Defining Coverage: The Importance of Context

Sevgi O. Aral
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Early Start of ART Reduces Risk of HIV Transmission To Partner

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Initiation of Antiretroviral Treatment Protects Uninfected Sexual Partners from HIV Infection (HPTN Study 052)

Study: Early HIV treatment preserves health

Global Health Policy

Prevent new infections,

Early H.I.V. Therapy Sharply Curbs Transmission
Antiretroviral Drugs in the Cupboard are Not Enough: The Impact of Health Systems’ Performance on Mother-to-Child Transmission of HIV

Pierre M. Barker, MBChB, MD, *† Wendy Mphatswe, MBChB, MPH, † and Nigel Rollins, MB, MD‡§
Use Topical/Oral PrEP 50%

Coverage of Topical/Oral PrEP 50%

Product 50% effective

Product 80% effective

100 Women Exposed to HIV (10% transmission risk)

50 have coverage

25 use

1.3 infections

0.5 infections

50 have no coverage

75 do not use

7.5 infections

7.5 infections

TOTAL

No Product – 10 infections

If 50% – 9 infections

If 80% – 8 infections

Slide provided by Ward Cates
The Topical/Oral PrEP Cascade – 95% Coverage/Adherence

100 Women Exposed to HIV (10% transmission risk)

Coverage of Topical/Oral PrEP 95%

Use Topical/Oral PrEP 95%

Product 50% effective

Product 80% effective

95 have coverage

5 have no coverage

90 use

10 do not use

4.5 infections

1 infection

1.8 infections

1 infection

TOTAL

No Product – 10 infections

If 50% – 6 infections

If 80% – 3 infections

Slide provided by Ward Cates
The Topical/Oral PrEP Cascade – Conclusions

- Public health impact is more affected by adherence and coverage than by increased topical/oral PrEP product effectiveness
- Behavioral and health services delivery factors crucial to product impact
- Evidence is needed NOW to improve coverage when product proven effective
Thus,

Coverage more important for population level impact than efficacy (of intervention)

What does coverage mean?
Today’s Outline

- Need for targeting / prioritization
- Benefits of prioritization / targeting
- Resource allocation models
- Context – specific targeting
  - Concentration
  - Variability (within group)
- Network – based targeting
• All populations are “structured”
  — comprising subpopulations
• There are subgroup differentials in prevalence and incidence of infection
Expand coverage to include:

- All persons
- Persons in certain age groups
- Sexually experienced persons
- Sexually active persons
- Sexually highly active persons
- Persons of particular sexual orientation
- Persons who live in certain geographic areas
- Persons in certain occupations

?
• Prevention identifying populations to cover; problematic

• Treatment cover the infected

limited $$ who to focus on?
limited time where to begin?
Expand coverage realizing that:

- epidemic evolution is non-linear
- intervention effectiveness is non-linear
  \( \uparrow \text{investment} \rightarrow \uparrow \# \text{reached} \rightarrow \text{those remaining harder to reach; harder to change} \)
- interventions in combination may avert fewer infections than single interventions implemented alone
  \( \bullet \bullet \text{same infection cannot be averted twice} \)
Prioritization of subpopulations – irrespective of approach - helps to:

- ↑ impact
- ↑ cost-effectiveness
- ↓ cost

Prioritization more effective:

- in concentrated epidemics
- when coverage is low

Prioritization improves impact in hyperendemic epidemics but not substantially
Prioritization suggested in the literature for a long time

• for maximum impact, programmes must be designed based on local conditions (composition of target groups)

• most effective strategies must target the main transmission groups for greatest impact

• target groups vary by setting and phase of the HIV epidemic

• at higher adult prevalence rates, the proportion of cases among SWs ↓; proportion among pregnant women ↑; STD clinic attendees ↑; youth ↑

<table>
<thead>
<tr>
<th>Linear models</th>
<th>Description</th>
<th>Objective</th>
<th>Intervention(s) Considered</th>
<th>Production Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaplan and others&lt;sup&gt;33&lt;/sup&gt;</td>
<td>A simple model with linear HIV epidemic growth</td>
<td>Maximize infections averted to a fixed budget</td>
<td>Prevention programs targeted to independent high-risk populations</td>
<td>Linear</td>
</tr>
<tr>
<td>Kaplan&lt;sup&gt;34&lt;/sup&gt;</td>
<td>A simple model with linear HIV epidemic growth that incorporates general production functions</td>
<td>Maximize infections averted subject to a fixed budget</td>
<td>Prevention programs targeted to independent high-risk populations</td>
<td>General</td>
</tr>
<tr>
<td>Dynamic models</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Kahn&lt;sup&gt;35&lt;/sup&gt;</td>
<td>A dynamic model of HIV in multiple independent populations</td>
<td>Evaluate infections averted for different allocations of a fixed budget</td>
<td>Prevention programs targeted to independent high-, medium-, or low-risk populations, early or late in an epidemic</td>
<td>Linear</td>
</tr>
<tr>
<td>Paal&lt;sup&gt;39&lt;/sup&gt;</td>
<td>A dynamic model of HIV in a single population</td>
<td>Evaluate cost per QALY saved</td>
<td>Prevention programs targeted to infected or susceptible individuals in a single population, or general prevention programs, early or late in an epidemic</td>
<td>Linear</td>
</tr>
<tr>
<td>Richter and others&lt;sup&gt;42&lt;/sup&gt;</td>
<td>A dynamic model of HIV in 2 independent populations</td>
<td>Maximize infections averted subject to a fixed budget</td>
<td>Prevention programs targeted to independent populations, 1 low risk and 1 high risk</td>
<td>General</td>
</tr>
<tr>
<td>Zaric and Brandeau&lt;sup&gt;44&lt;/sup&gt;</td>
<td>A theoretical model with dynamic epidemic growth that allows for multiple interacting subpopulations and general types of interventions</td>
<td>Maximize infections averted or QALYs gained subject to a fixed budget</td>
<td>General interventions that can change any epidemic parameters</td>
<td>General</td>
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<tr>
<td>Simulation models</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Bernstein and others&lt;sup&gt;46&lt;/sup&gt;</td>
<td>A simulation model of HIV in a severely affected east African city</td>
<td>Evaluate HIV prevalence and incidence</td>
<td>Prevention programs</td>
<td>Linear</td>
</tr>
<tr>
<td>Robinson and others&lt;sup&gt;48&lt;/sup&gt;</td>
<td>A simulation model of HIV and 2 other STDs in rural Uganda</td>
<td>Evaluate HIV infections averted, HIV prevalence, HIV incidence</td>
<td>Prevention programs</td>
<td>Linear</td>
</tr>
<tr>
<td>Hogan and others&lt;sup&gt;49&lt;/sup&gt;</td>
<td>A simulation model of HIV and other STDs in Sub-Saharan Africa and Southeast Asia</td>
<td>Evaluate effectiveness and cost-effectiveness (cost/DALY averted)</td>
<td>Prevention and treatment programs</td>
<td>Linear</td>
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</tbody>
</table>

Note: QALY = quality-adjusted life-year; STD = sexually transmitted disease; DALY = disability-adjusted life years.
1. Includes non-linearity of epidemic evolution and effects of interventions on drivers of the epidemic.

2. Considers how intervention effectiveness depends on target population and level of scale-up.

3. Captures benefit & cost differentials for combination interventions vs single interventions

4. Incorporates key constraints (social, political, etc.) which depend on context

5. Recommends optimal sets of “intervention – target group,” combinations based on context (typical resource allocations differ significantly from optimal ones).
Hypothetical STD / HIV prevention intervention
20% population coverage; 50% efficacy among those served

<table>
<thead>
<tr>
<th></th>
<th>Scenario 1:</th>
<th>Scenario 2:</th>
<th>Scenario 3:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group targeted</td>
<td>None</td>
<td>None</td>
<td>High risk group(s)</td>
</tr>
<tr>
<td></td>
<td>Receipt of intervention independent of STD risk</td>
<td>Low –risk people self-select intervention</td>
<td></td>
</tr>
<tr>
<td>Relative STD / HIV risk</td>
<td>1.0</td>
<td>0.1</td>
<td>2.5</td>
</tr>
<tr>
<td>Effective coverage</td>
<td>20%</td>
<td>2%</td>
<td>50%</td>
</tr>
<tr>
<td>(Percent of STDs accounted for by population served by intervention)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall STD / HIV reduction</td>
<td>10%</td>
<td>1%</td>
<td>25%</td>
</tr>
<tr>
<td>Impact on Disparities</td>
<td>None</td>
<td>↑ Disparities</td>
<td>↓ Disparities</td>
</tr>
</tbody>
</table>
Whether prevention efforts are organized around infections; behaviors; or determinants

- Uneven distribution in population
- Variability within the group being targeted
- One size does not fit all; each prevention context is unique

and – desired coverage needs to be defined based on context
Uneven distribution in population:

- Everything is unevenly distributed in populations
- Everything shows some degree of concentration
  
  Prevalent HIV
  Incident HIV
  Seroconversions
  # of partners
  # of sex acts

- Patterns of concentration vary by context
- Context is important in defining coverage
Paper # 137

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¹Africa Ctr for Hlth and Population Studies, Univ of KwaZulu-Natal, Durban, South Africa; ²Harvard Sch of Publ Hlth, Boston, MA, US; and ³Inst of Child Hlth, Univ Coll London, UK

**Conclusions:** Targeting efforts at settings where HIV transmission is most intense is crucial. Our study provides clear empirical evidence for the localized clustering of new HIV infections. The results show that even in a severely affected rural African community, interventions that specifically target, geographically defined, high-risk communities could be highly effective in reducing the overall rate of new infections.
HIV incidence across the study area with high-incidence clusters superimposed
Distribution of sero-conversions
...and it is not only infections that cluster geographically...

In the Bagalkot district of Karnataka in South India

15% of the villages accounted for 54% of all rural FSW

In the UK…Project SIGMA found “….Most individuals (60%) who engage in AI do so only once or twice a month, but there is a long tail of those who do it much more. In terms of the amount of AI acts, one-tenth of the individuals are performing half of the acts of AI. The Gini coefficient of concentration is high (0.55).”

Coxon PM and McManus TS. *The Journal of Sex Research* 2000
In the U.S.

20% of women account for 60% of vaginal sex acts in past 4 weeks

and

24% of men account for 61% of vaginal sex acts in past 4 weeks

Leichliter JS et al. Sex Transm Infect December 2010; 86(Suppl 3):
In the U.S.

20% of women account for 47% of opposite sex partners in past year

and

20% of men account for 57% of opposite sex partners in the past year

Leichliter JS et al. Sex Transm Infect December 2010; 86(Suppl 3)
In the U.S. (county level analysis)

20% of the population accounts for

- 39% of Chlamydia
- 52% of Gonorrhea
- 64% of Primary and Secondary Syphilis

and 43% of cumulative AIDS cases

Chesson HW et al. Sex Transm Infect December 2010; 86(Suppl 3)
Based on patterns of concentration prioritization of subpopulations could be by

- geography
- risk behavior
- vulnerable populations

None of these directly take into account the “population pattern of who contacts whom”
Annual percentage change in early syphilis rates in states that were and were not initially targeted for syphilis elimination

There is variability / diversity in subgroups

- **Diversity among adolescents:**
  
  “1/4 adolescents have an STD”

- **Diversity among MSM by:**
  
  — # of partners per year
  — # of sex acts per partnership
  — percent of sex acts protected by a condom
  — sexual positioning per sex act (insertive, receptive, versatile)

- **Diversity among SWs by:**
  
  — number of clients
  — type of clients
  — percent of sex acts protected by a condom
  — sexual practices (vaginal, oral, anal)
## Approaches to coverage

<table>
<thead>
<tr>
<th>Focus</th>
<th>Level</th>
<th>Prevention Strategy</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causes of cases</td>
<td>Individual</td>
<td>Population-at-risk</td>
<td>Lalonde 1974</td>
</tr>
<tr>
<td>Causes of incidence</td>
<td>Population</td>
<td>Whole population</td>
<td>Rose 1992</td>
</tr>
<tr>
<td>Causes of risks of risks</td>
<td>Social groups</td>
<td>Vulnerable population</td>
<td>Frohlich &amp; Potvin 2008</td>
</tr>
</tbody>
</table>

Interventions

Agentic  Structural

Pertaining to individual’s capacity to make the choice to act

more likely to worsen social inequalities in health

Pertaining to social institutions and norms that shape the actions of individuals

less likely to worsen social inequalities in health; may reduce disparities

Infectious disease epidemiology may necessitate alternative approaches

- outcome of exposure in one individual is not independent of outcomes in other individuals
- the population pattern of who contacts whom is crucial to infection spread
- transmission and characteristics of the infected individual may be more important than acquisition and characteristics of the susceptible individual

Adapted from Koopman J, Am J Public Health, 1996
“Almost all new infections occur when an infected person shares body fluids with an uninfected person, so prevention programmes must focus on situations in which this is happening”
Coverage to include:

- All susceptible
- All exposed
- All infected
- Groups with high prevalence
- Groups with high incidence
- Groups with high-risk behaviors
<table>
<thead>
<tr>
<th>Interventions to prevent acquisition</th>
<th>Interventions to prevent transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed persons</td>
<td>Infected persons</td>
</tr>
<tr>
<td>At risk populations</td>
<td>(Partners of infected)</td>
</tr>
<tr>
<td>Vulnerable populations</td>
<td></td>
</tr>
<tr>
<td>Whole populations</td>
<td></td>
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</tbody>
</table>
A model for allocating CDC's HIV prevention resources in the United States

Lasry A, Sansom SL, Hicks KA, Uzunangelov V.

Division of HIV/AIDS Prevention, Atlanta, GA 30333, USA. alasry@cdc.gov

Prioritization determined by:

- proportion of cases in key populations
- key populations
  - SWs
  - MSM
  - IDU
  - Young men

??  • proportion of current cases

  or

  proportion of transmissions caused by current cases (a sexual network approach)
For majority of HIV (and all STD), the relevant contact pattern is reflected in the sexual structure (sexual networks)

→ Prioritization may be based on sexual network status or connectedness

→ While epidemiologic context → where new infections are

sexual contact structure → where new infections will be
Example of connectedness
Network positions of HIV + individuals, (and highly connected HIV negative susceptibles) account for incidence and prevalence differences in populations.

High levels of centrality – associated with faster and greater spread.

Rothenberg et al, 1996; Friedman et al, 1997
Sexual networks are reflected in space and explain the geographic clustering of incident cases.
Needed Coverage/Different Sexual Structures

A

Dyads

\[
\frac{5}{10}
\]

B

Concurrent individuals

\[
\frac{3}{10}
\]

C

Mutually non-monogamous individuals

\[
\frac{1}{10}
\]
Prioritization of subpopulations based on sexual structure information:

↑ efficiency of scale-up
↑ cost – effectiveness of scale-up
↓ time to scale-up
↓ cost of scale-up
Detailed global network description is difficult

Focus on:

- mutual non-monogamy (symmetric concurrency)
- short duration partnerships
- short gaps
- mobility and turnover in key populations may help
Take home message

• Context matters
• Have to target – concentration
• High transmitters
  – Viral load based targeting
  – Network based targeting
• Feasibility
  – Network based targeting more feasible than VL-based targeting
Acknowledgements

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Thank You