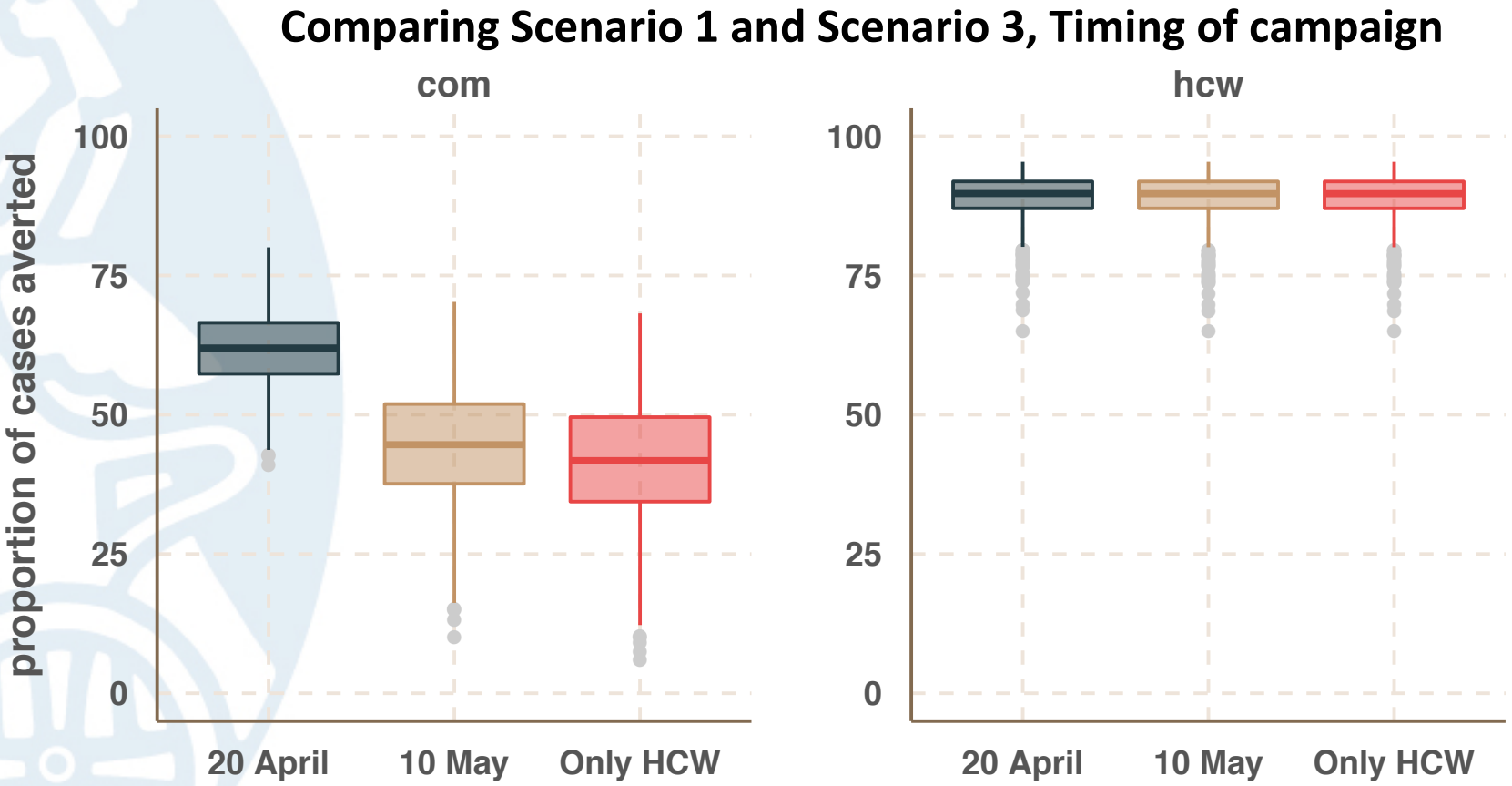
Proportion of cases averted



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
    - Limit spillover to the community

General approach

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Acknowledgements & further details

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

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