

Measuring HIV incidence: methods and results from South Africa

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HSRC RESEARCH

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1. Epidemiological methods

- Local/district-level HIV incidence: cohort studies (many!)
- National estimates:
 - Mathematically derived / Modeling: EPP/Spectrum, ASSA, STI-HIV Interaction model
 - HIV incidence estimation from HIV prevalence data collected in repeated national population-based surveys

2. Laboratory-based methods

- BED incidence estimates
- Multi - assay testing algorithm (2012 survey)

Use of UNAIDS (EPP & Spectrum) and ASSA models in official reporting

| YEAR | Estimated number of new infections (adults 15-49 years) | | Estimated number of new infections (adults 15-49 years) % per annum | | |
|--------------|---|---------|---|------|-----|
| | ASSA ³ | UNAIDS | ASSA | ASSA | |
| South Africa | 2010 | 324 150 | 281 000 | 1.47 | 1.2 |
| | 2009 | 335 700 | 310 000 | 1.5 | 1.3 |

**Source: 2010 National Antenatal Survey Report,
Department of Health, South Africa 2011**

Models are essential in estimating attributable program effects

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The effect of changes in condom usage and antiretroviral treatment coverage on human immunodeficiency virus incidence in South Africa: a model-based analysis

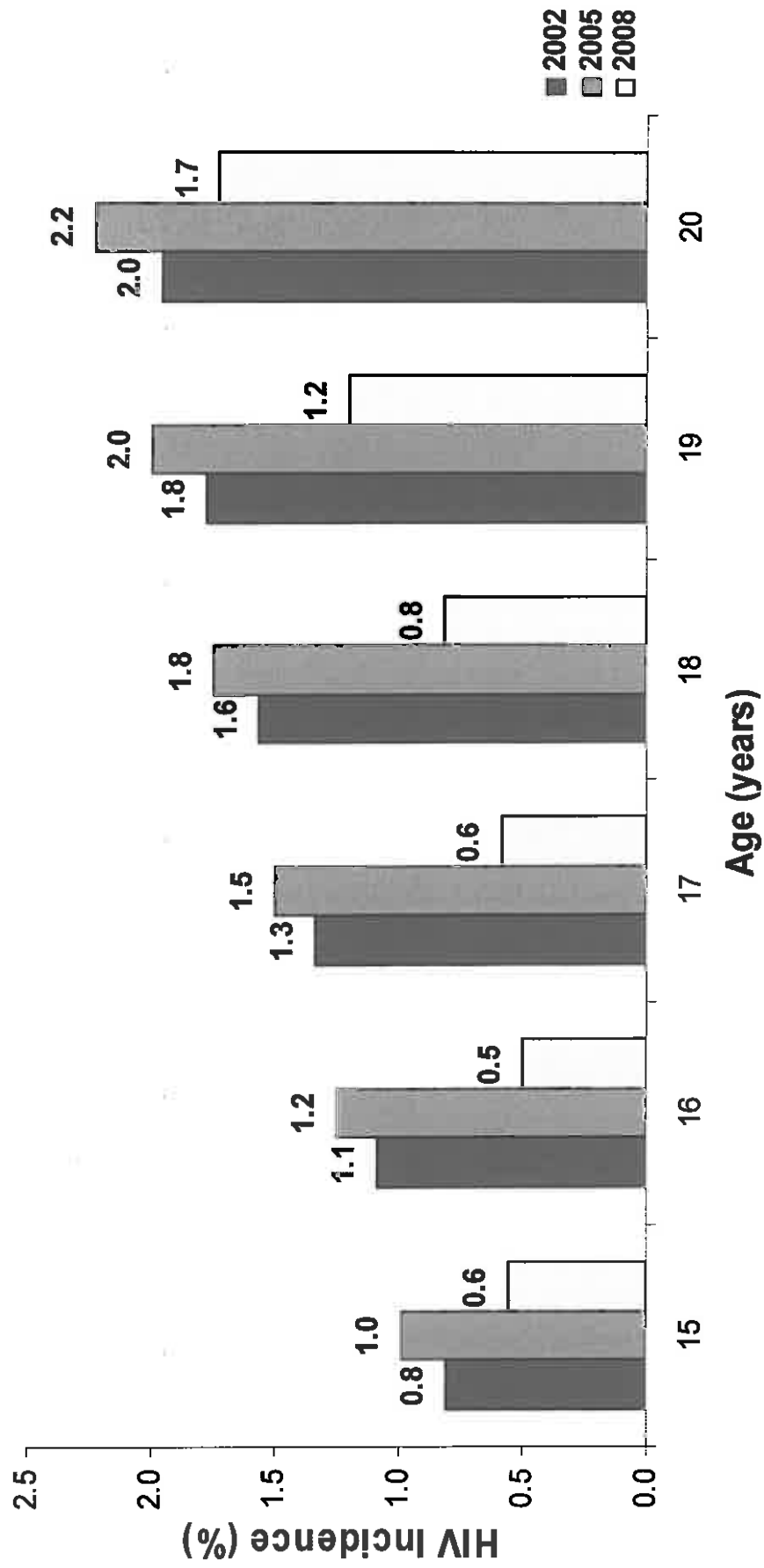
Leigh F. Johnson^{1,*}, Timothy B. Hallett³, Thomas N. Rehle^{1,4}
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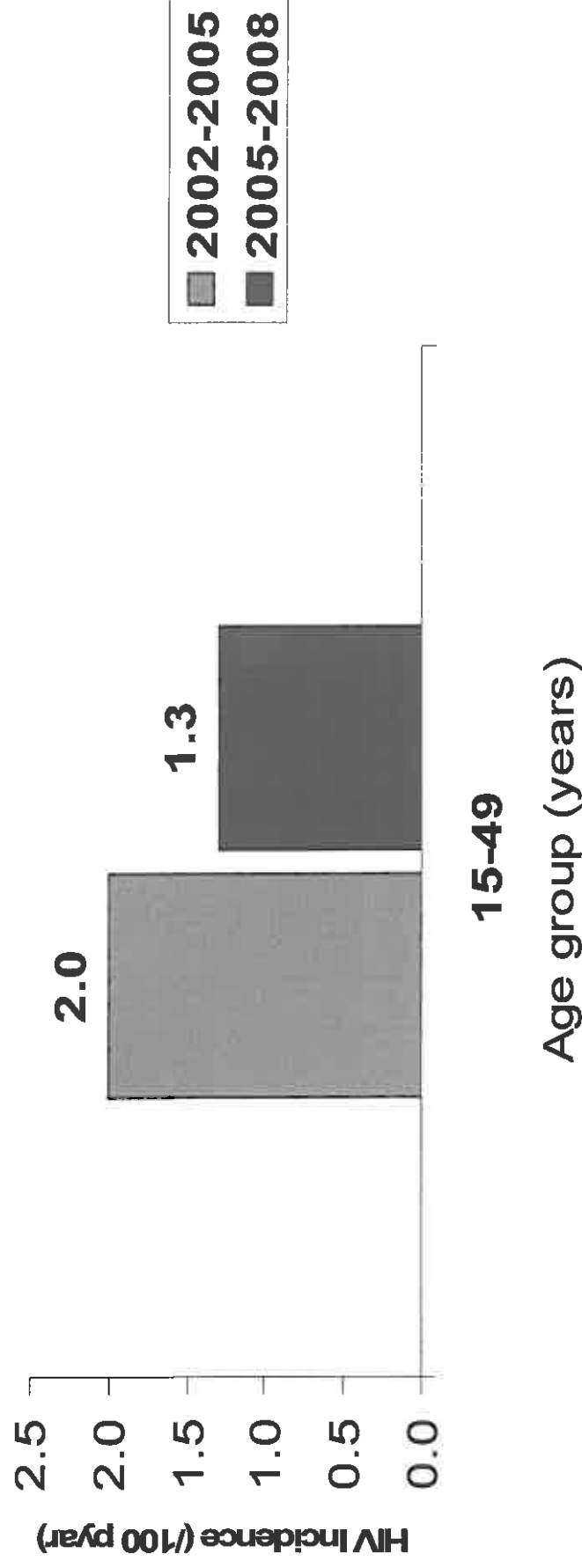
HIV incidence in 15-20 year olds derived from single year age prevalence South Africa 2002, 2005, 2008



A Decline in New HIV Infections in South Africa: Estimating HIV Incidence from Three National HIV Surveys in 2002, 2005 and 2008

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**Estimating HIV incidence from prevalence
data collected in 2002, 2005 and 2008
using synthetic cohort approach**

- **average annual HIV incidence rates for a given period between two surveys**
- **method is limited to general population, not applicable for subpopulations or specific risk groups (CSWs, IDUs)**



2. Laboratory- based methods

- **BED incidence estimates (2005 survey)**
- **Multi - assay testing algorithm (2012 survey)**

BED HIV incidence and behavior HSRC 2005 (age group 15 – 49 years)

| Variable | HIV incidence (% per year) |
|---|-------------------------------|
| <i>Marital status</i> | |
| Single | 3.0 |
| Married | 1.3 |
| Widowed | 5.8 |
| <i>Sexual history</i> | |
| Sexually active in the past 12 months | 2.4 |
| Current pregnancy | 5.2 |
| <i>Condom use at last sex (15-24 yrs)</i> | |
| Yes | 2.9 |
| No | 6.1 |

Evaluating the BED Capture Enzyme Immunoassay to Estimate HIV Incidence Among Adults in Three Countries in Sub-Saharan Africa

Andrea A. Kim,¹ John S. McDougall,² John Hargrove,³ Thomas Behle,⁴ Victoria Pilley-Van Wyk,^{4,5} Adrian Puren,⁶ Alexandre Ekra,⁷ Marie Yolande Borget-Alioué,⁷ Christiane Ache-Toure,⁷ Ahmed Sheikh Abdullahi,⁸ Linus Odawa,⁹ Lawrence Marum,⁹ and Bharat S. Parekh¹

South Africa 2005

| Age group (years) | Adjusted BED HIV incidence ^a % per year (95% CI) ^b | EPP and Spectrum model % per year | ASSA Spectrum model | BED to EPP and Spectrum ASSA ratio | BED to ASSA ratio |
|----------------------|--|-----------------------------------|---------------------|------------------------------------|-------------------|
| Adults (15–49 years) | 2.4 (1.7–3.1) | 2.0 (1.7–2.4) | 2.2 | 1.2 | 1.1 |
| Males | 1.0 (0.4–1.6) | 1.7 (1.4–2.0) | 1.9 | 0.6 | 0.5 |
| Females | 3.8 (2.6–5.0) | 2.4 (2.0–3.0) | 2.5 | 1.6 | 1.5 |

BED adjustments: externally vs locally derived
– which false recent rate (FRR) should be used?

Comparison of adjusted BED HIV incidence (% per year)
with ASSA model, South Africa 2005

| Age group | ASSA | BED | BED |
|--------------------|--------------|--------------------|--------------------|
| 15-49 years | model | FRR = 5.57% | FRR = 1.69% |
| Total | 2.2 | 2.4 | 3.7 |

(McDougal et al. 2006) (Bärnighausen et al. 2008)

Recent progress in assay-based incidence estimation – SACEMA (South African Centre for Epidemiological Modelling and Analysis)

2009:

First consistent analysis of ‘false recency’ still relied on simplifying assumptions (McWalter and Welte, Journal of Mathematical Biology)

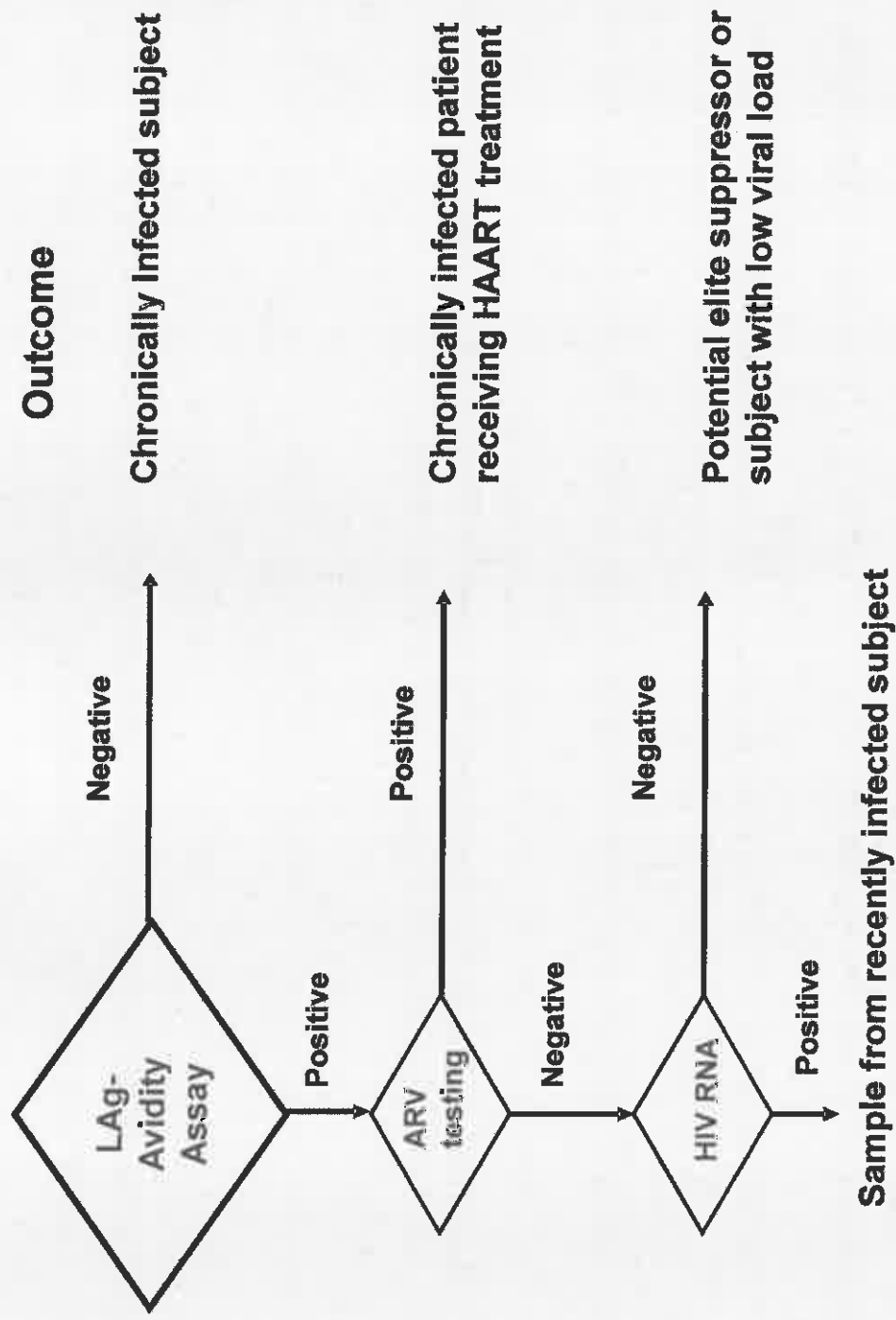
2011:

WHO/UNAIDS guidance incorporates these developments

2012:

- General analysis of recency test dynamics finally appears in print (Kassanjee et al, Epidemiology)
- SACEMA provides spreadsheet tools to implement general analysis (www.incidence-estimation.com)
- SACEMA hosts first WHO/CDC sponsored training workshop for end-users
- SACEMA coordinates HIV Modelling Consortium work package – phase one: optimal characterisation of recent infection tests.

Testing Algorithm for Recent Infection, Survey 2012



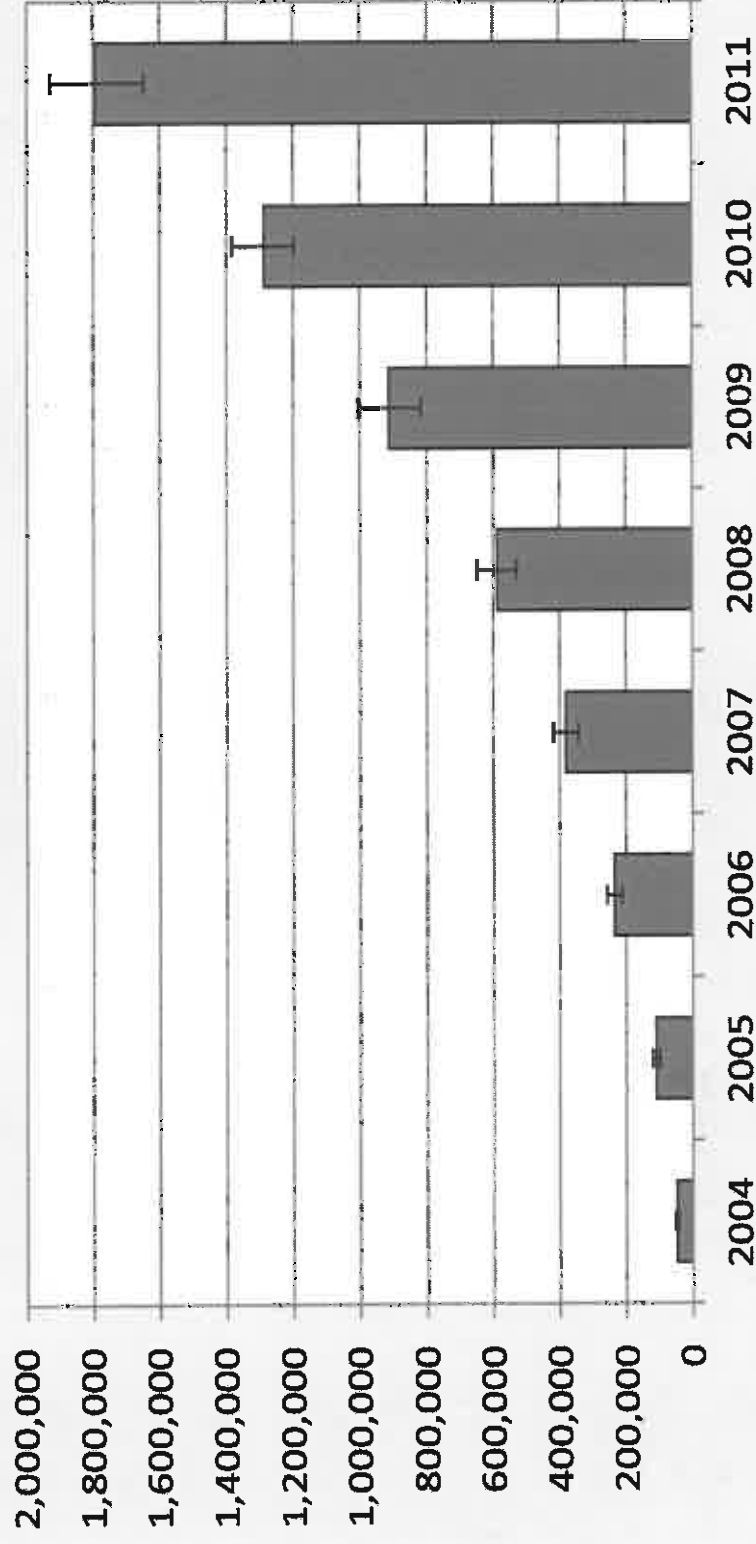
Mean recency period (in days) for LAg-Avidity EIA at cutoff of 1.0 by cohort/subtypes (Bharat Parekh, CDC 2012)

| Cohort | No. of Subjects (No. Spec) | HIV-1 Subtypes | Mean Recency Period (95% CI) |
|-------------------------|---------------------------------------|---------------------------|---|
| Amsterdam & Trinidad | 32 (170) | B | 132 (104-157) |
| Ethiopia | 23 (143) | C | 139 (106-178) |
| Kenya | 34 (80) | A, D | 143 (103-188) |
| ALL | 89 (393) | A, B, C and D | 141 (119-160) |

→ need to test for ARVs in HIV surveys!

ART rollout in South Africa

(Analysis by Leigh Johnson, 2012)



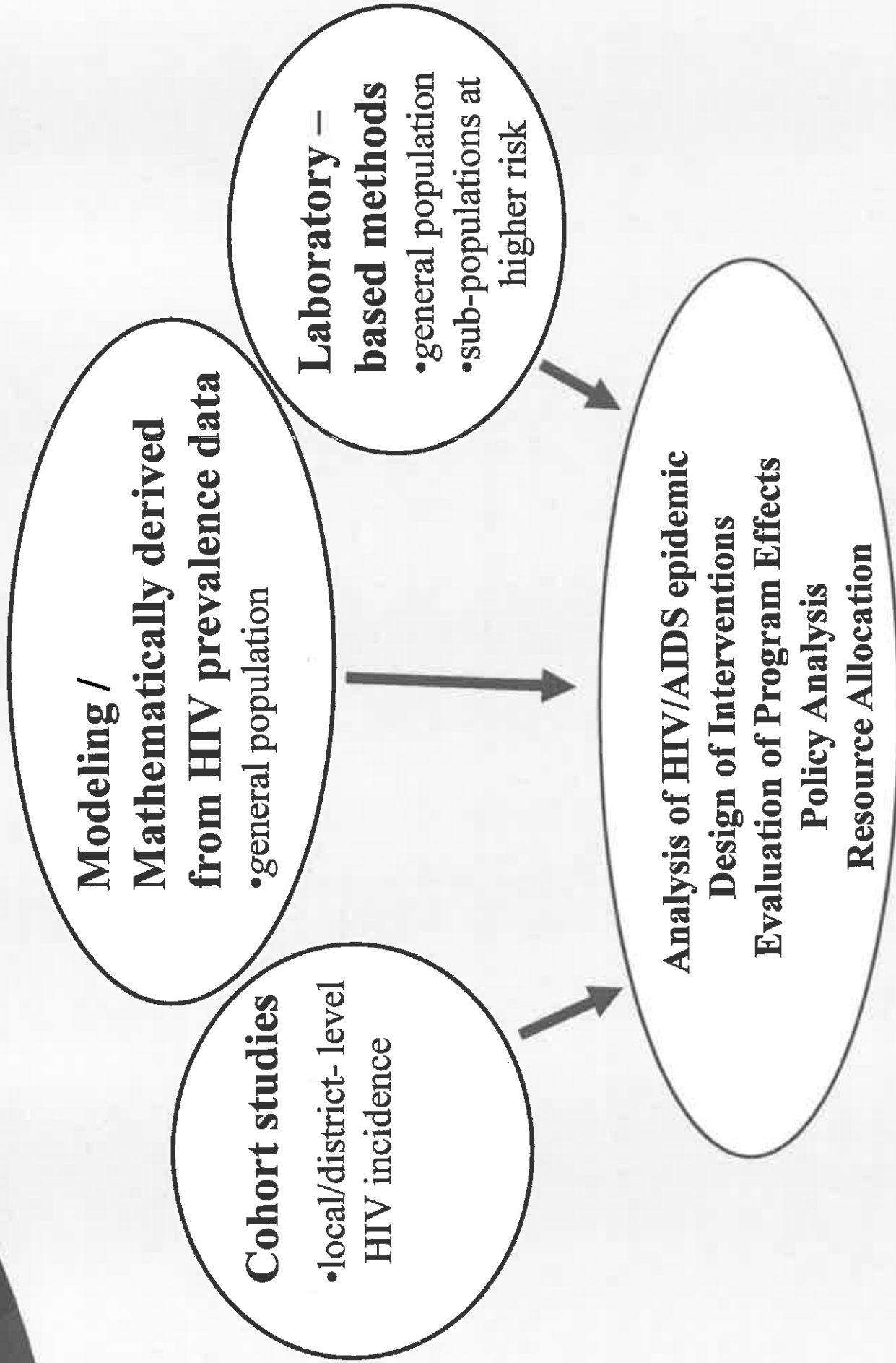
Testing for ARVs

- **Method:**
High Performance Liquid Chromatography coupled to Tandem Mass Spectrometry (HPLC – MS/MS)
- **Qualitative determination of ARVs (NRTI, NNRTI and PI) in HIV positive DBS samples:**

2008: Lopinavir, Ritonavir, Nevirapine, Efavirenz, Indinavir, Saquinavir, Zidovudine, Lamivudine, Stavudine

2012: Zidovudine, Nevirapine, Efavirenz, Lopinavir, Atazanavir, Darunavir

Combination HIV incidence estimation



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