Impact of mass vaccination campaigns on measles transmission during an outbreak in Guinea, 2017

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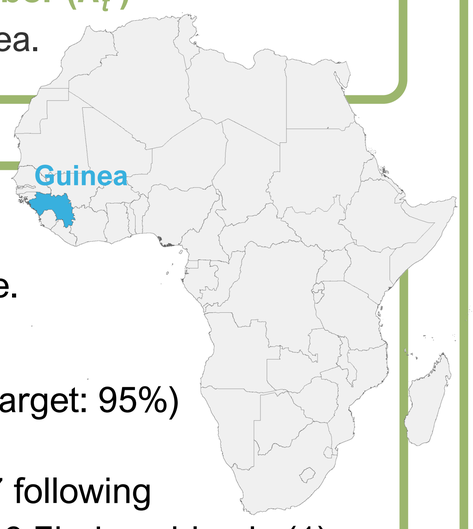
Objective

Evaluate the effectiveness of **outbreak response vaccination (ORV)** campaigns and the **effective reproduction number (R_t)** of measles during a nationwide outbreak in Guinea.



Background

The **measles virus** is spread through droplets (e.g., via coughing) but can also become airborne.

Measles is a **vaccine-preventable** disease.
2016 vaccination coverage in Guinea: **48%** (target: 95%)

A nationwide outbreak began early January 2017 following **disruptions to vaccination** during the 2014–2016 Ebola epidemic (1). **ORV** campaigns were implemented to reduce transmission, morbidity, and mortality (2):

Guinea measles ORV campaigns in 2017

Campaign	Campaign dates	# of health districts	Target age (months)	Number vaccinated
1	Mar 13–19	1	6–119	148,344
2	Apr 9–17	5	6–119	662,733
3	Apr 25–May 1	22	6–59	1,315,918

If R_t—the average number of secondary cases produced by an infectious individual within a partially immune population—is <1, incidence is reduced and outbreaks taper off.

Methods

We **estimated R_t for all measles cases** with illness onset in calendar year 2017 using a piecewise constant model for R_t where

$$R_t = \begin{cases} R_1, & \text{for } t < t_0 \\ R_2, & \text{for } t_0 \le t < t_1 \\ R_3, & \text{for } t_1 \le t < t_2 \\ R_4, & otherwise \end{cases}$$

…and the renewal equation

$$E(i_t) = R_t \sum_{i=1}^{t-i} i_{t-s} g_s$$

$E(i_t)$ = estimated incidence at time *t*
R_t = reproduction number at time *t*
i_{t-s} = incident cases at time *t*
g_s = probability mass function of the measles virus generation time using a gamma distribution

…and minimized the negative log likelihood.

- Akaike information criterion (AIC) values and visual model fit were used to select the final model.

Outbreak growth rate by time period was calculated from $E(C(t)) = ae^{rt}$

Results

5,932 measles cases

- Median age: 2 years (96% < 15 years)
- Case-fatality rate: 0.5%
- Unvaccinated: 74.7%

Table 1. Effective reproduction number based on ORV timing

	Effective reproduction number (95% CI)				
Timing	Before ORV	Campaign 1	Campaign 2	Campaign 3	AIC
Start of campaign	1.60 (1.55–1.67)	0.76 (0.74–0.79)	----------	----------	2564
	1.60 (1.55–1.67)	0.75 (0.71–0.79)	----------	0.77 (0.73–0.80)	2566
	1.60 (1.55–1.67)	0.75 (0.71–0.79)	0.91 (0.84–0.98)	0.71 (0.68–0.75)	2545
End of buffer periods	1.23 (1.19–1.27)	0.79 (0.76–0.82)	----------	----------	3060
	1.23 (1.19–1.27)	0.89 (0.84–0.94)	----------	0.71 (0.68–0.75)	3031
	1.23 (1.19–1.27)	0.89 (0.84–0.94)	0.69 (0.63–0.76)	0.72 (0.68–0.77)	3033

Figure 1. Measles outbreak cases and effective reproduction number

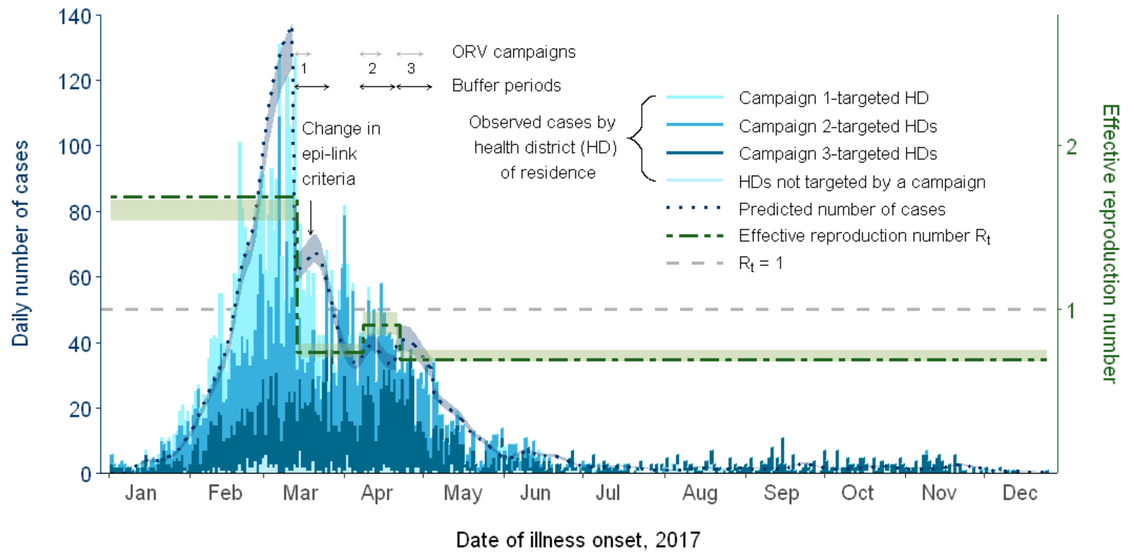


Table 2. Growth rate of the outbreak by ORV timing and area

		ORV campaign targeted area		
Parameter	Nationwide (95% CI)	Campaign 1 (95% CI)	Campaign 2 (95% CI)	Campaign 3 (95% CI)
a	8.96 (7.40, 10.70)	2.37 (1.84, 2.98)	3.86 (2.73, 5.21)	2.62 (1.94, 3.42)
r1	0.03 (0.03, 0.04)	0.04 (0.04, 0.05)	0.03 (0.03, 0.04)	0.03 (0.03, 0.04)
r2	-0.04 (-0.05, -0.04)	-0.14 (-0.17, -0.12)	-0.02 (-0.03, -0.01)	-0.01 (-0.02, -0.01)
r3	0.02 (-0.004, 0.03)	-0.10 (-0.54, 0.34)	-0.02 (-0.05, 0.002)	0.03 (0.02, 0.05)
r4	-0.05 (-0.06, 0.03)	-0.03 (-0.37, 0.31)	-0.04 (-0.06, -0.03)	-0.05 (-0.06, -0.05)

Discussion

- Transmission was largely driven by children born during and following the 2014–2016 Ebola epidemic, as previously predicted (3).
- Reduction in R_t and *r* from the third to fourth time periods may indicate that having campaigns in more than one area was critical to maintaining control of the outbreak.

Conclusions

- R_t was reduced to and maintained < 1 following the ORV campaigns.
- Calculation of R_t from case count data using basic modeling methods can help policymakers and those on the ground objectively understand outbreak situations and evaluate control measures nearly in real time.

Acknowledgements and references

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