Optimal timing regularly outperforms higher coverage in prophylactic measles SIAs

Katherine Rosenfeld*, Kurt Frey, Niket Thakkar, and Kevin McCarthy
Institute for Disease Modeling (IDM)
IDM Symposium

*Katherine.Rosenfeld@gatesfoundation.org
Effectiveness of measles SIAs is a delicate balance of timing and efficacy

Delays to SIA campaigns can incur serious measles outbreaks. In the past 10 years there have been at least 6 examples of AFR outbreaks occurring during this “inter-SIA” period due to delays.

How can we quantify the relative gains of a less effective SIA implemented “on-time”?
SIA cadence and coverage expectations

Previous modeling suggests high coverage SIAs (90%) are necessary for countries to delay the next outbreak by at least 3 years.

Adapted from Verguet et al. (2015)
Stochastic simulations exhibit a diversity of outbreak behaviors

Seasonality and births introduce periodic outbreak behavior, **but without SIAs** the periodicity is difficult to predict.

### Baseline EMOD Simulation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Size</td>
<td>1 million*</td>
</tr>
<tr>
<td>Age pyramid</td>
<td>Nigeria</td>
</tr>
<tr>
<td>Maternal immunity</td>
<td>Yes</td>
</tr>
<tr>
<td>Importation</td>
<td>Yes*</td>
</tr>
<tr>
<td>Birth rate</td>
<td>25 – 40 / 1k pop</td>
</tr>
<tr>
<td>Seasonality factor</td>
<td>0 – 0.5</td>
</tr>
<tr>
<td>Routine immunization</td>
<td>30%, 70%</td>
</tr>
</tbody>
</table>

*considered in sensitivity analysis
Planned SIAs stabilize periodicity

Iterative SIA schedule generator

- **Fixed set of simulation trajectories (BR, seasonality, importation, RI)**
- **Identify last outbreak**
- **Plan 90% SIA**
- **4 mo. prior**
- **Re-run sims**
- **Reduce coverage of last SIA**

---

*SIAs doses go first to children who received a dose from RI*

Identification of upcoming outbreak and retroactively plan SIA

SIA conducted, identify next outbreak and plan SIA
Delay results for fixed SIA coverage

- Outbreak sizes are large with short (6 month) delays, between 1 to 4% depending on RI
- Delays also decrease a campaign’s cost-benefit ratio, reducing the number of infections averted per dose
Well-timed, lower coverage SIAs can outperform delayed, high coverage campaigns

- For low RI (30%) context:
  - Immediate 50% SIA has **fewer infections** than 90% SIA delayed by 6 months
  - Immediate 50% SIA has less severe outbreak peak than 90% SIA delayed by 6 months

- For high RI (70%) context:
  - Requires timely and higher SIA coverage for impact
Dose association impacts how effectiveness of lower coverage, timely SIAs

1 year infection outcomes for 50% SIA compared to delayed 90% SIA

All children equally likely

RI children immunized first

Better than 90% SIA delayed by 6 months

Worse than 90% SIA delayed by 6 months
Effect of SIA campaign coverage on timing for the next

- Higher quality SIAs provide more time (honeymoon period) until next outbreak
  - High quality SIAs provide more consistent effect to delay outbreak
- Weak dependence on birth rate and seasonality
Summary

• Large outbreaks have been observed in between SIAs for multiple countries and regions

• Using coverage as the primary metric of SIA performance can incentivize delays in execution, potentially resulting in less impactful/effective campaigns

• Reduced quality campaigns can still impact outbreak size and severity

• Trade-off between an SIA’s near and long-term effects for disease control

• Campaign quality and local factors should be a consideration for planning the following SIA