# Defining Coverage: The Importance of Context

**Sevgi O. Aral**

July 15, 2011

(6th IAS Conference)

Rome, Italy

# Early Start of ART Reduces Risk of HIV Transmission To Partner

May 12, 2011

HPTN HIV Prevention Trials Network

**FOR IMMEDIATE RELEASE:**
Thursday, 12 May 2011, 11 am EST

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

**Study: Early HIV treatment prevents new infections, preserves health**

Center for Global Health Policy

Subscribe: Home Delivery / Digital Log In Register Now Help

Search All NYTimes.com

HOME PAGE | TODAY'S PAPER | VIDEO | MOST POPULAR | TIMES TOPICS

The New York Times

Research

WORLD U.S. N.Y. / REGION BUSINESS TECHNOLOGY SCIENCE HEALTH SPORTS OPINION ARTS STYLE TRAVEL JOBS REAL ESTATE AUTOS

Inside Health

Research Fitness & Nutrition Money & Policy Views Health Guide

Search Health 3,000+ Topics

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‡§*

*J Acquir Immune Defic Syndr* 2011; 56(2):e45-e48

# The Topical/Oral PrEP Cascade – 50% Coverage/Adherence

**100 Women Exposed to HIV**
**(10% transmission risk)**

| | | |
|---|---|---|
| Coverage of Topical/Oral PrEP 50% | 50 have coverage | 50 have no coverage |
| Use Topical/Oral PrEP 50% | 25 use | 75 do not use |
| Product 50% effective | 1.3 infections | 7.5 infections |
| Product 80% effective | 0.5 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% | 95 have coverage | 5 have no coverage |
| Use Topical/Oral PrEP 95% | 90 use | 10 do not use |
| Product 50% effective | 4.5 infections | 1 infection |
| Product 80% effective | 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

*Slide provided by Ward Cates*

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

  ( ↑ investment → ↑ # reached → those remaining harder to reach; harder to change)
- interventions in combination may avert fewer infections than single interventions implemented alone

  ( ∵ same infection cannot be averted twice)

Alistar SS & Brandeau ML, Medical Decision Making. Published online: December 29, 2010

## 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

Gabriela Gomez – Presentation in Atlanta May 3, 2011; Personal communication – May 3, 2011

## 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 ↑

Ainsworth & Teokul, 2000; Piot & Seck, 2001; Kumaranayake & Watts, 2001; G Hutton et al, 2003

Examples of Academic Models of HIV Resource Allocation

| | Description | Objective | Intervention(s) Considered | Production Functions |
|---|---|---|---|---|
| **Linear models** | | | | |
| Kaplan and others[55] | A simple model with linear HIV epidemic growth | Maximize infections averted subject to a fixed budget | Prevention programs targeted to independent high-risk populations | Linear |
| Kaplan[34] | A simple model with linear HIV epidemic growth that incorporates general production functions | Maximize infections averted subject to a fixed budget | Prevention programs targeted to independent high-risk populations | General |
| **Dynamic models** | | | | |
| Kahn[56] | A dynamic model of HIV in multiple independent populations | Evaluate infections averted for different allocations of a fixed budget | Prevention programs targeted to independent high-, medium-, or low-risk populations, early or late in an epidemic | Linear |
| Paltiel[59] | A dynamic model of HIV in a single population | Evaluate cost per QALY saved | Prevention programs targeted to infected or susceptible individuals in a single population, or general prevention programs, early or late in an epidemic | Linear |
| Richter and others[42] | A dynamic model of HIV in 2 independent populations | Maximize infections averted subject to a fixed budget | Prevention programs targeted to independent populations, 1 low risk and 1 high risk | General |
| Zaric and Brandeau[60] | A theoretical model with dynamic epidemic growth that allows for multiple interacting subpopulations and general types of interventions | Maximize infections averted or QALYs gained subject to a fixed budget | General interventions that can change any epidemic parameters | General |
| **Simulation models** | | | | |
| Bernstein and others[62] | A simulation model of HIV in a severely affected east African city | Evaluate HIV prevalence and incidence | Prevention programs | Linear |
| Robinson and others[63] | A simulation model of HIV and 2 other STDs in rural Uganda | Evaluate HIV infections averted, HIV prevalence, HIV incidence | Prevention programs | Linear |
| Hogan and others[28] | A simulation model of HIV and other STDs in Sub-Saharan Africa and Southeast Asia | Evaluate effectiveness and cost-effectiveness (cost/DALY averted) | Prevention and treatment programs | Linear |

Note: QALY = quality-adjusted life-year; STD = sexually transmitted disease; DALY = disability-adjusted life years.

Sabina Alistar & Margaret Brandeau. *Medical Decision Making*, Published online: 29 December 2010

# An Accurate Resource Allocation Model

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).

Sabina Alistar & Margaret Brandeau. *Medical Decision Making*, Published online: 29 December 2010

# Hypothetical STD / HIV prevention intervention

## 20% population coverage; 50% efficacy among those served

| | Scenario 1: | Scenario 2: | Scenario 3: |
|---|---|---|---|
| Group targeted | None<br>Receipt of intervention independent of STD risk | None<br>Low –risk people self-select intervention | High risk group(s) |
| Relative STD / HIV risk | 1.0 | 0.1 | 2.5 |
| Effective coverage (Percent of STDs accounted for by population served by intervention) | 20% | 2% | 50% |
| Overall STD / HIV reduction | 10% | 1% | 25% |
| Impact on Disparities | None | ↑ Disparities | ↓ Disparities |

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**

# Identification of Localized Clusters of High HIV Incidence in a Widely Disseminated Rural South African Epidemic: A Case for Targeted Intervention Strategies

Frank Tanser*[1], T Bärnighausen[1,2], and M-L Newell[1,3]

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

*Session 38-Oral Abstracts*
http://www.retroconference.org/2011/Abstracts/41395.htm

**Paper # 137**

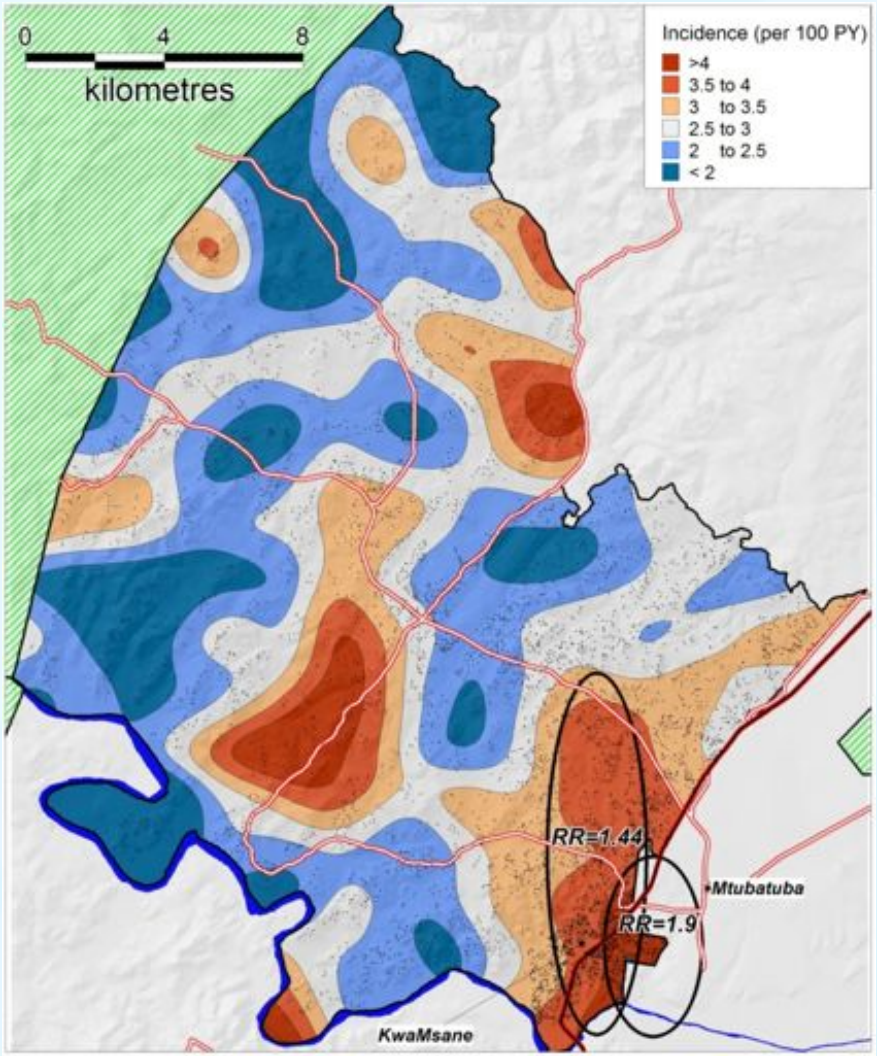
**Identification of Localized Clusters of High HIV Incidence in a Widely Disseminated Rural South African Epidemic: A Case for Targeted Intervention Strategies**

**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.

*Session 38-Oral Abstracts*

http://www.retroconference.org/2011/Abstracts/41395.htm

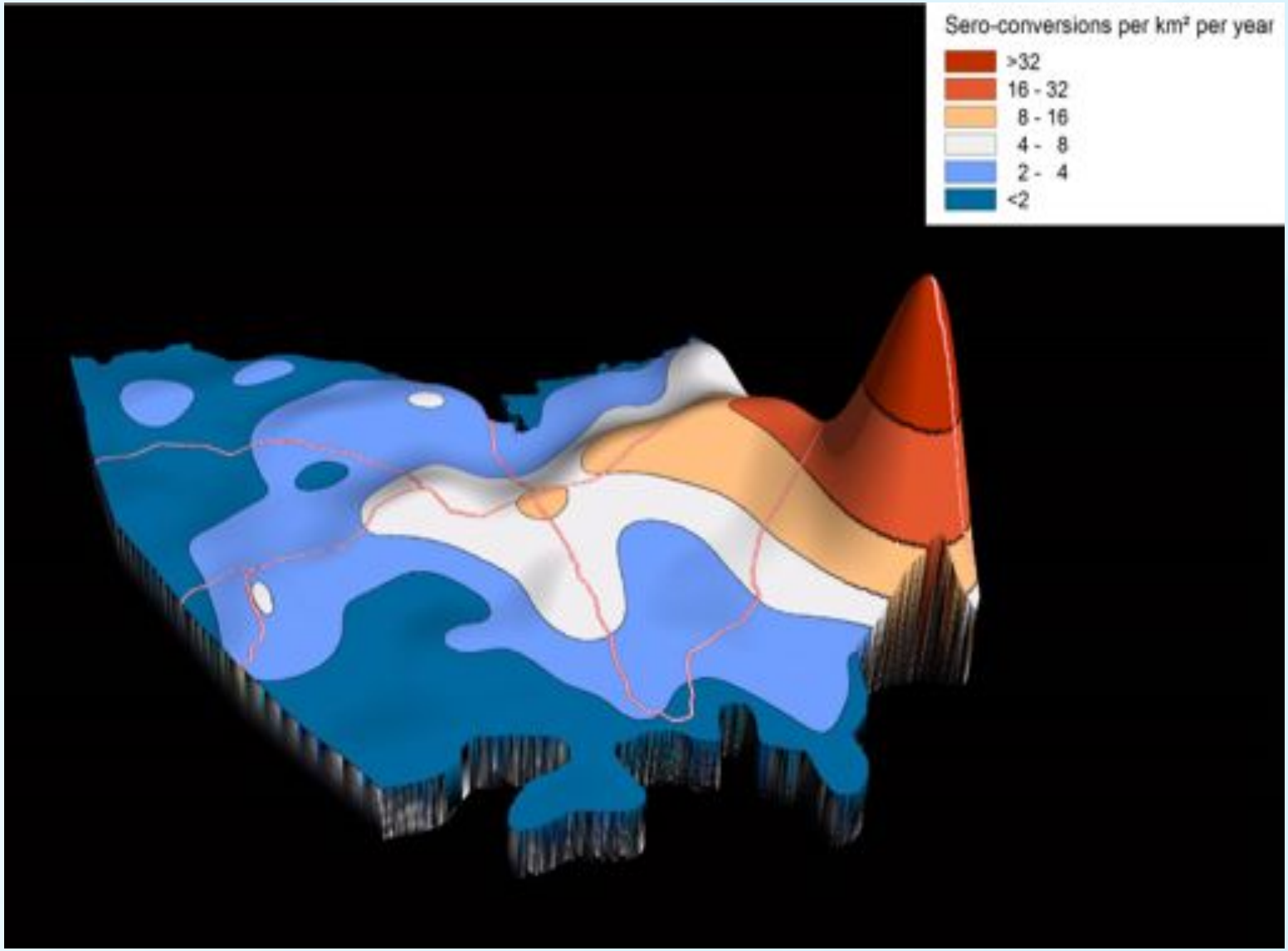
# HIV incidence across the study area with high-incidence clusters superimposed




*Session 38-Oral Abstracts*

http://www.retroconference.org/2011/Abstracts/41395.htm

# 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

Blanchard JF et al. *Sex Transm Infect* 2007; 83:i30-i36 d oi:10.1136/sti.2006.023572

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

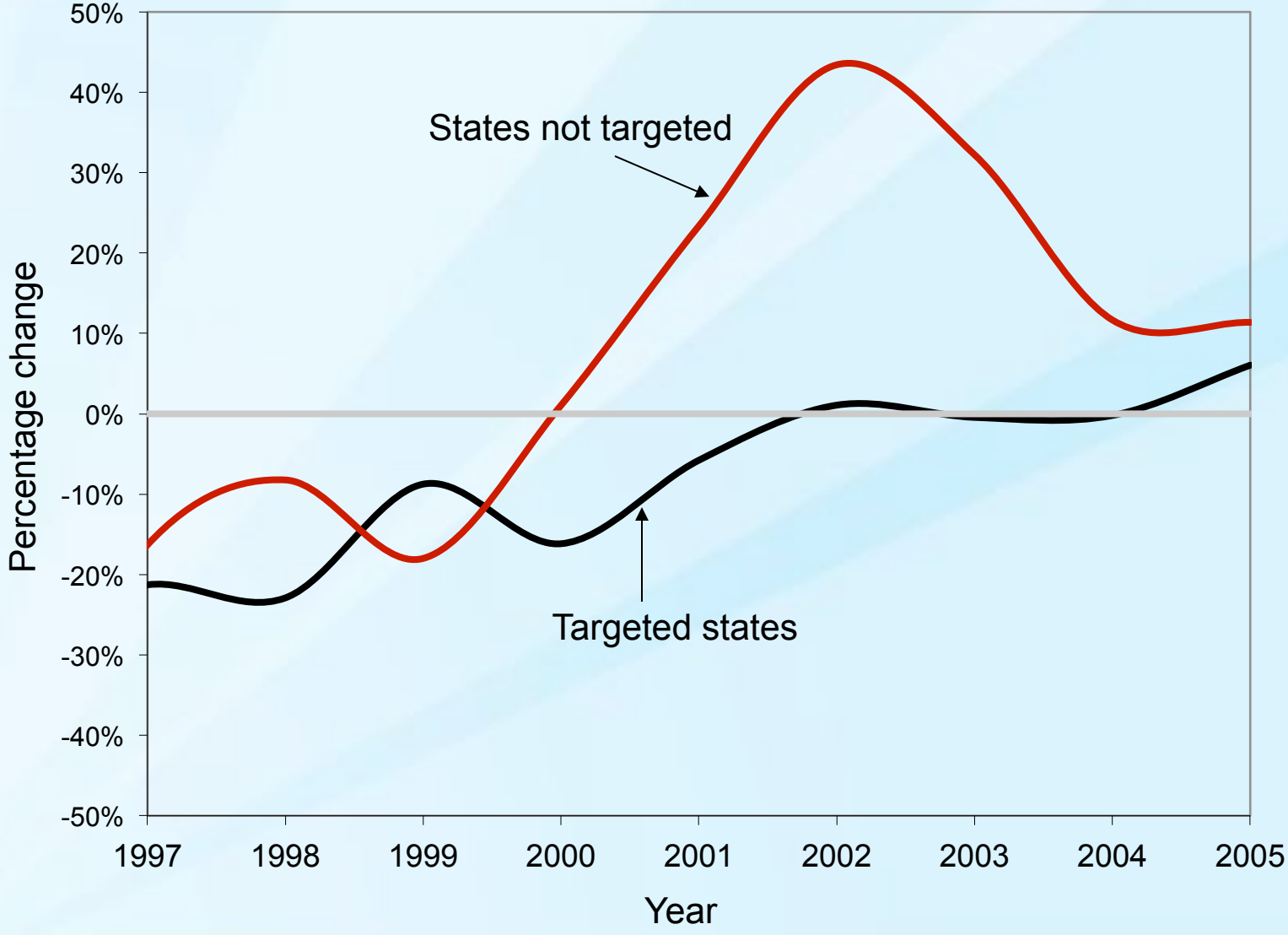
Chesson HW et al. *Sex Transm Infect* December 2010; 86(Suppl 3)

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




Chesson & Owusu-Edusei, *Soc Sci Med* 2008.

# 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

| Focus | Level | Prevention Strategy | Author |
|---|---|---|---|
| Causes of cases | Individual | Population-at-risk | Lalonde 1974 |
| Causes of incidence | Population | Whole population | Rose 1992 |
| Causes of risks of risks | Social groups | Vulnerable population | Frohlich & Potvin 2008 |

Frohlich KL & Potvin Louise, *Am J Public Health*, 2008
McLaren L, McIntyre L, Kirkpatrick S, *Int. J Epidemiol*, 2010

# 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

McLaren L, McIntyre L, Kirkpatrick S, *Int. J Epidemiol*, 2010

# Infectious disease epidemiology may necessitate alternative approaches

- outcome of exposure in one individual is <u>not</u> 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”

Pisani E, et al. *BMJ* 2003

# Coverage to include:?

All susceptible

All exposed

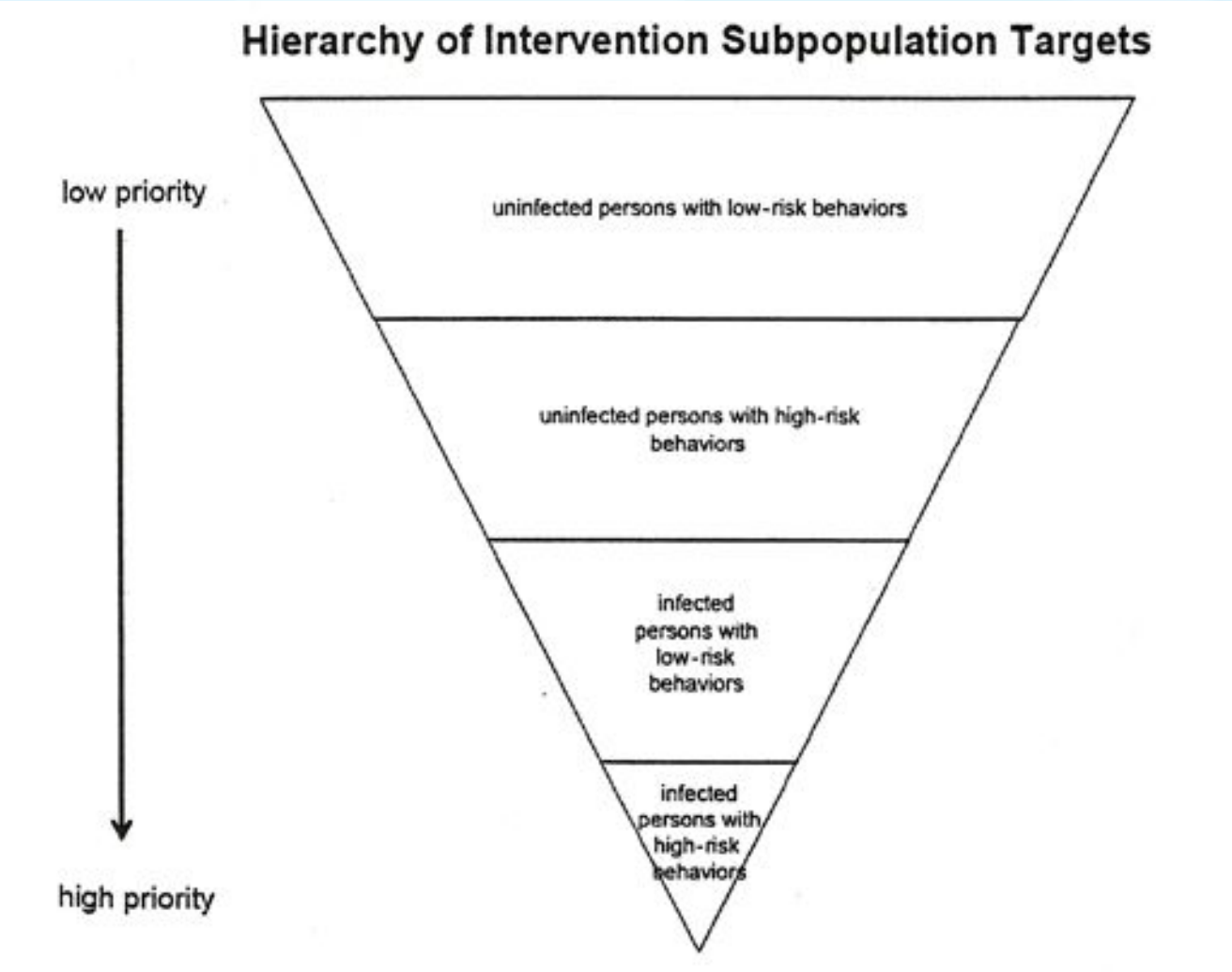
All infected

Groups with high prevalence

Groups with high incidence

Groups with high-risk behaviors

| Interventions to prevent acquisition | Interventions to prevent transmission |
| --- | --- |
| Exposed persons | |
| At risk populations | |
| Vulnerable populations | |
| Whole populations | |
| | Infected persons (Partners of infected) |




Aral SO & Douglas JM, Jr. eds. Lipshutz JA. assoc ed. (2007) *Behavioral Interventions for Prevention and Control of Sexually Transmitted Diseases.*. New York: Springer Science+ Business Media, LLC

# 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**

Health Care Manag Sci. 2011 Mar;14(1):115-24. Epub 2010 Dec 24

# 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)

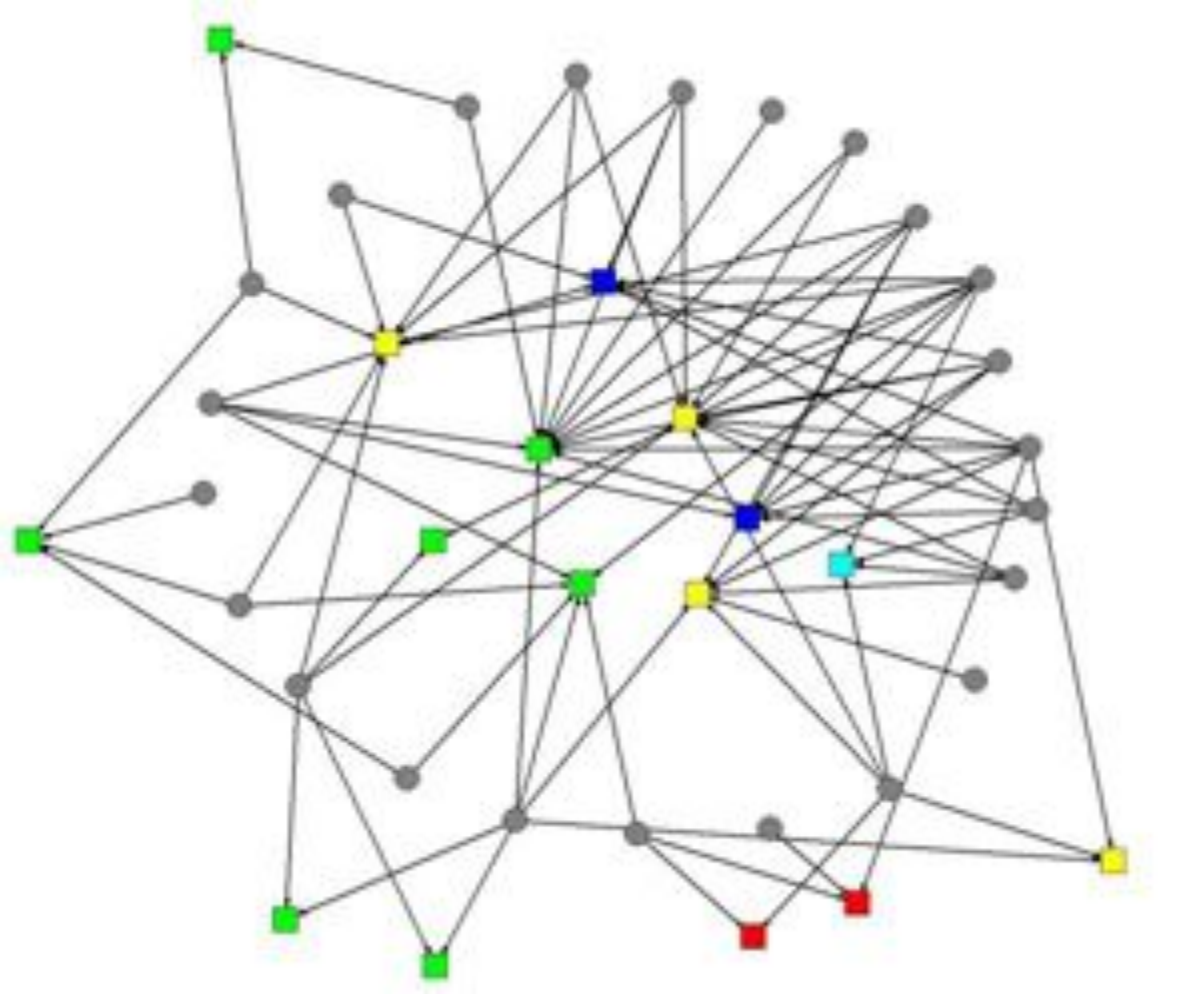
For majority of HIV (and all STD), the relevant contact pattern is reflected in the sexual structure (sexual networks)

→ 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.

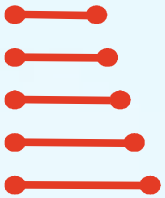
High levels of centrality – associated with faster and greater spread.

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

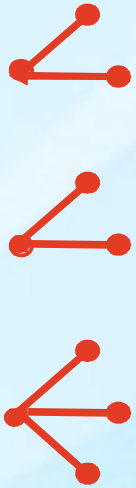
**A**



Dyads

$\frac{5}{10}$

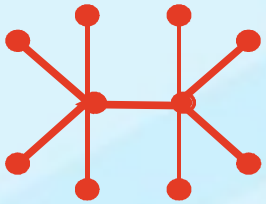
**B**



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

James Blanchard

Ward Cates

Harrell Chesson

Patricia Jackson

James Koopman

# Thank You