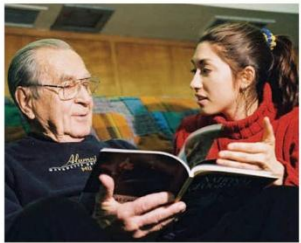




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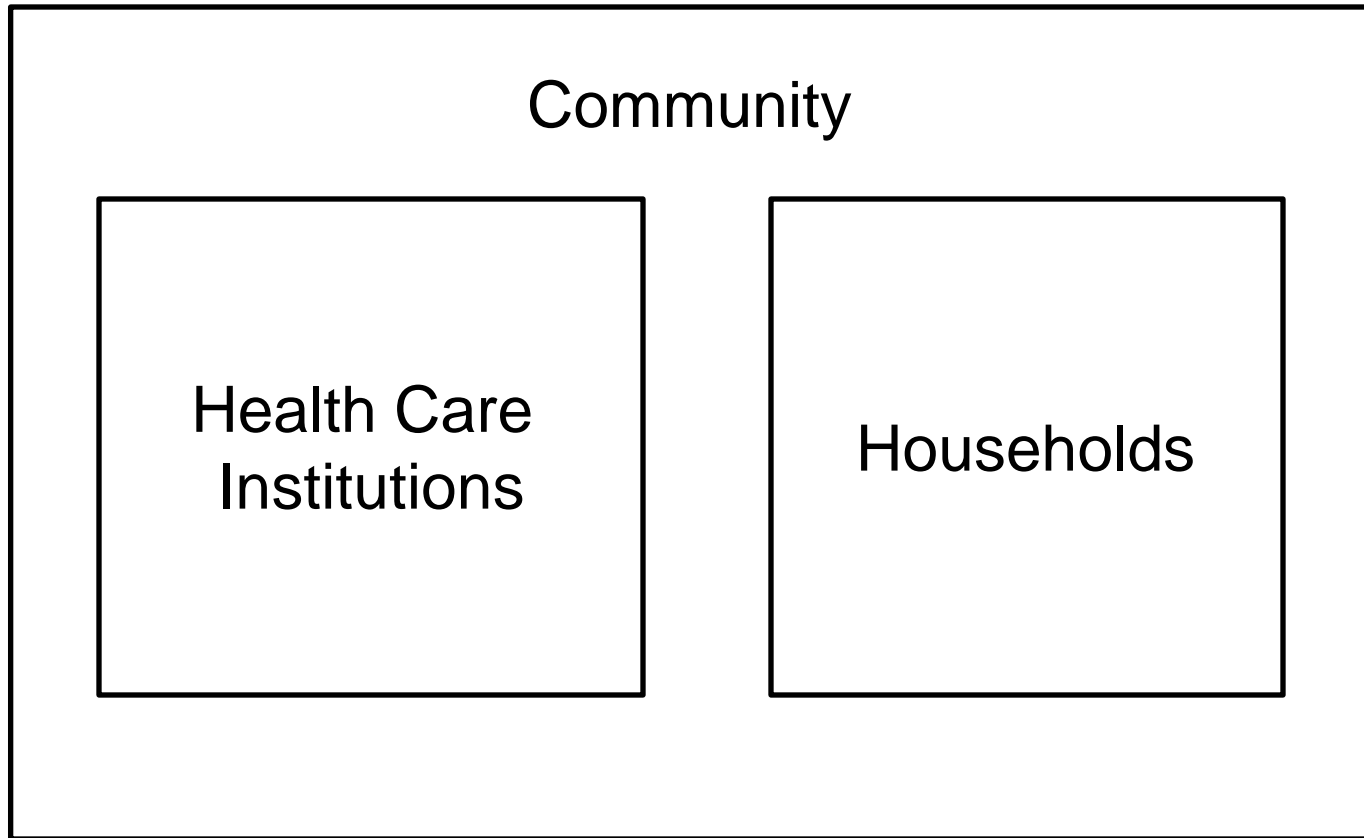
# Tuberculosis Transmission in Households and Communities

Christopher C. Whalen, M.D., M.S.  
Department of Epidemiology and Biostatistics

Be Part of the Solution

# Model for *M. Tuberculosis* Transmission

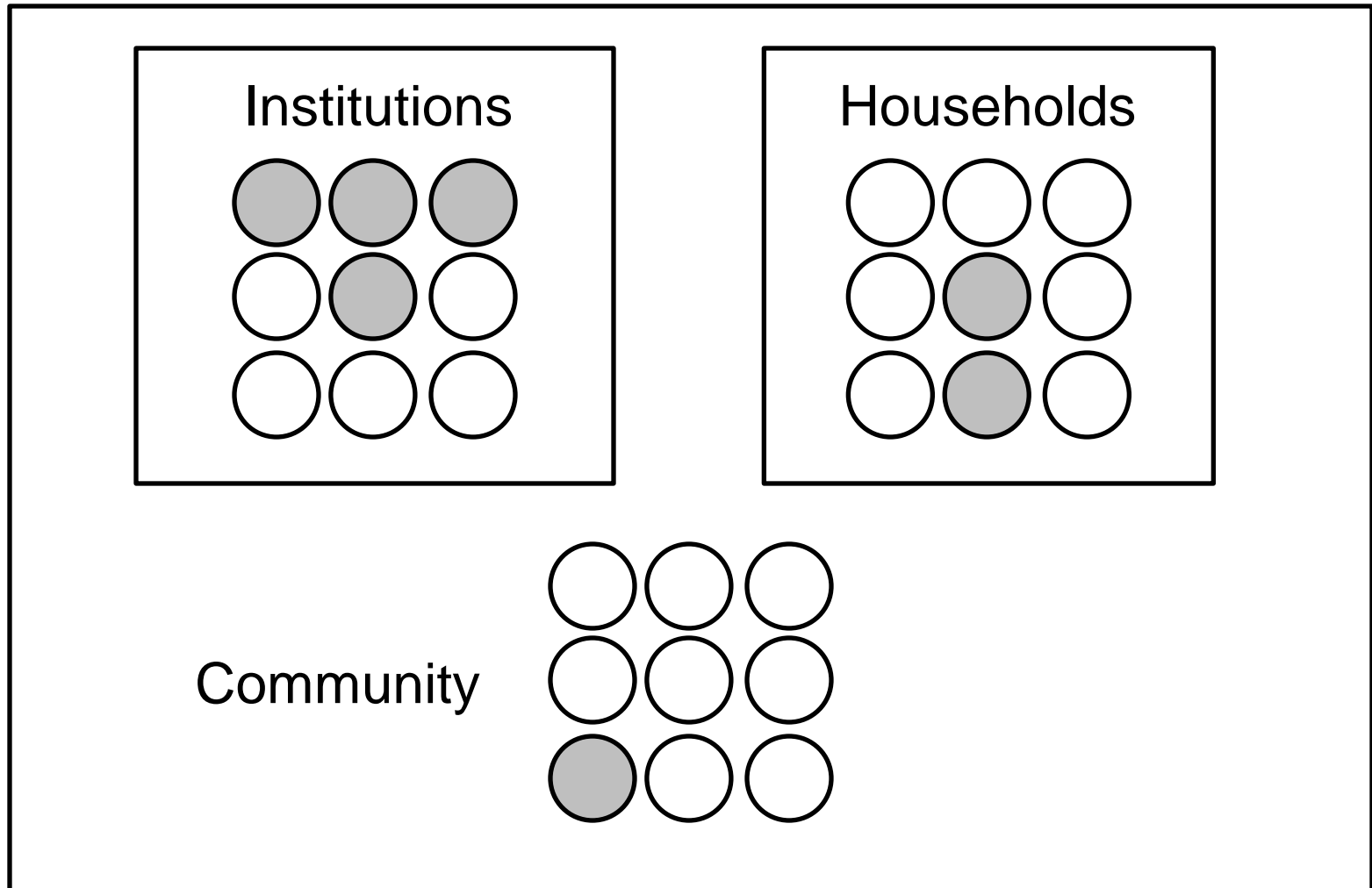
Partition transmission by social constructs



Universe of *M. tuberculosis* Transmission

# Model for *M. Tuberculosis* Transmission

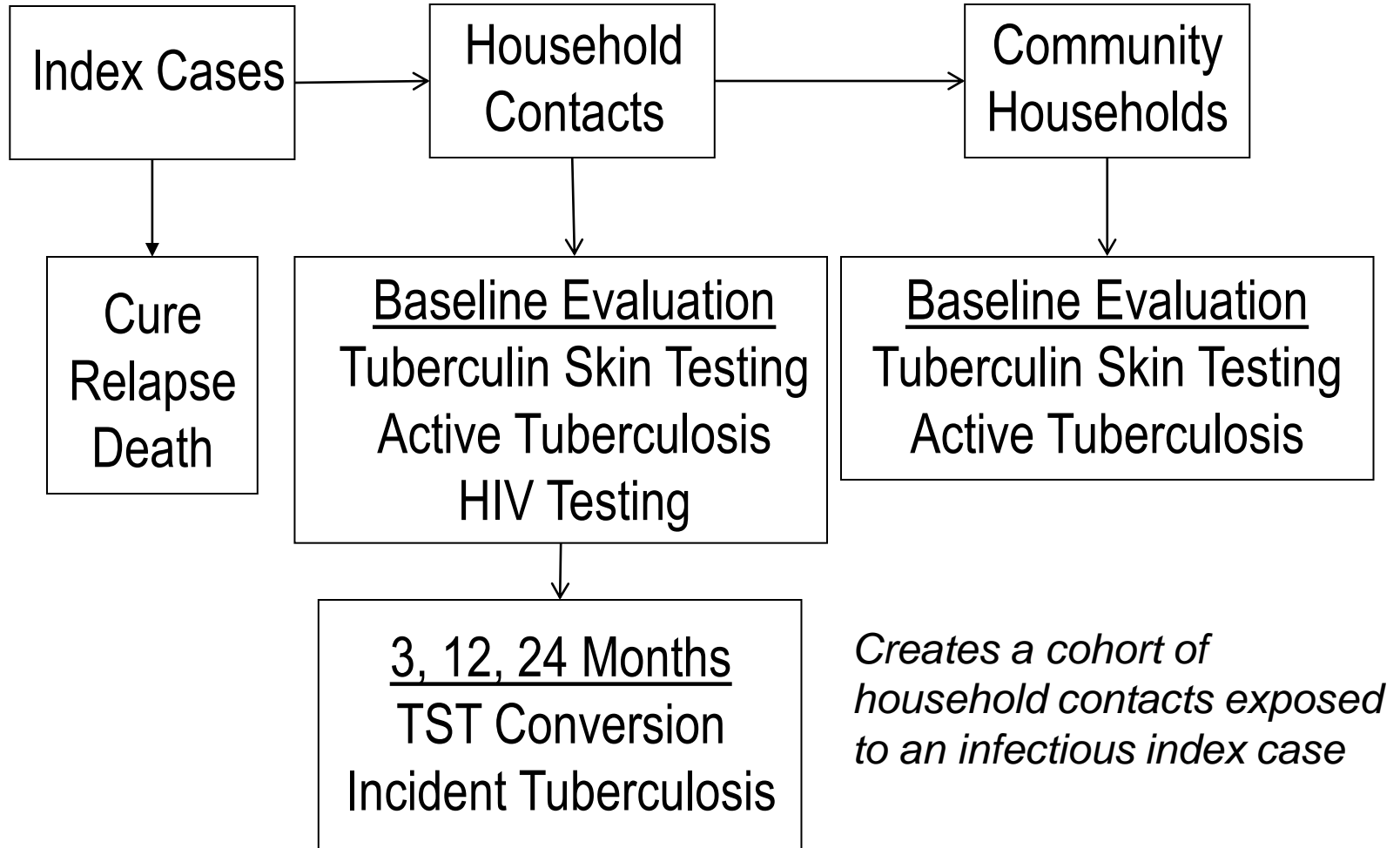
Assortment of susceptible individuals within social constructs



# Kawempe Community Health Study

- Household Contact Study
  - Kawempe Division, Kampala Uganda
  - 1996 – 2010
- Research Aims
  - Estimate household transmission
    - *M. tuberculosis* infection
    - Tuberculosis disease
  - Stratify by HIV serostatus

# Household Contact Study Design

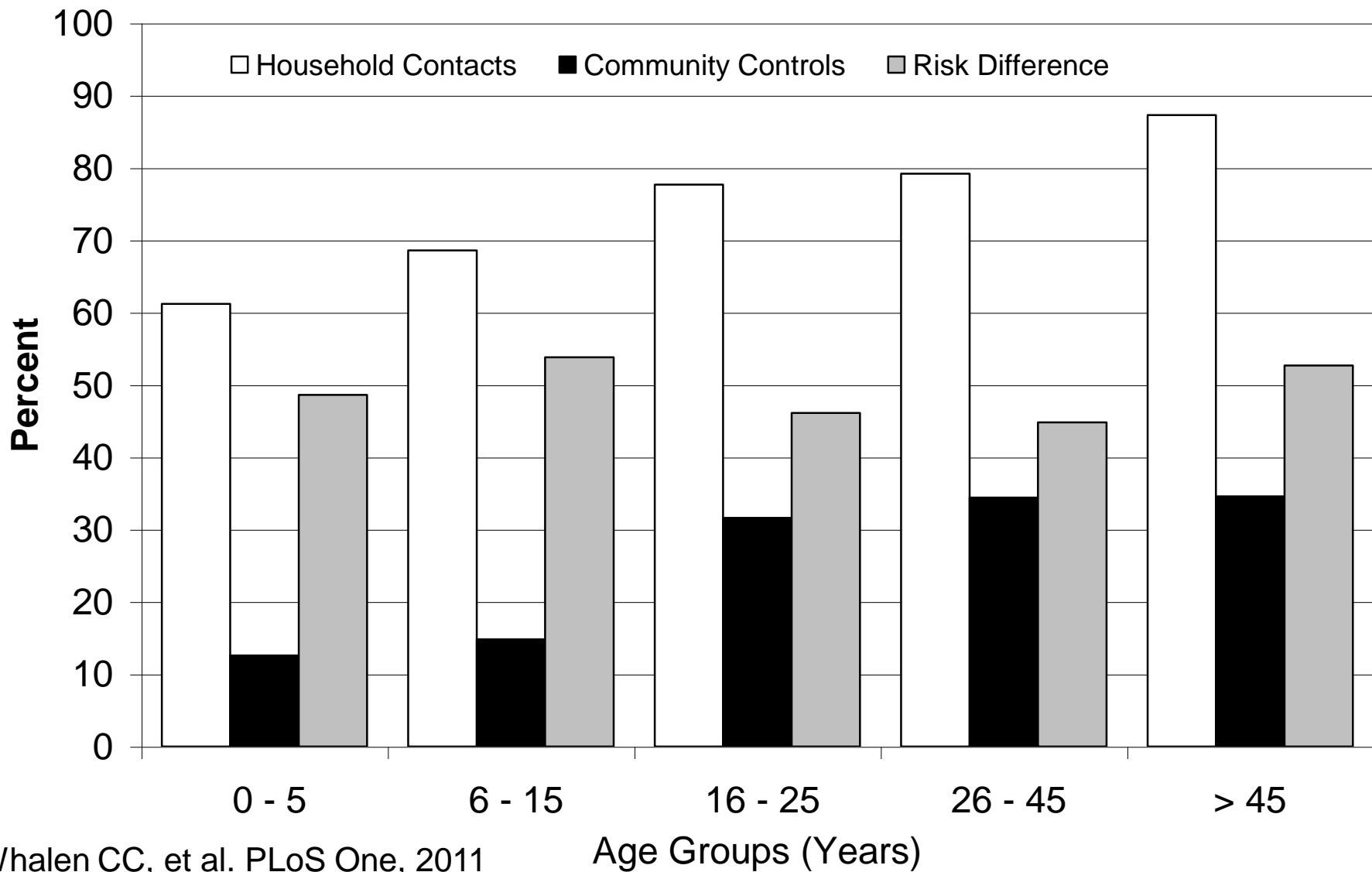


# Effect of HIV Serostatus on TB

Contact Characteristic	HIV Serostatus of Index Case		P Value
	Seropositive (n = 249)	Seronegative (n = 251)	
	----- n (%) -----		
No. contacts	962	960	-
HIV seropositive	157 (16)	46 (5)	0.000
Latent TB Infection	685 (71)	769 (80)	0.000
Active TB	35 (3.6)	41 (4.3)	NS
	HIV Serostatus of Contacts		
	Seropositives (n = 203)	Seronegatives (n = 1459)	
Latent TB Infection	151 (74)	1096 (75)	NS

# Age-Specific Prevalence of TB Infection

## Household Contacts vs. Community Members



# Secondary Attack Rates

	SAR TB	SAR Infection	Risk of TB after new Infection
	----- % -----		
Overall	3.0	47.4	6.33
Age			
<= 5	5.1	50.3	10.1
>5	2.2	48.5	4.5
HIV serostatus			
HIV+	8.8	47.4	18.6
HIV-	2.5	47.4	5.3

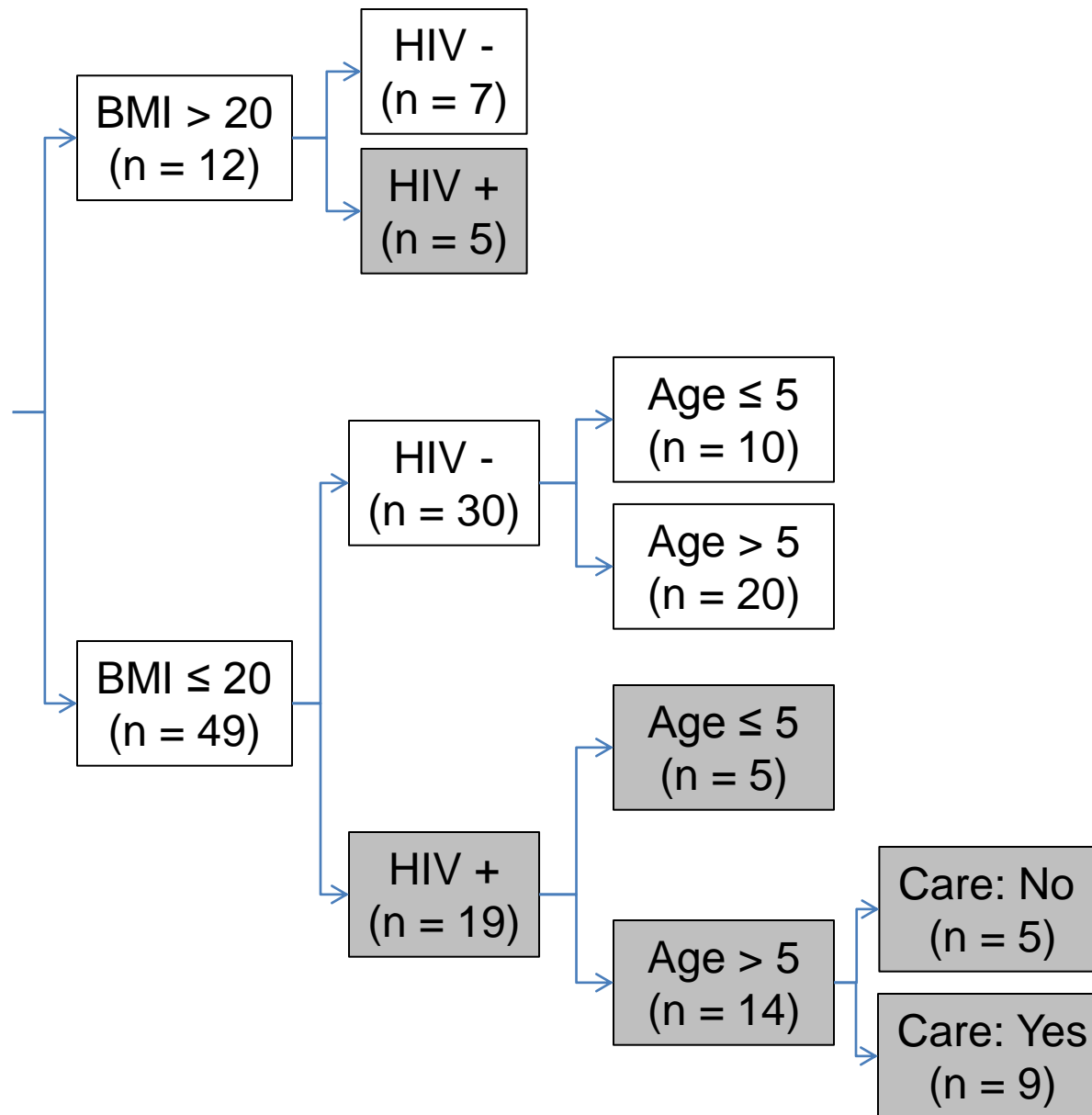


# DNA Fingerprinting

## Household Contacts with Active TB by HIV Sero-Status

HIV Status	n	RFLP Pattern Compared with Index Case Isolate	
		<b>Match</b>	<b>No Match</b>
		--- n (%) ---	--- n (%) ---
HIV negative	39	33 (84)	6 (16)
HIV positive	22	13 (59)	9 (41)
<b>Total</b>	<b>61</b>	<b>46 (75)</b>	<b>15 (25)</b>

# CART Analysis of MTB Transmission



RFLP Pattern	
Same	Different
3	4
1	4
10	0
18	2
5	0
4	1
5	4

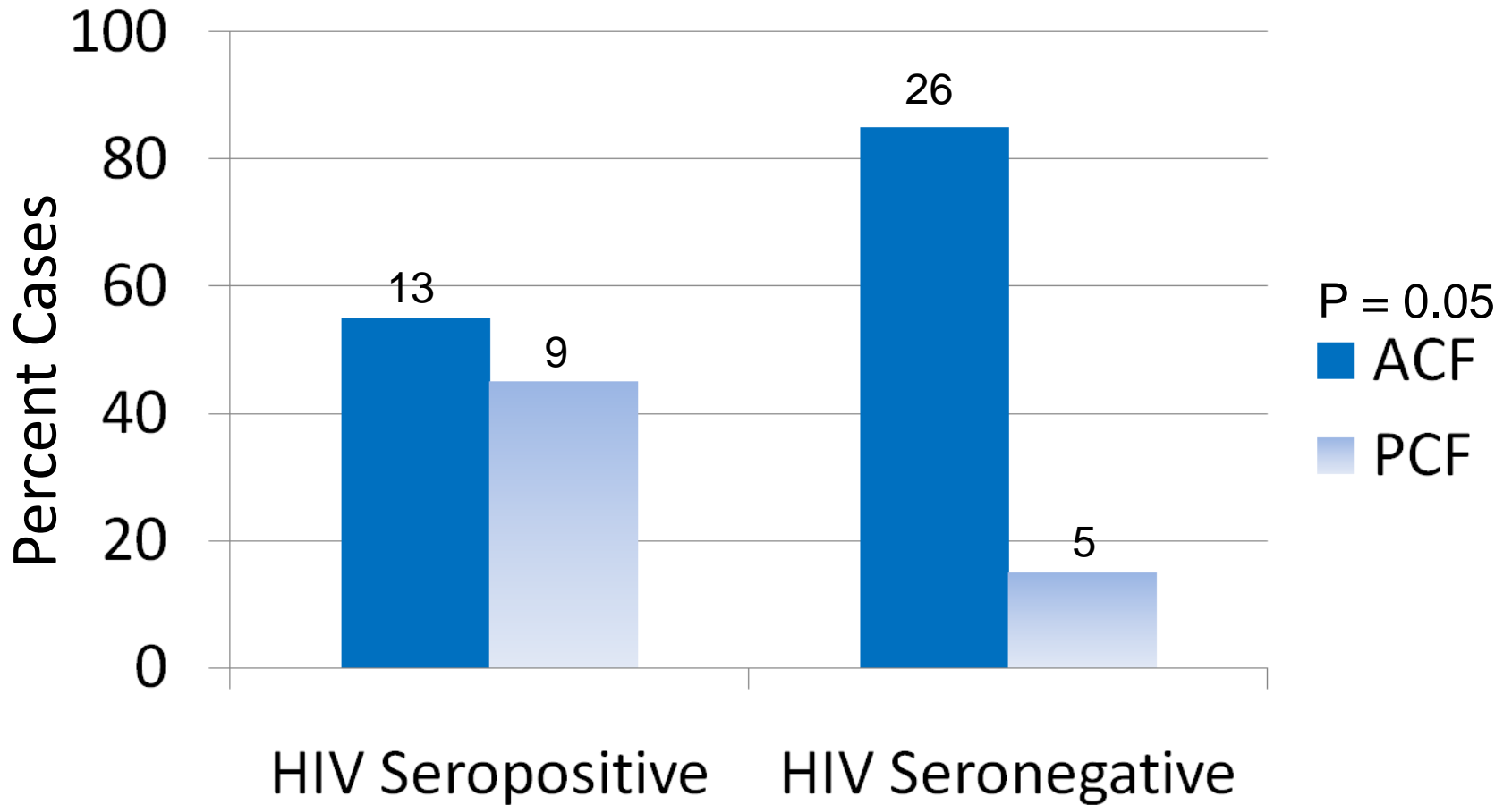
# TB Transmission in Community

- Cough Survey
  - Rubaga Division, Kampala, Uganda, 2007 - 2012
  - Random community sample
  - Cough > 2 weeks -> sputum microscopy and culture

Total Screened	5088		
	N	% Total	% Subgroup
Chronic Cough	195	3.8	-
Active TB	53	1	27
HIV+	22	0.4	41
HIV-	31	0.6	59

# Active Case Finding for TB

Rubaga Division, Kampala, Uganda

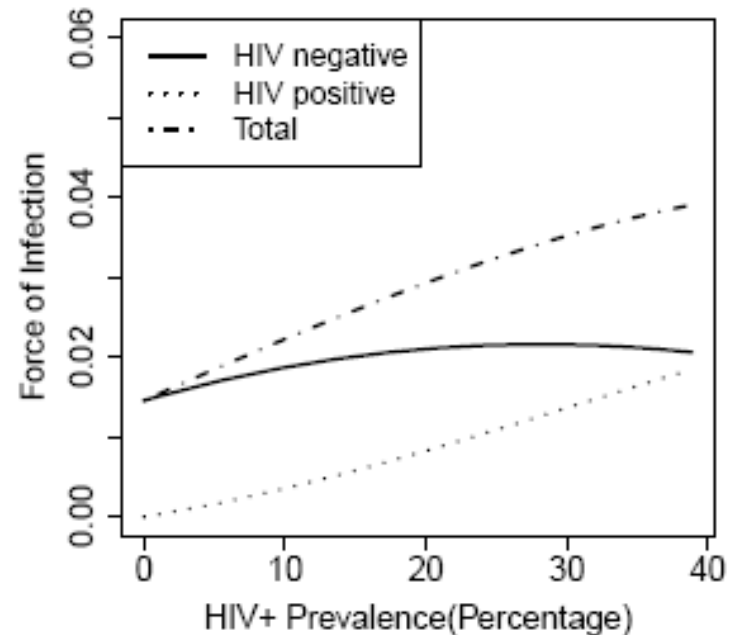
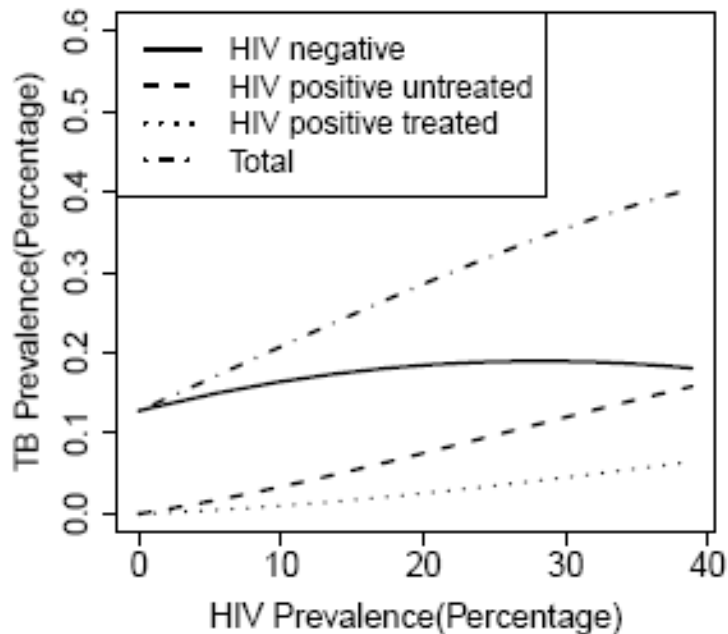


ACF – Active Case Finding

PCF – Passive Case Finding

# Mathematical Model of TB Dynamics

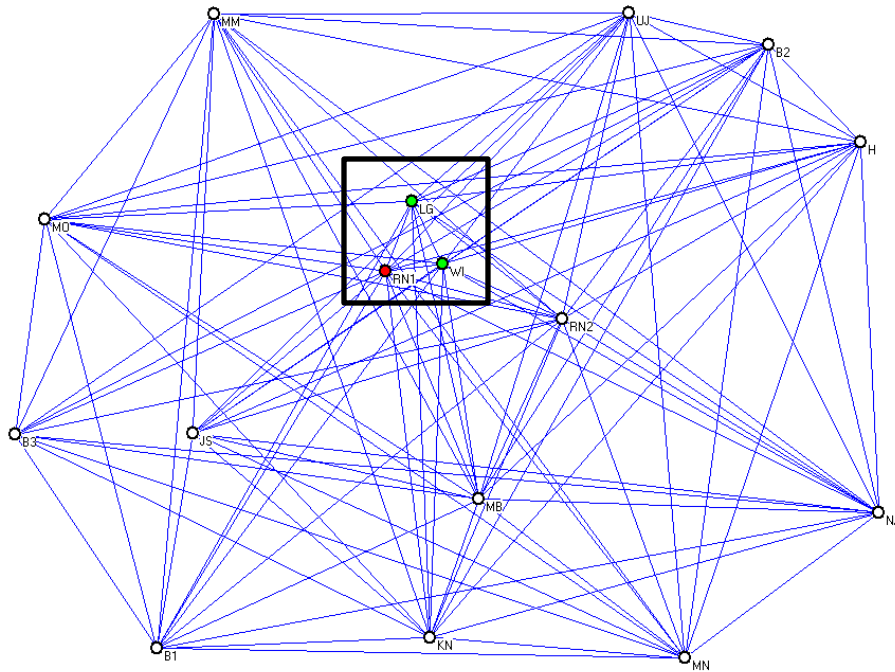
TB Epidemic driven by HIV seronegative TB cases when HIV prevalence is less than 30%



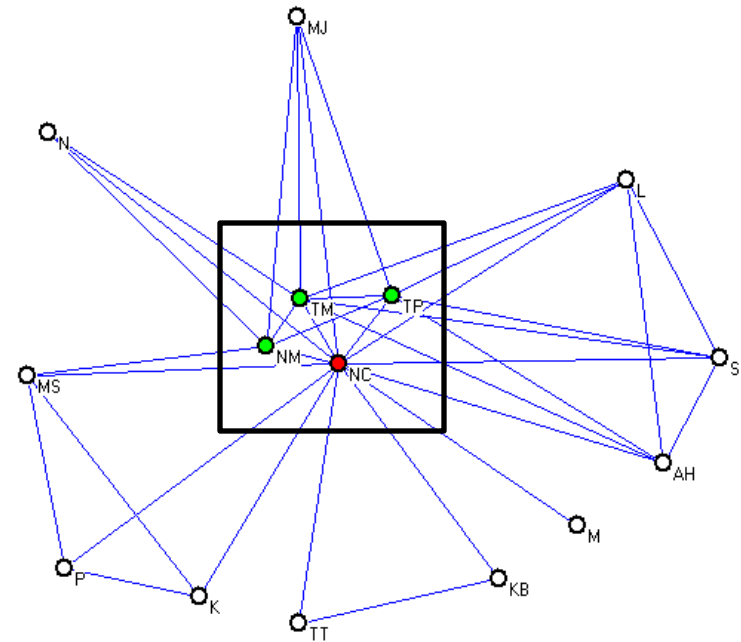
Relative steady-state prevalence of tuberculosis according to HIV prevalence in population

# TB Contact Networks

## Rubaga Division, Kampala, Uganda

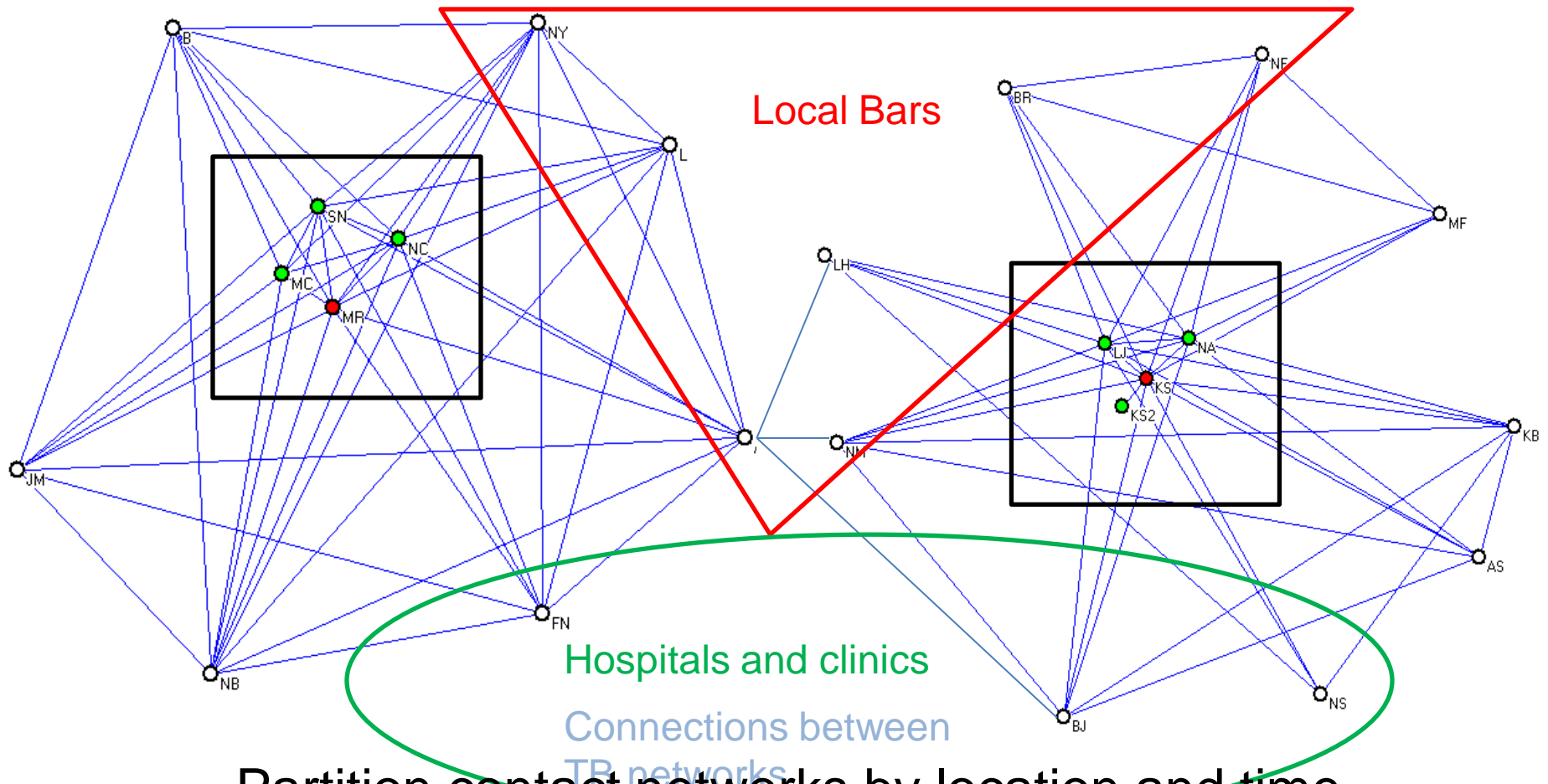


Network Size = 16  
Density = 0.88  
Degree mean = 13



Network Size = 15  
Density = 0.34  
Degree mean = 4

# TB Contact Networks Kampala Uganda



Partition contact networks by location and time  
Relate to TB infection and disease

# Summary

- HIV seropositive index TB cases
  - More frequent HIV+ contacts
  - Possibly less infectious
- HIV seropositive contacts
  - Similar likelihood for infection as other contacts
  - Increased risk (3-fold) for disease
- HIV seropositive co-prevalent TB cases
  - Different strains imply additional contact networks besides the household
- HIV seronegative TB cases appear to drive the TB epidemic until HIV prevalence is very high



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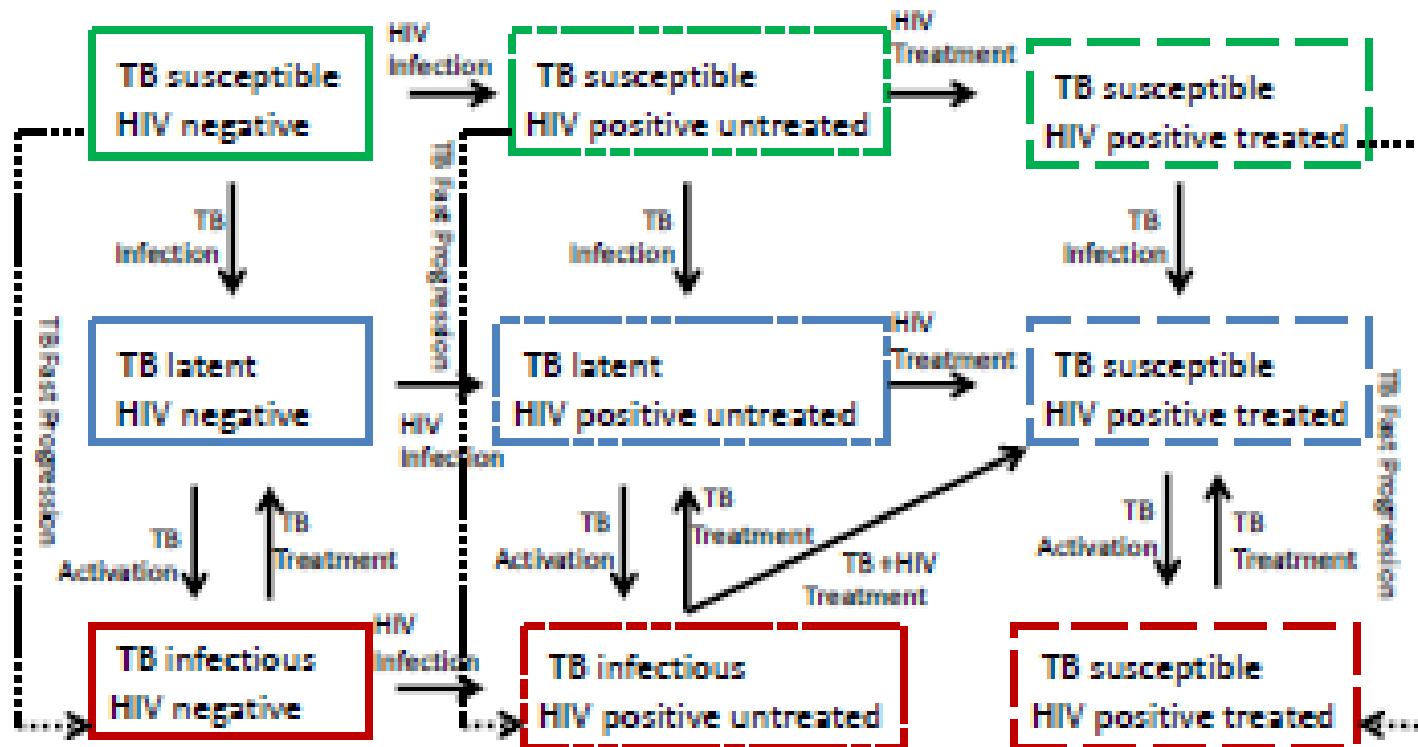
# Estimation of Secondary Attack Rates

$$SAR_D = SAR_I^* \rho_D$$

$$SAR_D = \frac{\text{Cases with same strain}}{\text{Total number of contacts}}$$

$$\begin{aligned} SAR \text{ infection} &\cong P_{H \in h} - P_{C \in c} \\ P_{H \in h} - P_{C \in c} &= ARI^t SAR \end{aligned}$$

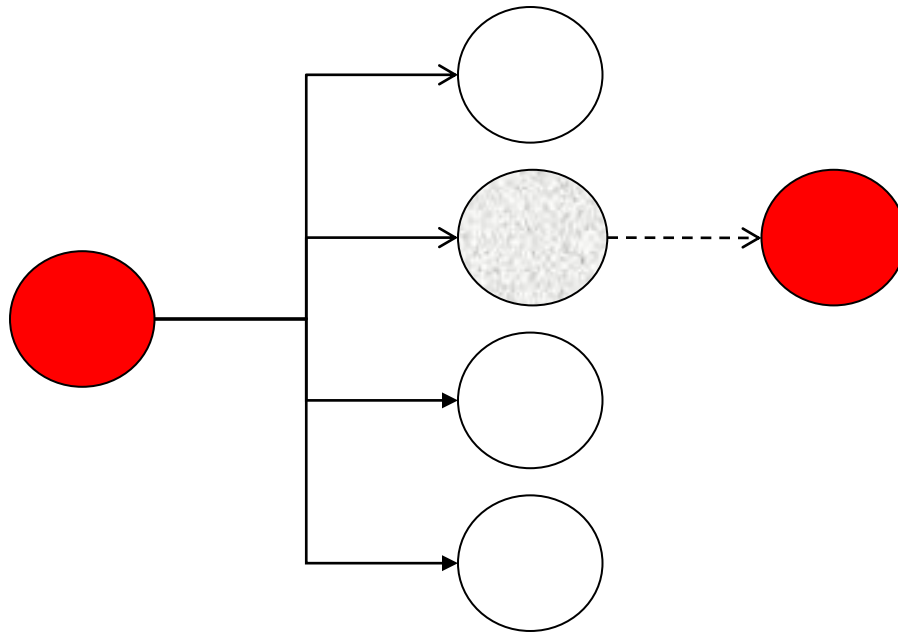
$$\rho_D = \frac{\text{SAR disease}}{\text{SAR infection}}$$



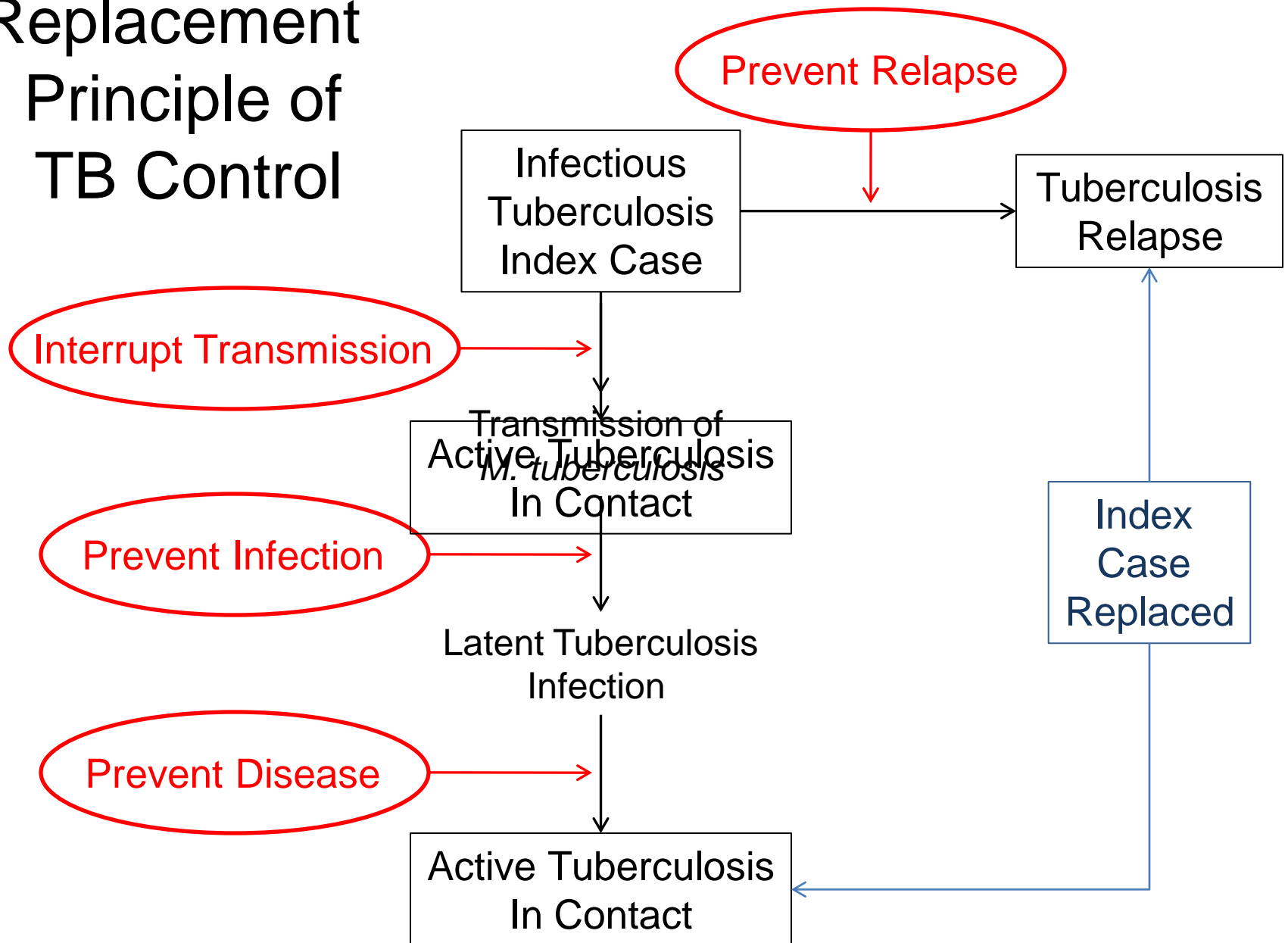
Latent TB Infection in Contacts (%)			
		HIV +	HIV -
Age	≤ 5	62	66
	> 5	76	80
Total		74	75

# Replacement Principle

As long as one case of tuberculosis is replaced by another, elimination of tuberculosis cannot be achieved



# Replacement Principle of TB Control



# Platform for Global Public Health Action

## Comprehensive Plan for TB Elimination

DOTS

Treat LTBI

Active Case Finding

Environmental Controls

Vaccination

HIV Care

Scientific Research

New Drugs

New Vaccines

New Diagnostics

New Surveillance

Sustainable Development

Poverty Mitigation

Affordable Modern Housing

Medical and Public Health Care Systems

Competent TB Control Programs

Stable and Supportive Government Commitment to TB Elimination

***Regional TB Control Alliances between  
Industrialized and Developing Countries***

