Modelling the impact of a rectal microbicide

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Gender Violence & Health
What is modelling?

- Mathematical modelling is a tool that enables us to simplify reality and make predictions
- Build up a simplified system – making assumptions
- Parameterise and ‘fit’ model to the data available from a specific setting
- Use the fitted model to make predictions
Modelling & Health Policy

Modelling can be used to inform health policy and to support advocacy efforts by:

- Projecting the HIV epidemic in different settings and among different population groups
- Helping to interpret trends in HIV epidemic over time
- Exploring the importance of different STIs in enhancing the HIV epidemic
- Estimating the potential impact (and determinants) of different prevention / targeting strategies
- Highlighting gaps in data / research
Modelling microbicides can give insights into a range of issues:

- Potential impact of widespread distribution
- Possible advantages of targeted distribution
- Estimates of individual benefit
- Relative importance of difference product attributes
- Relative merits of alternative intervention strategies
- Possible effect of ‘condom migration’
- Estimated cost-effectiveness

To date, focus of modelling been on vaginal microbicides or rectal microbicides used by gay men in US
### Potential public health impact of vaginal microbicide

<table>
<thead>
<tr>
<th>Region</th>
<th>Cumulative HIV infections averted 3 years (millions)</th>
<th>Present value of direct cost savings to health system (billions)</th>
<th>Present value of productivity gains (billions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Asia and Pacific</td>
<td>0.79</td>
<td>1.30</td>
<td>0.43</td>
</tr>
<tr>
<td>Eastern Europe and Central Asia</td>
<td>0.13</td>
<td>0.20</td>
<td>0.04</td>
</tr>
<tr>
<td>Latin America and the Caribbean</td>
<td>0.05</td>
<td>0.06</td>
<td>0.03</td>
</tr>
<tr>
<td>South Asia</td>
<td>0.89</td>
<td>0.65</td>
<td>0.17</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>0.68</td>
<td>0.48</td>
<td>0.36</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2.54</strong></td>
<td><strong>2.69</strong></td>
<td><strong>1.04</strong></td>
</tr>
</tbody>
</table>

Background to amfAR project

• Supported by these earlier estimates of the public health impact of vaginal microbicides, subsequent advocacy efforts have resulted in vaginal microbicide spending more than doubling since 2002

• Such information on the potential impact of rectal microbicides could similarly boost advocacy efforts and lead to an increase in funding for rectal microbicide research
Aim of project

Use detailed biological and behavioural data from MSM in Bangalore, India and Lima, Peru to model impact of rectal microbicide.
Specific objectives

1. Project HIV epidemic trends among MSM in Bangalore & Lima
2. Explore influence of MSM on broader epidemics in these settings
3. Estimate impact on HIV epidemic among MSM of rectal microbicide use by MSM for different scenarios of efficacy, coverage and patterns of use
4. Investigate impact of rectal microbicide use by MSM on HIV epidemic among female partners of MSM
5. Explore effect of possible declines in condom use after introduction of rectal microbicide
Steps in analysis

• Build model structure and programme model code
• Estimate biological parameters such as transmission probabilities and condom efficacy from literature
• Analyse behavioural data from setting to develop values for behavioural parameters
• Model validation
• Fit the model to known prevalences of HIV and other STIs
• Conduct uncertainty analysis
• Project HIV epidemic among MSM in both settings
• Estimate impact of rectal microbicide use by MSM in both settings
Importance of identity grouping

Different identity groups may:

1. Differ in their contribution to the HIV epidemic
2. Respond differently to intervention – access and use
3. If targeted with intervention, this may have disproportionate effects on reducing HIV prevalence
Features of the model

- **Identity grouping**: population divided into role-based groups (insertive, receptive, versatile) → incorporate epidemiological and behavioural differences between groups e.g. attitude to condom or microbicides

- **Sexual mixing matrix**: model accounts for preferences in partner-seeking behaviour

- **Infection stages**: model accounts for different transmission probabilities at different stages of HIV infection

- **Other STIs**: need to incorporate the effect of having one or more other STIs e.g. HSV-2, syphilis or chlamydia on the likelihood of acquiring HIV
Identity groups in model

**Bangalore**
- Panthi
- Bisexual
- Double Decker

**Lima**
- Activo
- Pasivo
- Moderno

Key:
- ■: predominantly insertive
- ●: predominantly receptive
- ▲: versatile
Parameters & fitting

• Bangalore model parameterised and fitted to data gathered in monitoring and evaluation of Avahan, the India AIDS initiative, funded by Bill & Melinda Gates Foundation

• Data collected for the study of HSV-2 treatment on HIV acquisition in HPTN 039 will be used to form the basis of modelling efforts in Lima, along with additional data from HPTN 036, a preparatory study assessing HIV incidence and prevalence and HSV-2 prevalence in Lima.
Bangalore data by identity group

<table>
<thead>
<tr>
<th></th>
<th>Panthi / Bisexual</th>
<th>Kothi / Hijra</th>
<th>Double Decker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total MSM population</td>
<td>22%</td>
<td>51%</td>
<td>27%</td>
</tr>
<tr>
<td>Average no. of partners per month</td>
<td>9</td>
<td>57</td>
<td>19</td>
</tr>
<tr>
<td>Proportion of insertive acts</td>
<td>73%</td>
<td>8%</td>
<td>12%</td>
</tr>
<tr>
<td>Proportion of sex acts protected by condom before intervention</td>
<td>59%</td>
<td>76%</td>
<td>65%</td>
</tr>
</tbody>
</table>

The Bangalore data were collected as part of the monitoring and evaluation of Avahan, the multisite HIV prevention intervention funded by the Bill & Melinda Gates Foundation.
Initial model explorations

Model validation

- No epidemic if transmission probability set to zero or if no infection seeded into population
- Stable population size if no AIDS mortality
- Epidemic curve shape as expected
- HIV/STI interactions in expected directions
- Intervention effects reduce epidemic
  - Check with condom intervention first before build in microbicide use
Preliminary findings: hypothetical strengthened condom intervention in Bangalore
Overall prevalence of HIV following a universal condom intervention

A 5% increase is an absolute increase protecting an additional 5% of sex acts with a condom for every MSM
% cases averted among all MSM: reaching all MSM or all identity group

% cases averted in a 5yr intervention period
% cases averted among all MSM: weighted by size of identity group

% cases averted in a 5yr intervention period

% cases averted among all MSM per 100 weighted by size of identity group

% cases averted in a 5yr intervention period

% increase

5% increase 10% increase

Universal
PB targeted
KH targeted
DD targeted
Trade-offs between size of group and risk behaviour

- Reaching a Double Decker in a targeted 10% condom use increase intervention will avert 1.3 times as many HIV infections as reaching a Kothi or Hijra.

- However, in our survey population, there were twice as many Kothi & Hijra as Double Deckers, so a Kothi/Hijra-targeted intervention may actually have more impact.
Limitations

- **Fluidity of identity groupings**: helpful to categorise into insertive, receptive & versatile but limiting. Many MSM change role behaviour over time & in different situations

- **‘Hidden’ MSM**: data used for parameterisation & fitting limited by sampling methods - biased towards ‘high-risk’ MSM and possibly away from ‘hidden’ MSM

- **Sexual mixing**: lack of data on sexual mixing between identity groups – who has sex with who
Next steps

- Identify more model fits to evaluate the uncertainty in the projections
- Incorporate rectal microbicide parameters into model - efficacy, coverage and patterns of use
- Analyse data from Peru
- Parameterise and fit the model to data from Peru
- Expand the model to consider female partners of MSM in both settings
- Model projections of potential rectal microbicide impact in both settings for different scenarios
Importance of the project

Findings will establish the:

• Likely impact of a rectal microbicide in the reduction of HIV transmission among MSM and to their female partners in India and Peru

• Relative impact associated with different microbicide efficacies, coverage and patterns of use

• Effect on potential microbicide impact if reduction in condom use occurs after introduction of microbicide

It is hoped that these findings will lend weight to the advocacy efforts of IRMA and others
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