The Role of Supplementary Immunization Activity Scheduling on Measles Incidence in Nigeria

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Measles 2
Overview

• Introduction to Measles Burden in Nigeria

• Results from Spatially Homogeneous Simulations of Nigeria
  – Incidence, age-at-infection; inputs to EMOD simulation software

• Differences in Pre- and Post- Supplementary Immunization Eras
  – SIAs have created a regularity in measles incidence

• Consequences of SIA Scheduling
  – Opportunities for burden reduction through timing interventions
Measles in Nigeria
2007-2016

Major groupings indicate DHS regions with reported measles incidence per total population.

Total Reported Cases:
Northwest: 55%
Northeast: 25%
Elsewhere: 20%

Estimated 2015 Population:
Northwest: 25% (48M)
Northeast: 14% (26M)
Elsewhere: 61% (115M)
Spatially Homogeneous Simulations
Calculated and Observed Incidence

Case-based incidence reports of measles have been used to estimate measles infectivity-related descriptors in IDM’s Epidemiological Modeling software (EMOD).
EMOD Specifications

Simulations were focused entirely on the under-five cohort; this cohort encompasses 17% of the total population, and 80% of the total measles burden.

This iteration of the model represents the entire country as a single, well-mixed population, using overall averages for demographic parameters.

- Raw birthrate of 40/1000; seasonal birthrate forcing of around 30%
- Age dependent non-disease mortality (i.e., neo-natal, infant, etc.)

Disease descriptors:
- 10 ± 2 day incubation period
- 8 ± 2 day infectious period
- No disease-specific deaths

Maternal immunity:

<table>
<thead>
<tr>
<th>Age (Month)</th>
<th>0 - 3</th>
<th>5</th>
<th>7</th>
<th>9</th>
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</thead>
<tbody>
<tr>
<td>100%</td>
<td>51%</td>
<td>26%</td>
<td>13%</td>
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Vaccination immunity results from a 40% rate of routine immunization, and SIA campaign schedules / coverages as reported by the WHO for the period 2005 – 2015.
Regular follow-up campaigns of supplementary immunizations have created a corresponding regularity to the intensity of measles outbreaks in Nigeria.

Outbreaks in the current era can either be self-limited (from a depletion of susceptibles), or seasonally-limited (from an annual decrease in infectivity).

Note:
Infectivity = Disease * Mixing
Scheduling SIAs

Heuristics suggest scheduling interventions several months prior to peak infectivity.

Logistic challenges sometimes result in delays (e.g., 2010 and 2015).
Scheduling SIAs

With a 2-year time window, targeting an SIA for October or November provides the greatest burden reduction.
Next Steps

• Evaluate the time horizon needed to establish an equilibrium for biennial SIAs

• Explore the trade-offs involved with annual SIAs
  – Contrast with expanded age-range SIAs

• Improve spatial resolution
  – Examine subnational regions of Nigeria independently
  – Investigate heterogeneous SIA scheduling
Questions
Figure
Figure

Bimonthly Reported Measles Incidence in Nigeria

Observed
Simulations
Figure

**Age-at-Infection (<5yr Cohort)**

- **Mean Value**
  - Simulations: 1.8
  - Observed: 2.0

**Age (yr)** 0 1 2 3 4 5

**Fraction**

0.0 0.1 0.2 0.3 0.4
Figure
Figure

![Graph showing observed and reported monthly incidence from 2009 to 2014 with peaks in 2011 and 2013 marked as National SIA.](image-url)
Figure

National SIA Implementation

2010 2011 2012

Feb  Jan  Dec  Nov  Oct  Sept

Base Case
Figure