HIV Resource Allocations using AEM

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Conference on Improving Efficiency in Health
3-4 February 2016
World Bank, Washington DC, USA
What is the AIDS Epidemic Model?

- **AEM** – a behavioral process model
  - Simulate transmission dynamics in concentrated epidemics
  - Major transmission routes include:
    - Vaginal sex (sex work, casual and marital)
    - Anal sex (receptive and insertive)
    - Needle sharing
  - ART by sub-population
    - Infectivity reductions on ART
    - Coverage of ART in a given population
    - Eligibility criteria
  - **NOTES:**
    - Pediatric transmission through Spectrum
    - External infections can be added (blood, migrants, etc.)
What groups are included in AEM?

- Low or no risk male
- Low or no risk female
- Client
- MSM/MSW
- FSW/ISW
- IDU (M/F)
- TG

Those that are important in concentrated epidemics
As country needs dictate, add new groups
Internal male and transgender structure in AEM

15 year old males

Heterosexual

Non-Client

Client

Male IDU

Low risk network

High risk network

Transgender

Sex workers

Casual partners

Regular partners

Same-sex male

MSM1

MSM2

MSW

15 year old males

Note: this movement Allows for turnover in The various groups

Death
Internal female structure in AEM

15 year old females

General Female

Female IDU
- Low risk network
- High risk network

Female Sex Worker
- FSW1 Non-injecting
- FSW1 ISW
- FSW2 Non-injecting
- FSW2 ISW

Death
Each sub-group has uninfected & infected
New infections through different routes calculated from behaviors

- Visit sex workers
  - Extramarital sex
    - Infected wives

- Male Non-Clients
- IDUs
- MSMs
- MSWs
- Death
How are new infections calculated?

\[ N_{\text{new Infections}} = n_{\text{contacts HIV}} P_{per\_contact} \]

- **New Infections**
  - \( N_{\text{new Infections}} \) = Size of risk group
  - \( n_{\text{contacts HIV}} \) x Freq of contacts
  - \( P_{per\_contact} \) x HIV prevalence of partners
    (Chance to meet positive partners)
  - \( n_{\text{contacts HIV}} \) x Fraction unprotected
  - \( P_{per\_contact} \) x Transmission probability
  - \( n_{\text{contacts HIV}} \) x Adjustments for STI & circumcision
  - \( P_{per\_contact} \) x Adjustments for ART

Total number of unprotected contacts with HIV positive partners
That determines the key inputs needed

• Biological data trends
  – HIV prevalence, STI prevalence, circumcision in males

• Behavioral data trends - sexual
  – Frequency of sexual activity, condom use with different partners, duration of sex work/clienthood (for turnover)

• Behavioral data trends – injecting
  – Frequency of injection, level of needle sharing, duration

• Sizes of key populations
  – Entered as % of adult male or female population
Adjusting epidemic parameters
The result: a model tuned to the country’s epidemiological & behavioral situation

Green lines are observed national prevalence

Changing probabilities & cofactors alters curves
AEM Outputs
Dashboard: customizable overview

Asia baseline
Results for the year: 2020
- New HIV infections: 94,437
- Current PLHIVs: 1,011,104
- Annual AIDS death: 78,626
- Annual ART needs: 471,489
- Number on ART: 235,744
- Male-Female Inc Ratio: 1.91
- Cumulative infections: 2,293,994
- Cumulative deaths: 1,282,890
- Cumulative M/F Ratio: 2.08

HIV prevalence by population, 1990-2020

Total Adult ART Coverage and Need, 1990-2020


Distribution of new HIV infections in 2020
Total 94,437 HIV Infections
- Clients: 26%
- Male IDU: 3%
- MSW: 6%
- MSM: 6%
- TG: 1%
- LR Males: 0%
- FSW: 0%
- RDU: 0%
- LR Women: 5%

Distribution of current HIV infections in 2020
Total 1,011,104 HIV Infections
- Clients: 23%
- Male IDU: 3%
- MSW: 30%
- MSM: 5%
- TG: 35%
- LR Males: 2%
AEM Outputs – modes of transmission
Details of new infections in a given year

New and Current HIV Infections by Population Source and Modes of Transmission

Set the year you would like to look at here: 2020 OR use the scroll bar to tab through the years OR push >>> to cycle through all years

New HIV Infections by Sub-Population in 2020
Total 94,437 infections

Clients 51%
LR Women 26%
FIDU 2%
FSW 6%
LR Males 3%
MSM 5%
MSW 1%
Male IDU 6%

Distribution of Source of Infection by Sub-Population, 2020

- Sex with Female Sex Workers
- Spouses / Regular Partners
- Casual Sex Partners
- Injecting with other IDU
- Sex with IDU
- Sex with TG
- Sex with Male Sex Workers
- Sex with MSM
- Sex with Clients of SW
- Additional / external infections
## AEM Outputs – modes of transmission

Details of infection sources

<table>
<thead>
<tr>
<th>Source of HIV Infection</th>
<th>SW Clients</th>
<th>Male IDU</th>
<th>Male SW</th>
<th>MSM</th>
<th>TG</th>
<th>LR Males</th>
<th>FSW</th>
<th>Female IDU</th>
<th>LR Females</th>
<th>Total</th>
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<tbody>
<tr>
<td>Sex with Female Sex Workers</td>
<td>48,505</td>
<td>66</td>
<td>55</td>
<td>486</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>49,113</td>
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<tr>
<td>Spouses / Regular Partners</td>
<td>108</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td>2,490</td>
<td>-</td>
<td></td>
<td></td>
<td>21,967</td>
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<td>Casual Sex Partners</td>
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<td>151</td>
<td>-</td>
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<td>Injecting with other IDU</td>
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<td>5,337</td>
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<td>11</td>
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<td>125</td>
<td>41</td>
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<td>758</td>
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<td>Sex with TG</td>
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<tr>
<td>Sex with Male Sex Workers</td>
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<td>Sex with MSM</td>
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<td>656</td>
<td>3,532</td>
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<td>28</td>
<td>333</td>
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<td>4,548</td>
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<tr>
<td>Sex with Clients of FSW</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td></td>
<td>5,369</td>
<td>-</td>
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<td>5,369</td>
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<tr>
<td>Additional /external infections</td>
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<td>-</td>
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</tbody>
</table>
AEM Tools Suite: the Workbooks

- **AEM Baseline**: contains full inputs & results of a projection
- **AEM Intervention**: allows exploration of impacts & costs of alternative program scenarios to address the epidemic
- **AEM Impact Analysis**: compares scenarios on key policy outputs
### AEM Optimization Tool – add-on to AEM Tools Suite

**Cost**

<table>
<thead>
<tr>
<th>RunID</th>
<th>FSW1 Cost</th>
<th>FSW2 Cost</th>
<th>IDU Cost</th>
<th>MSM Cost</th>
<th>MSW Cost</th>
<th>TG Cost</th>
<th>Total Cost</th>
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<td>4,085,160</td>
<td>2,548,398</td>
<td>819,600</td>
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<td>6,171,991</td>
<td>3,497,898</td>
<td>2,015,294</td>
<td>689,344</td>
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<tr>
<td>1,000</td>
<td>2,728,613</td>
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<td>6,171,991</td>
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<td>3,081,501</td>
<td>689,344</td>
<td>17,735,927</td>
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</table>

**Coverage**

<table>
<thead>
<tr>
<th>RunID</th>
<th>FSW1 Cov</th>
<th>FSW2 Cov</th>
<th>IDU Cov</th>
<th>MSM Cov</th>
<th>MSW Cov</th>
<th>TG Cov</th>
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<tbody>
<tr>
<td>1</td>
<td>33.0%</td>
<td>51.3%</td>
<td>68.1%</td>
<td>9.0%</td>
<td>38.6%</td>
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<td>2</td>
<td>34.9%</td>
<td>36.9%</td>
<td>70.6%</td>
<td>21.3%</td>
<td>36.3%</td>
<td>48.0%</td>
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<td>3</td>
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<td>34.3%</td>
<td>69.6%</td>
<td>19.0%</td>
<td>33.8%</td>
<td>50.5%</td>
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<td>4</td>
<td>31.1%</td>
<td>34.3%</td>
<td>75.5%</td>
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<td>52.1%</td>
<td>55.6%</td>
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<td>...</td>
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<tr>
<td>6</td>
<td>36.8%</td>
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<td>62.6%</td>
<td>19.0%</td>
<td>52.1%</td>
<td>55.6%</td>
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<tr>
<td>7</td>
<td>29.3%</td>
<td>34.8%</td>
<td>75.5%</td>
<td>16.8%</td>
<td>52.1%</td>
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<tr>
<td>1,000</td>
<td>38.7%</td>
<td>34.8%</td>
<td>73.1%</td>
<td>15.6%</td>
<td>52.1%</td>
<td>40.3%</td>
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</table>

**Impact**

<table>
<thead>
<tr>
<th>RunID</th>
<th>New HIV 2017</th>
<th>New Death 2017</th>
<th>PLHIV 2017</th>
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</thead>
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<tr>
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<td>1,062</td>
<td>856</td>
<td>8922</td>
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<td>1,095</td>
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<td>1,139</td>
<td>857</td>
<td>8996</td>
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<tr>
<td>4</td>
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<td>8938</td>
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<td>1,003</td>
<td>856</td>
<td>8863</td>
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<td>1,135</td>
<td>857</td>
<td>8843</td>
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<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>1,000</td>
<td>983</td>
<td>855</td>
<td>8843</td>
</tr>
</tbody>
</table>

With similar total amount of funding, which scenario gives us the best impact?
AEM has been applied extensively to modeling epidemics in Asia and in Peru & Ukraine.
AEM has been applied in many analyses for improving efficiency in resource allocation

- Cost-effectiveness analysis
- Investment case analysis
- Optimization analysis (Allocative Efficiency)
- Strategic ART use analysis
- Combined treatment & prevention impact
- Exploring any combination of coverage, costs and program effectiveness

Countries applied AEM for

- Input for strategic planning (NSPs)
- Input for GF NFM Concept Note
- Tools for advocacy, e.g., resource mobilization
AEM Process (1)
First, produce historical AEM baseline

- Size estimates
- Risk behaviors
- HIV prevalence
- Costs
- Coverage

Data collation and review, analysis, calibration and trend extraction

FSW, clients, MSM, PWID, Gen pop M&F

Model is tuned to country context
This provides a clear picture of where epidemic has been, where it is & where it is going.

**Annual New HIV Infections: by Risk Population, 1990-2020**

- **New HIV by mode of transmission, 2014**
  - Total 1,363 infections
  - Husband to wife 54%
  - Wife to husband 3%
  - Male-male sex 21%
  - Sex work 4%
  - External infections (Migrants) 11%
  - Needle sharing 6%

**Distribution of Source of Infection by Sub-Population, 2020**

- Clients (48,626)
- Male IDU (5,463)
- MSW (710)
- MSM (4,434)
- TG (0)
- LR Males (2,766)
- FSW (5,450)
- FIDU (2,309)
- LR Females (2,472)

**Legend:**
- Sex with Female Sex Workers
- Spouses/Regular Partners
- Casual Sex Partners
- Injecting with other IDU
- Sex with IDU
- Sex with TG
- Sex with Male Sex Workers
- Sex with MSM
- Sex with Clients of SW
- Additional/external infections

**Nepal**

[Graph showing annual new HIV infections by risk population from 1990 to 2020, with a pie chart indicating the distribution of new HIV cases by mode of transmission in 2014.]
AEM Process (2)
Second, calculate program effects on epidemic

- AEM Baseline Workbook
  - Baseline risk behaviors
  - Population sizes

- AEM Intervention Workbook
  - Coverage
  - Unit costs
  - Program effectiveness

- AEM
  - Behavior change

- A new set of impacts (new infections, deaths, HIV prevalence, etc.)
  - Total cost of the response
AEM Process (3)
Third, compare program alternatives, select most effective both with existing resources and with even more

- Indonesia – different geographic prioritizations
- Philippines – reversing the epidemic

Towards ‘Ending AIDS’
Impact on number of PLHIV up to 2030

Under ‘Ending AIDS’, total number of current infections begins to fall in 2018

Only ‘Ending AIDS’ actually reverses the epidemic
AEM analysis done as national in-country process

• Normally a series of 3 or more workshops
• National program usually leads
• Extensive engagement of stakeholders
  – Epidemiologists, program managers, behavioral scientists, national planners, policy makers, communities, international partners, donors
  – Assist in finding data & validating models
  – Choose and assess feasibility of scenarios
  – Jointly plan for dissemination & advocacy
• Informs NSP, concept note development
Process involves extensive scenario analysis

- Many scenarios are run to assess impact of alternative responses

Vietnamese scenarios explored
Process raises awareness of critical issues

- Philippines – low coverage
- Vietnam – shrinking resources

**Intervention coverage is still far below the level required to contain the epidemic**

- FSW: 16% (Range: 4-62%)
  - Target: 80%
- PWID: 6.3%
  - Target: 80%
- MSM: 9.3%
  - Target: 80%
- MSM <25 yrs: 7.2%
  - Target: 80%
- ART: 20% (of all PLHIV)
  - Target: 90%

**Figure 7: HIV commitments and funding gap, 2012-2016**

Source: VAAC

HIV Prevention (HIV Test) and ART Coverage, 2014 GARPR DOH-NEC
(See also Annex 2 for coverage per sub-epidemic region)
Process highlights costs of effective responses

- Indonesia – living with HIV

Current Infections (Total) for Total Adult, Non-Papua 2013-2030

Resource needs

Resource Needs for Total Resource Needs (000 USD), Non-Papua 2013-2030
Process highlights return on investment

- Keep Focusing prevention
- Expanding ART in Thailand leading to “Treat All” policy with highly cost-benefit

Population Groups:

<table>
<thead>
<tr>
<th>Mode of Transmission</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casual and Extramarital sex</td>
<td>6%</td>
</tr>
<tr>
<td>Spousal transmission</td>
<td>32%</td>
</tr>
<tr>
<td>Injection Drug User</td>
<td>10%</td>
</tr>
<tr>
<td>Sex worker and clients</td>
<td>11%</td>
</tr>
<tr>
<td>Male who had sex with male</td>
<td>41%</td>
</tr>
</tbody>
</table>

Geographic Focus:

65% of new HIV infections happen in 31 provinces

Excellent return on investment

- Current annual investments by Thailand on the AIDS response: $300 million
- Total additional investments required in the next decade: $100 million
- Estimated economic benefits on investment (through treatment and hospitalisation costs averted): $300 million

Every additional dollar invested now gets three dollars in returns

- Total number of deaths averted: 22,000
- Total number of new infections averted: 20,000
- Cost/DALY saved (including ARV costs): $1165
Lesson learned: in-country engagement has many benefits – process as important as product

- Brings more data and program information into the light
  - Maximize data use, people who share have more ownership
- Lets the data “talk” to people who haven’t seen it before
- Raises general awareness of strengths and weaknesses in:
  - Data systems (e.g. data gaps)
  - Capacity to respond
  - Responses themselves
- Builds a common understanding of the epidemic and what is most important to containing it
- Builds ownership of the outputs and strengthens advocacy process
Lesson learned: process keeps audience in mind

- Write the analysis results for a general audience
  - Focus on key messages
  - Keep technical details to appendices or other

- Additional policy briefs and advocacy material have proven helpful

Philippines and Thailand briefs prepared for policy advocacy
Example of AEM analysis: Thailand

Thailand can end AIDS

Thailand can achieve HLM targets and move towards being the first country to end AIDS

Number of new HIV infections

- Current Response
- HLM 2015 target
- Optimized Response
- The end of AIDS in Thailand
Example of AEM analysis: Viet Nam

Viet Nam Investment Case: Funding vs New infection

New infection in 2030 by different investment scenarios

Total investment during 2013-2030 (’000 USD)

- Baseline
- Halfway
- National target
Viet Nam Investment Case

= $100 million
= 100,000 years of life

Saving lives saves money. Every $1 invested generates $5.5 of economic activity

This will prevent 150,000 HIV infections, saving 4.15 million years of life

Ending AIDS requires an investment of $92 million/year, or $1.47 billion
Example of AEM analysis: Philippines
Philippines Investment Options
Towards ‘Ending AIDS’: impact on annual new infections up to 2030

‘Ending AIDS’ reduces new HIV infections to less than 500 a year by 2020. At that level, HIV will no longer be a major public health threat.
Example of AEM analysis: Indonesia Indonesia Optimization Analysis

# New Infections (Total) for Total Adult, 2012-2025

- Non-Papua With GF Without Optimization
- Non-Papua With GF Optimized Scenario from 500 Run with 50% Range
- Non-Papua National Strategy LKB Medium+ 75 Priority District
- Non-Papua Worse Case Without GF
### Example of AEM analysis: Bangladesh

#### Bangladesh Investment Case

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Epidemiological outcomes</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>New HIV infections per annum</td>
</tr>
<tr>
<td><strong>Baseline: Continuation: current coverage &amp; costs</strong></td>
<td>&gt;1,000</td>
</tr>
<tr>
<td><strong>Option 1: Continuation: current coverage; unit costs reduced</strong></td>
<td>&gt;1,000</td>
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<tr>
<td><strong>Option 2: Ending AIDS: high-impact</strong></td>
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</tr>
<tr>
<td><strong>Option 3: Ending AIDS: half coverage in non-priority districts</strong></td>
<td>&lt;300</td>
</tr>
<tr>
<td><strong>Option 4: Ending AIDS: moderate prevention scale up in priority districts</strong></td>
<td>&lt;300</td>
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<tr>
<td><strong>Option 5: Ending AIDS: moderate prevention scale up in priority, half coverage in non-priority districts</strong></td>
<td>&gt;300</td>
</tr>
</tbody>
</table>
Example of AEM analysis: Nepal Nepal Investment Case

Return on investment: Saving lives + Saving money

Disability Adjusted Life Years (DALY) saved

- ART 90% (CD4 500)
- CD4 500 TASP among KAP
- Optimized Resource
- Midway of Ending AIDS
- Ending AIDS

Number of DALYS Saved

28 million 28.6 million 29 million 30 million 36 million

Average Annual Investment
Example of AEM analysis: Cambodia Policy Analysis

# New Infections (Total) for Total Adult, 2013-2030

- ART 500 by 3 Years then Treat All with IDU scaleup
- ART 500 TasP by 3 Years then Treat All with IDU scaleup
- Eliminating HIV new infections
- Intervention Baseline
Example of AEM analysis: Myanmar

Myanmar Fast tract for Ending AIDS:

Number of New Infections

Fast track_90% at 2020
Baseline: business as usual
Example of AEM analysis: Malaysia
Malaysia Investment impact: Return of investment

Total investment for ‘Ending AIDS’: USD 429 million (RM 1.6 billion) in 7 years
- Prevention: USD 78 million (18%)
- ARV: USD 351 million (82%)

Save 644,000 Life years (DALY) equivalent of USD 6.8 billion (RM 25 billion) GDP

Invest 1 USD → Get 16 USD
Saving USD 6.4 billion!

Save lives + Save money
Conclusions

• The AEM model forms an organizing framework for linking epi & behavior to programs and their impacts

• Applied in a collaborative AEM process it:
  – Engages key stakeholders
  – Educates people about their epidemic & response
  – Provides direct estimates of comparative program impacts

• Building capacity to apply AEM in-country builds capacity for informed program guidance and impact assessment