Quantitative OR methodologies I

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Operations Research Mini Course

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Broad methodologies of OR

- Modeling (classic)
  - Develop mathematical model to mimic health care system
    - Manipulate to find the best possible “solution”
      - Optimize efficiency
      - Maximize X given constraints Y
- Intervention-based (Population Council)
  - Design/test best way to deliver services
  - Similarities to quality improvement (IHI/WHO)

Intervention-based OR

Population Council

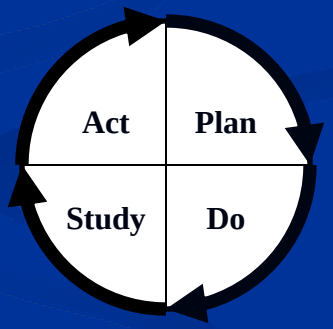
Linear

1. Identify program problem
2. Generate program solution
3. Test program solution
4. Use/disseminate results

IHI Collaborative

Cyclical

1. Plan
2. Do
3. Study
4. Act



Step 1: Identifying the program problem

- Problem usually determined in an ongoing program
- A discrepancy noted between the desired and observed situation
  - Routine program/clinic data (continuous indicators)
  - Program evaluation (point indicators)
- Feasible, effective, and sustainable solution is possible
- Problem can be solved by the program manager

Step 2:
Generate a program solution

- Actions that a program manager can take
- Has potential to make a large improvement
- Effects can be measured
- Easy to implement
- Affordable/sustainable

Sources of solutions

- How to develop a solution?
  - Understand the current health system policies and workflow
  - Talk to Program staff, clients
  - Review data from “good” programs in your system
  - Review experiences of other similar programs, scientific literature

- An understanding of the system is critical to develop an appropriate solution

What if a potential solution is not obvious?

- Consider an *exploratory study* to better understand problem
  - Review of program data and experiences
  - Quantitative / Qualitative research on patients / staff / policy-makers
  - Compare program to other programs with better indicators
  - Review of previous research

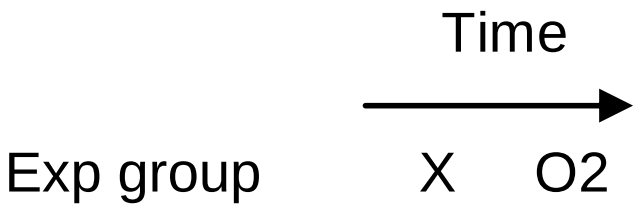
- Get to a point where you can identify a solution
  - Refining not always necessary

Step 3:
Test program solution

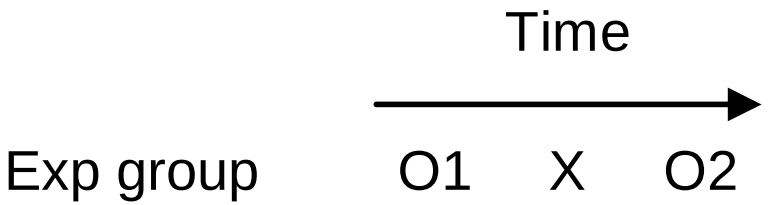
- Common OR study designs
  - Non-experimental
  - Experimental
  - Quasi-experimental

Non-experimental designs:
No randomization or good control group

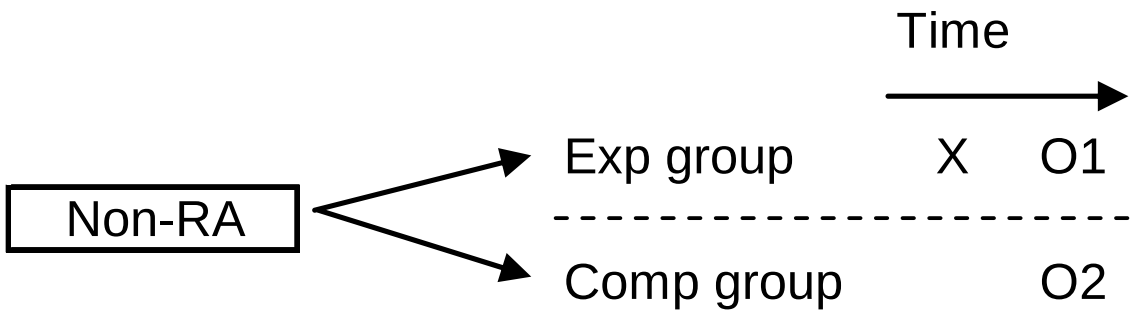
Posttest-only Design



Pretest-Posttest Design



Static-group Comparison Design

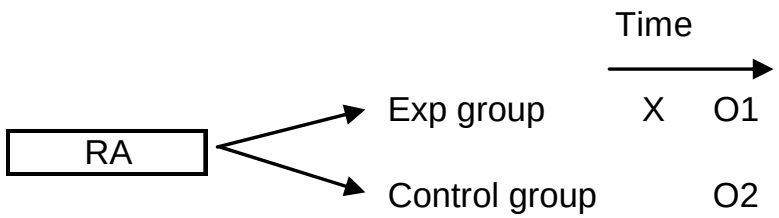


Non-experimental designs

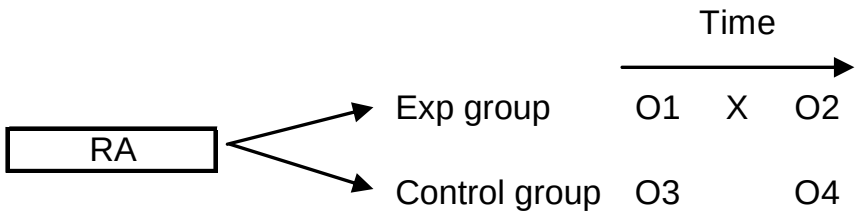
- Advantages = easy and can get some information
- Disadvantages = Subjected to many biases (threats to validity):
  - History bias
  - Selection bias
  - Testing/maturation bias
  - Instrumentation bias
  - Differential mortality
- Typically used if little time and money, or want to know basic characteristics of an intervention (i.e. basic pre/post data, uptake, perceptions)
  - Descriptive, small case studies

Experimental designs:
Random assignment & control group

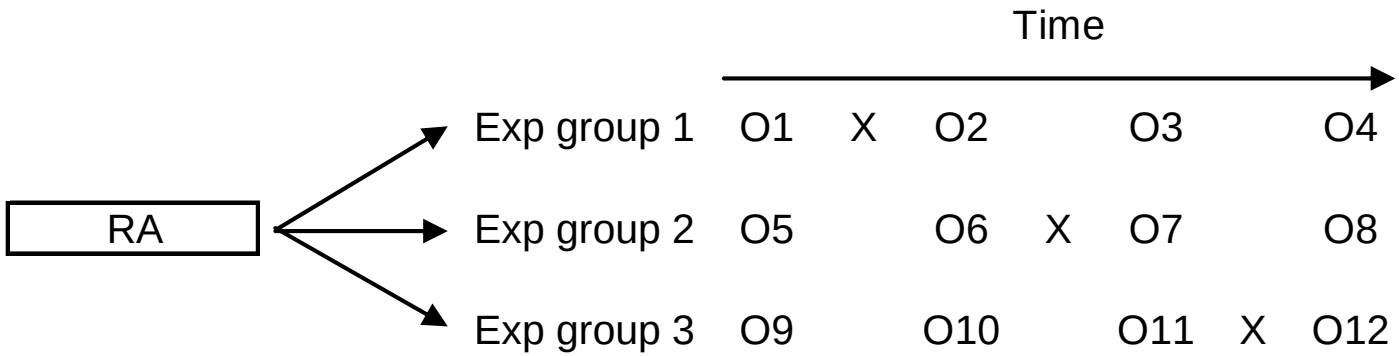
Posttest-only Control Group Design



Pretest-Posttest Control Group Design



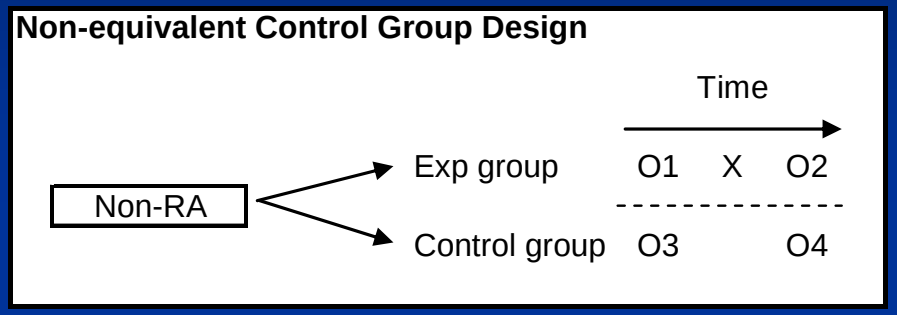
Stepped-Wedge Time-Series Design

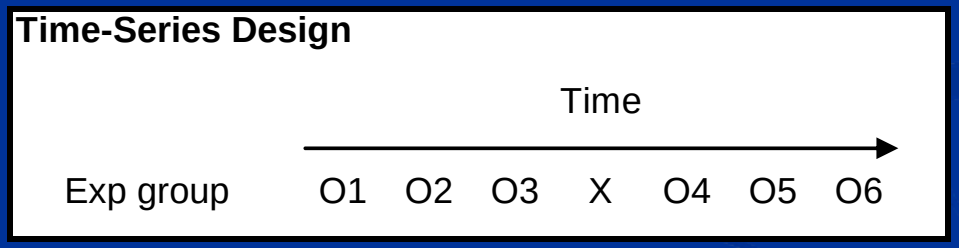


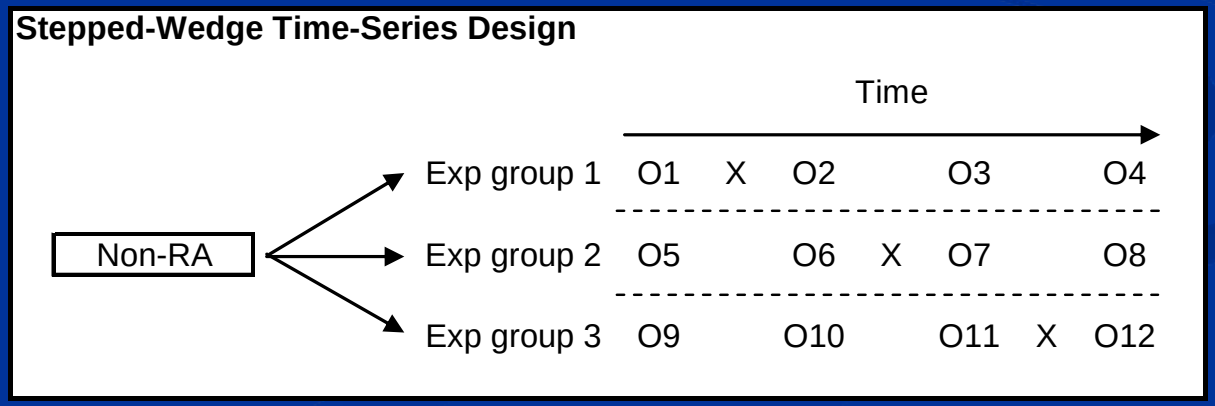
Experimental designs

- Advantages:
  - Reduces many sources of bias:
    - Control group: reduces testing/maturation bias, instrumentation bias, history bias (stepped-wedge)
    - Randomization: reduces selection bias
  - Allows best isolation of effect to intervention (“gold standard”)
- Disadvantages:
  - Higher costs
  - May be difficult or impractical
  - Still subjected to
    - History bias
    - Differential mortality

Quasi-experimental designs:
Non-random assignment & control group







Quasi-experimental designs

- Advantages:
  - Often times more practical than randomized studies
  - Reduces many sources of bias:
    - Control group: reduces testing/maturation bias, instrumentation bias, history bias (time-series/stepped-wedge)
    - Selection bias not reduced, but can be mitigated by matching
- Disadvantages:
  - Still subjected to
    - Selection bias
    - History bias
    - Differential mortality

Study issues to consider:
Choosing study design

- Weigh advantages and disadvantages of complex designs
  - Money & time
  - Meaningful magnitude of effect
  - Consequences of “wrong answer” on health and resources
  - Reality of field conditions (sometimes randomization is impossible)

- Advantages of using facilities as unit of intervention (vs. individuals)
  - Able to look at “real-world” application
  - Easier to measure added programmatic costs (training, costs)

Study issues to consider:
Choosing study outcomes

- Choice of program outputs, outcomes, and impacts
  - What are you interested in programmatically?
    - Will ↑ testing → ↑ enrollment in clinic → ↑ starting HAART?
    - Will ↑ number on HAART → ↓ adherence?
    - Will ↑ number on HAART → ↓ HIV mortality?
  - Are proximal outputs good enough?
  - Are distal impacts attributable to your intervention?

- Routine data vs. added data gathering
  - Money & time
  - Adequacy/accuracy of routine indicators

Study issues to consider:
Measure progress of implementation

- Important to measure if intervention was implemented as intended
  - Evaluates feasibility of intervention
    - Staff/patient acceptance
    - Problems encountered and overcome
    - Learn from experience for wider implementation
  - How intervention was implemented may effect your results

Example 1: Strategy to increase MCH service utilization in Senegal*

- Program problem: Low utilization of available MCH services in health units
  - Pre/post natal visits
  - Child vaccinations
  - STD testing & treatment
  - Child growth monitoring
  - Family planning

* Sanogo D, et al, Using Systematic Screening to Increase Integration of Reproductive Health Services Delivery in Senegal, Frontiers in Reproductive Health Program, 2005.

Interventional study

- Potential solution: Integration of services via "check-list"
  - Used during outpatient visits
  - Serves as clinical reminder
  - Improve documentation of services provided

Figure 1.
Short screening checklist used in Senegal

To be filled in by screener

Client's age _____ **Principal reason for visit** _____

_____

Before the consultation, always ask the client if, in addition to the principal reason for her visit, she would like to receive one of the following services (circle number)		*After the consultation, always note the result of the visit (write the number of the corresponding code)*		
		1 Offered	2 Appointment	3 Referral
1	Prenatal consultation			
2	Vaccination for tetanus			
3	Postnatal consultation			
4	Family planning			
5	Screening or treatment for RTI/STI			
6	Vaccination of child			
7	Growth monitoring of child			

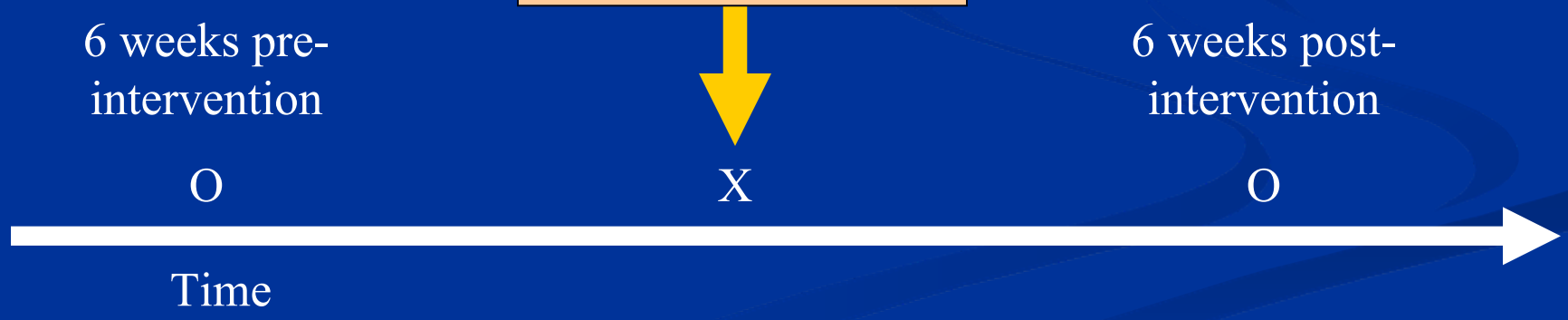
Source: Sanogo et al. 2005.

Study design: Pre/post non-experimental

Pre-intervention measurement (7 sites)
- Interview women after clinic visit
- Ask about number of services received

Implementation of intervention
- Clinical training (1/2 day)
- Supervision of use of checklist (2 days)

Post-intervention measurement (7 sites)
- Interview women after clinic visit
- Ask about number of services received



Results

Table 2. Mean Services and Appointments per Visit by Health Post and Area

Health Posts	Mean Services per Visit		% Change	Mean Appointments per Visit	
	Pre	Post		Pre	Post
Total Dakar	1.17	1.40*	20	0.15	0.20*
HLM1	1.20	1.51*	25	0.20	0.21
Georges Lahoud	1.16	1.46*	26	0.11	0.09
Derklé	1.12	1.28*	16	0.11	0.40*
Liberté IV	1.21	1.30*	7	0.10	0.01*
Total Kebemer	1.44	1.79*	35	0.18	0.20
Diokoul	1.38	1.95*	41	0.05	0.07
Gueoul	1.61	1.81*	12	0.58	0.37
Sagatta	1.27	1.59*	25	0.40	0.56*

*p<.001

Example 2: Strategy to increase HIV care utilization in TB patients in Mozambique

- Program problem:
  - Few TB patients tested for HIV at local VCT
    - New TB patients enrolled ~ 250/mo
    - TB patients tested for HIV ~20/mo
  - ~8% of estimated TB-HIV patients enrolled into care at HIV clinic*

- Likely due to HIV testing/care system for TB patients

* *Micek, MA, Integrating TB and HIV Care in Mozambique: Lessons from an HIV Clinic in Beira. CORE TB/HIV Case Study, The CORE Group, Washington DC, September 2004.*

Potential solution: Change HIV care for TB patients

Old system

TB patient treated at TB center

↓

Referred to VCT center for HIV testing

↓

If HIV+

- Continue at TB clinic for: TB treatment
- Referred to HIV clinic for: HIV counseling, Treatment of OIs, CTX proph., HAART

New system

TB patient treated at TB center

↓

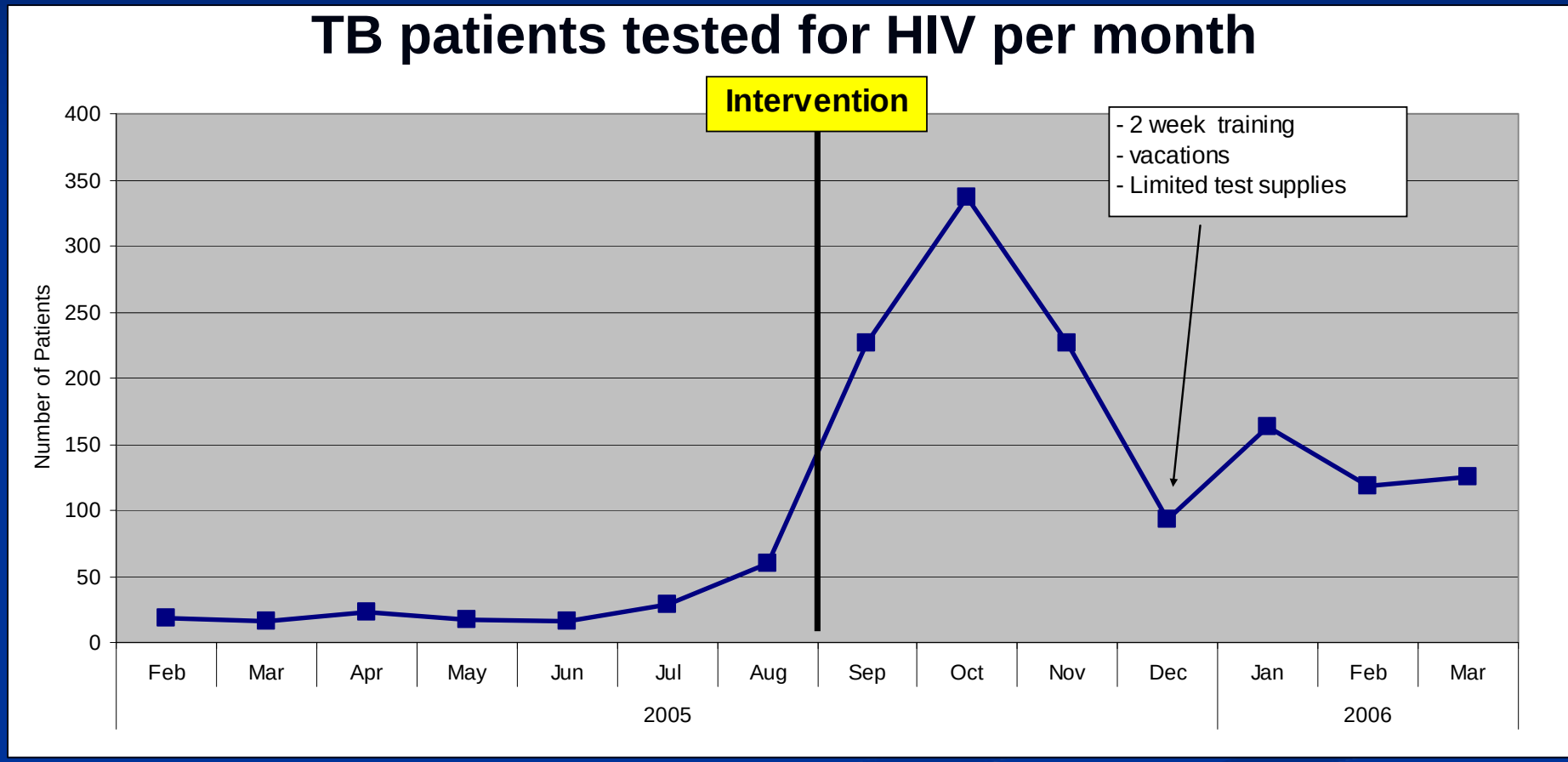
"Opt-out" HIV testing at TB center
Rotating VCT counselors
TB nurses

↓

If HIV+

- Continue at TB clinic for: HIV counseling, TB treatment, CTX proph.
- Referred to HIV clinic for: HIV counseling, Treatment of OIs, HAART

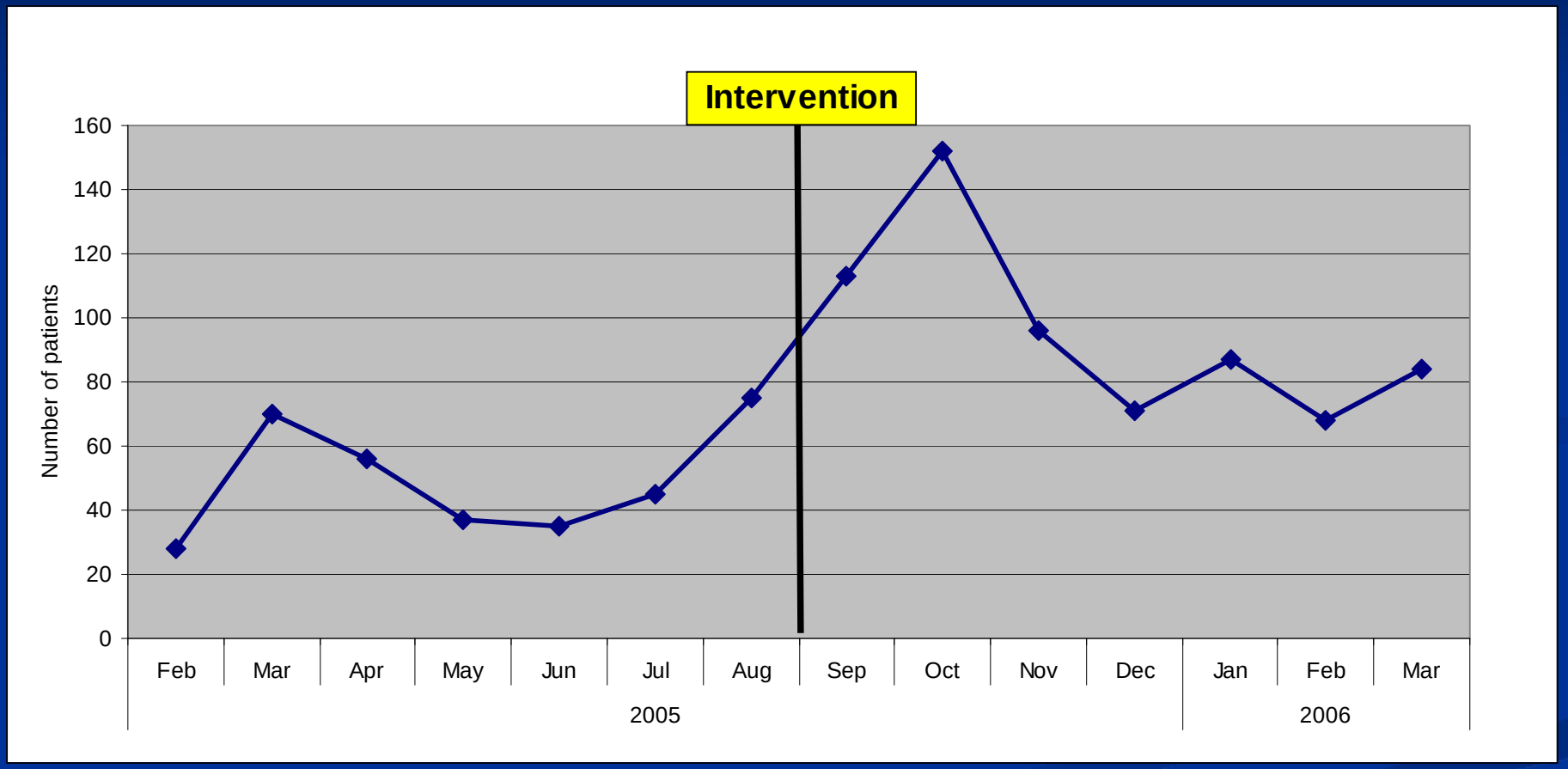
Study design: Time series (quasi-experimental)



Average 25/mo (7 mos prior) → 184/mo (7 mos after), p=.002

- Remained significant after adjustment for time (p=.003)

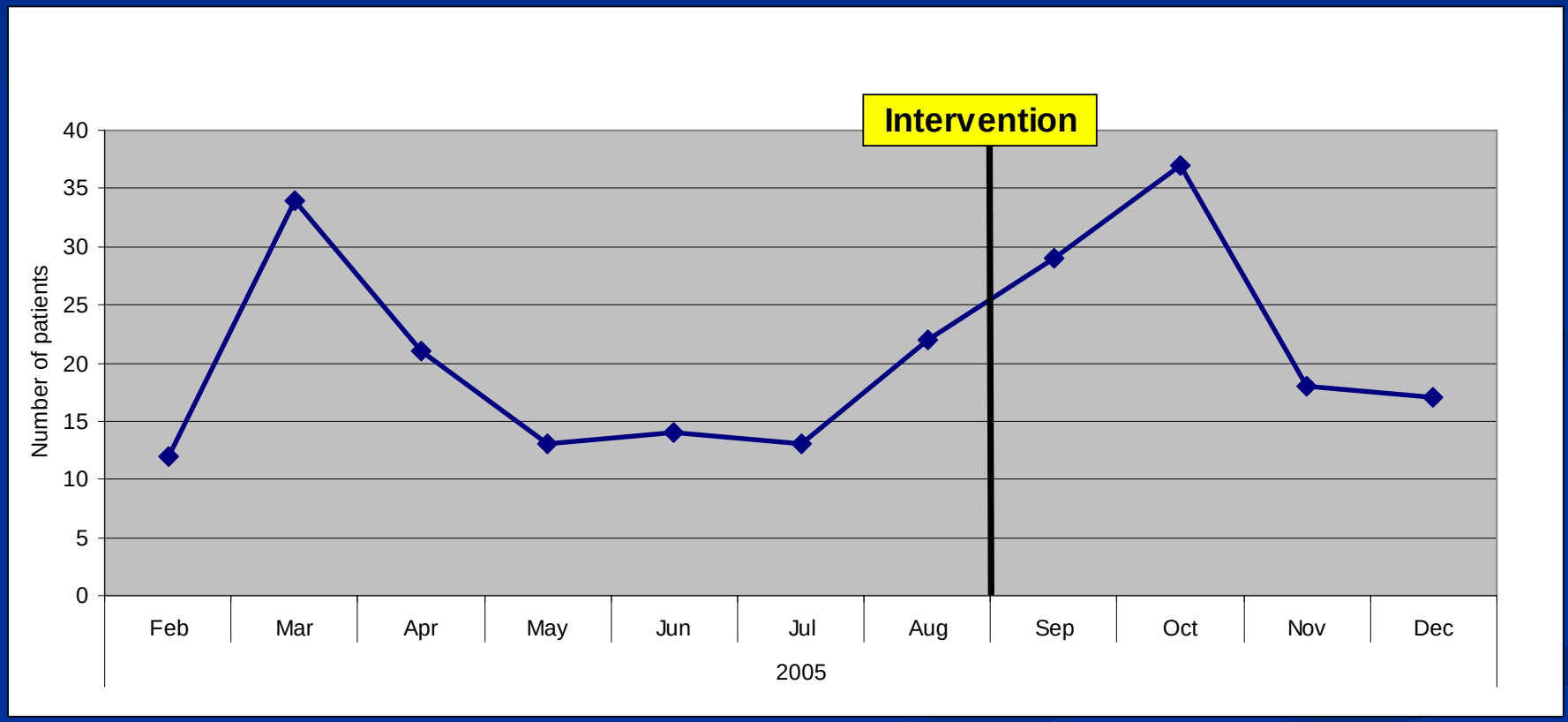
TB patients registered at the Beira HIV clinic per month, Feb 2005 - Mar 2006



Average 49/mo (7 mos prior) → 96/mo (7 mos after), p=0.001

- Remained significant after adjustment for time (p=.020)

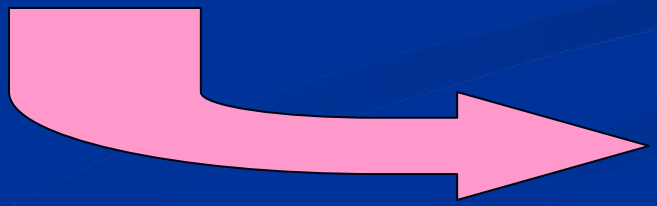
TB program patients starting HAART, by month of registration at Beira HIV clinic, Feb 2005 - Dec 2005



Average 18/mo (7mos prior) → 25/mo (4mos after), p=0.23

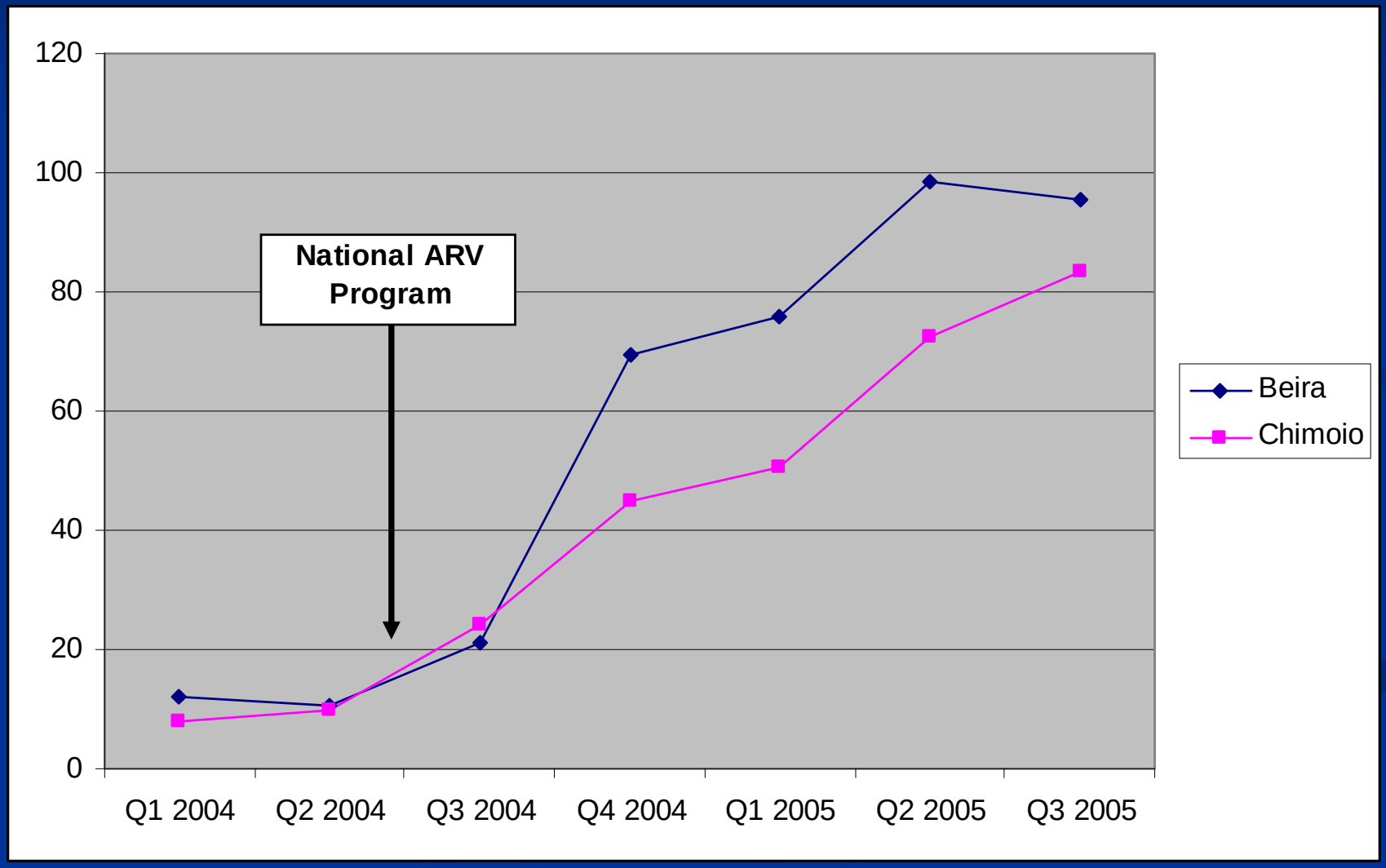
Next steps

- TB treatment outcome analysis pending
- More work needed
  - Overcome barriers to HIV testing (mostly logistical)
  - Increase referral to HIV clinic– better counseling?
  - Improve flow at HIV clinic– streamline TB patients?
  - Decentralize more HIV services to TB sites?
    - CD4 counts
    - HAART, with appropriate personnel

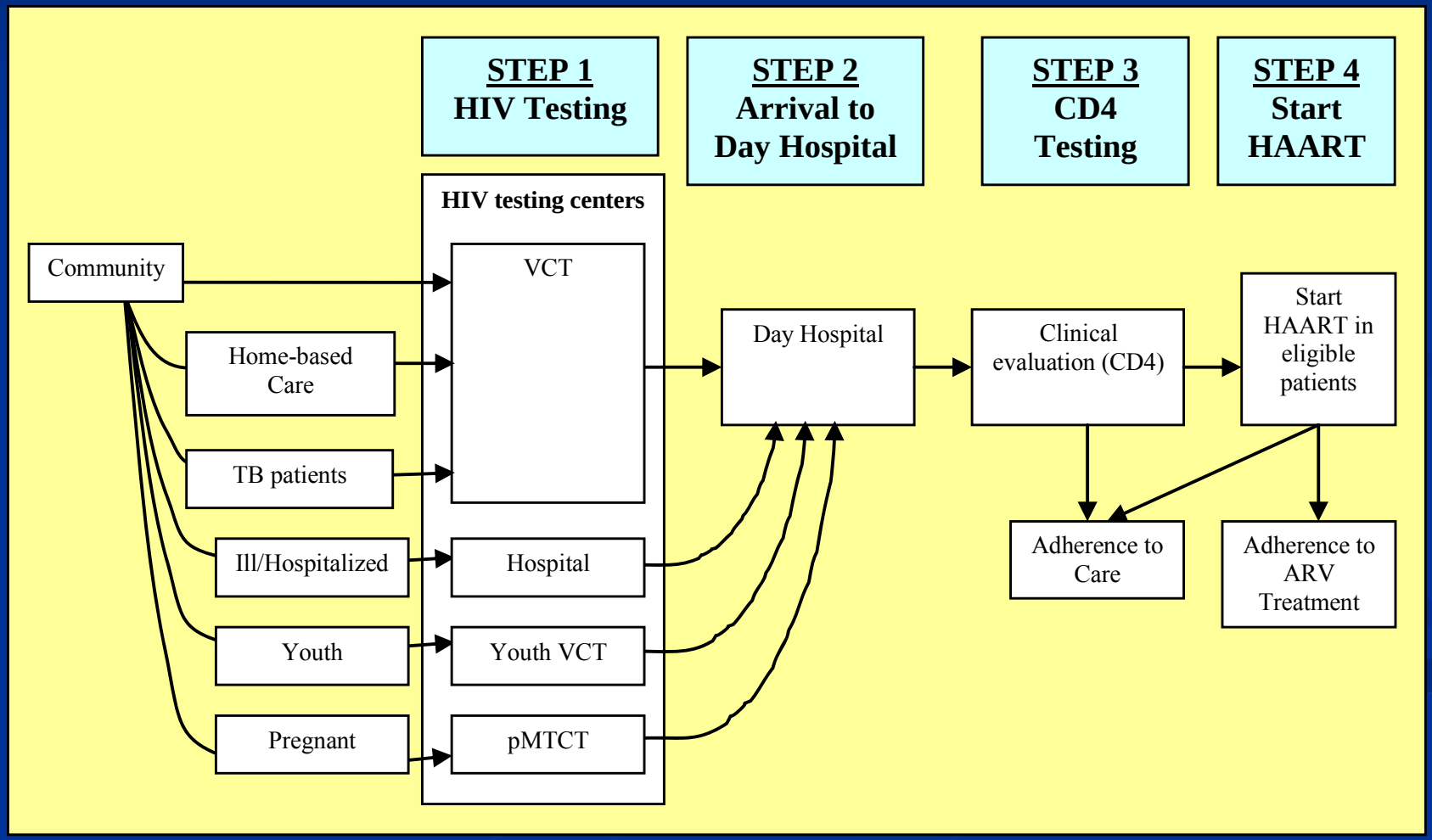


New OR cycle

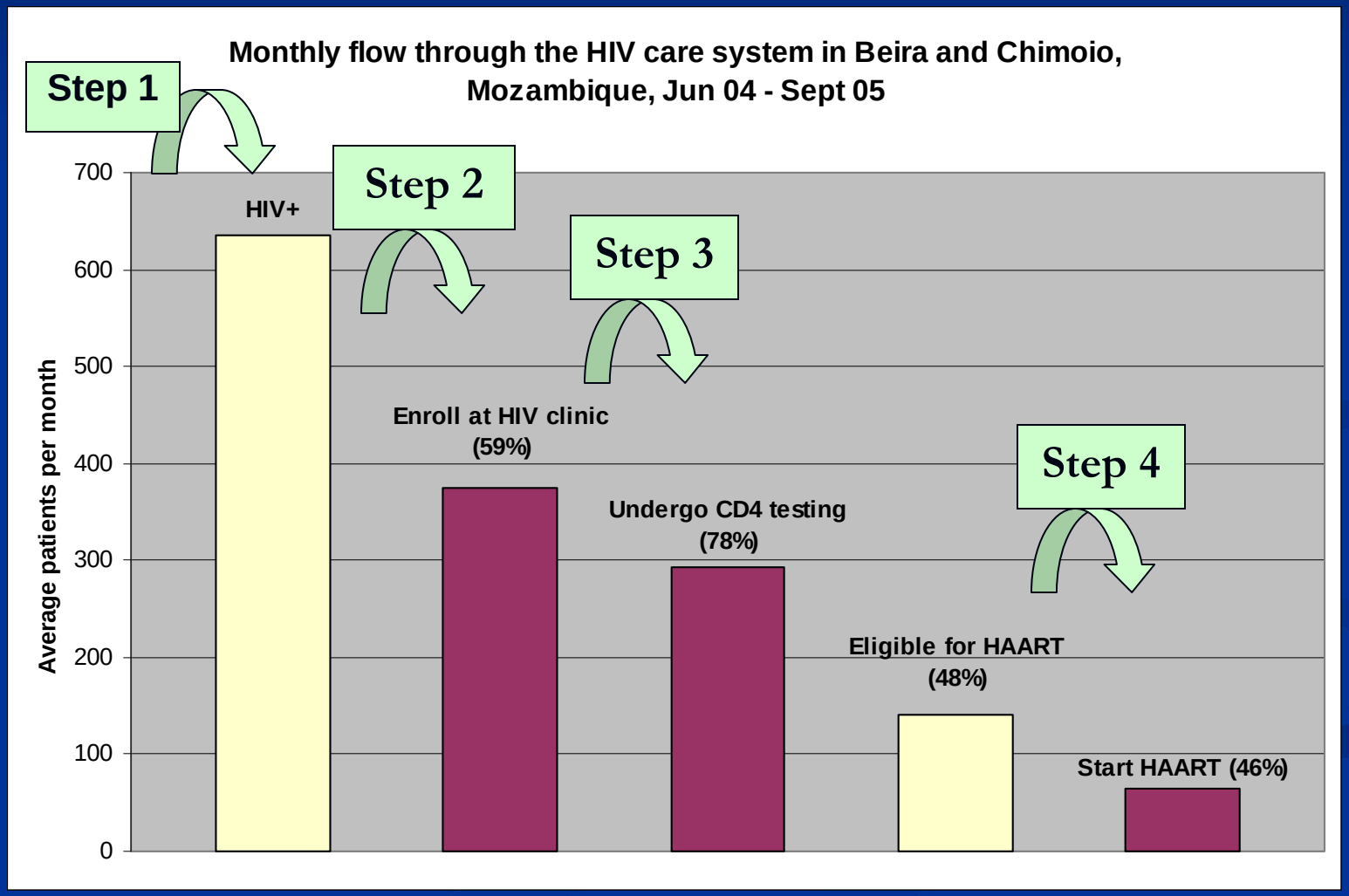
Example 3: How to increase the number of patients who start HAART?



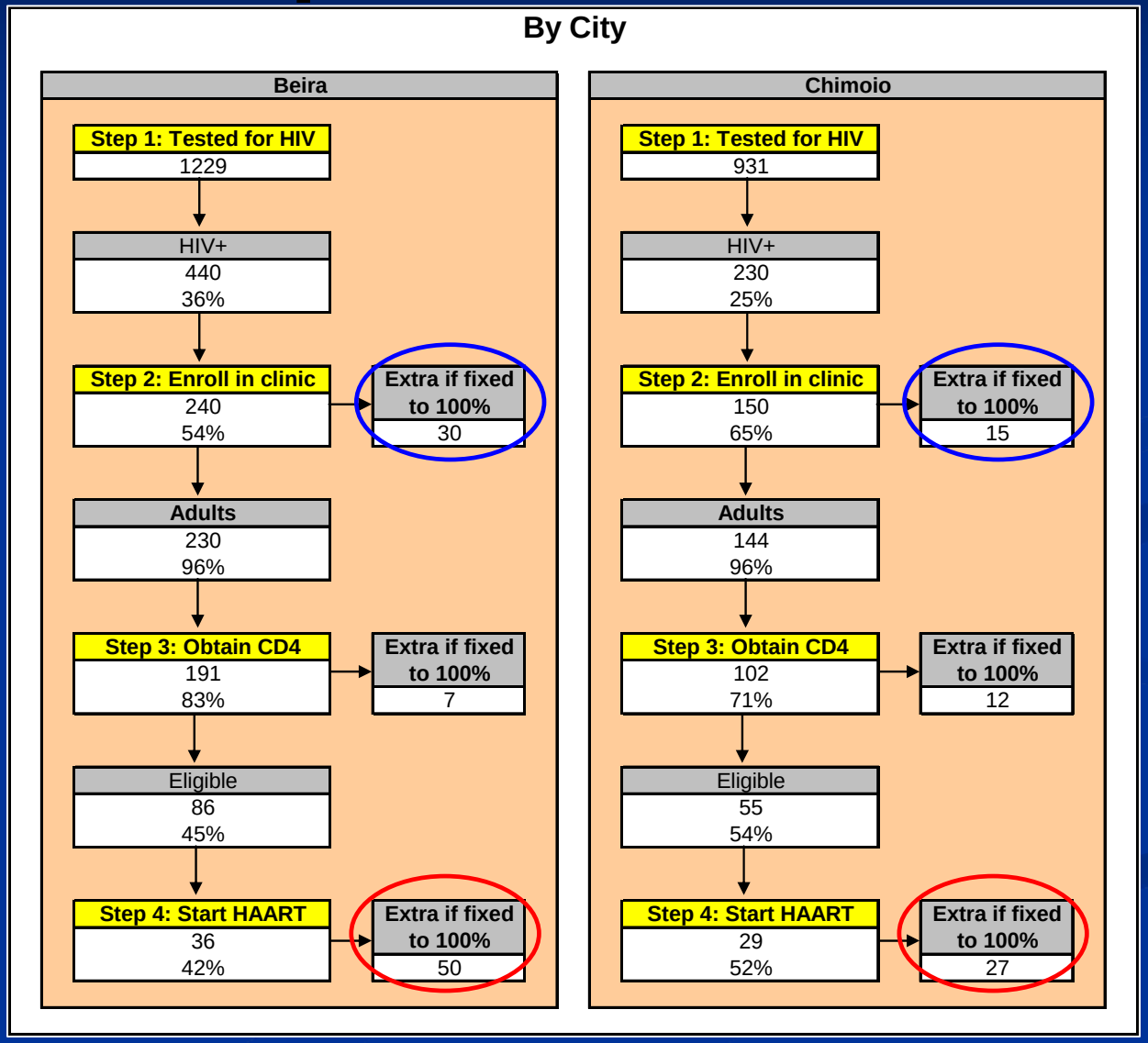
Identify steps required to start ART



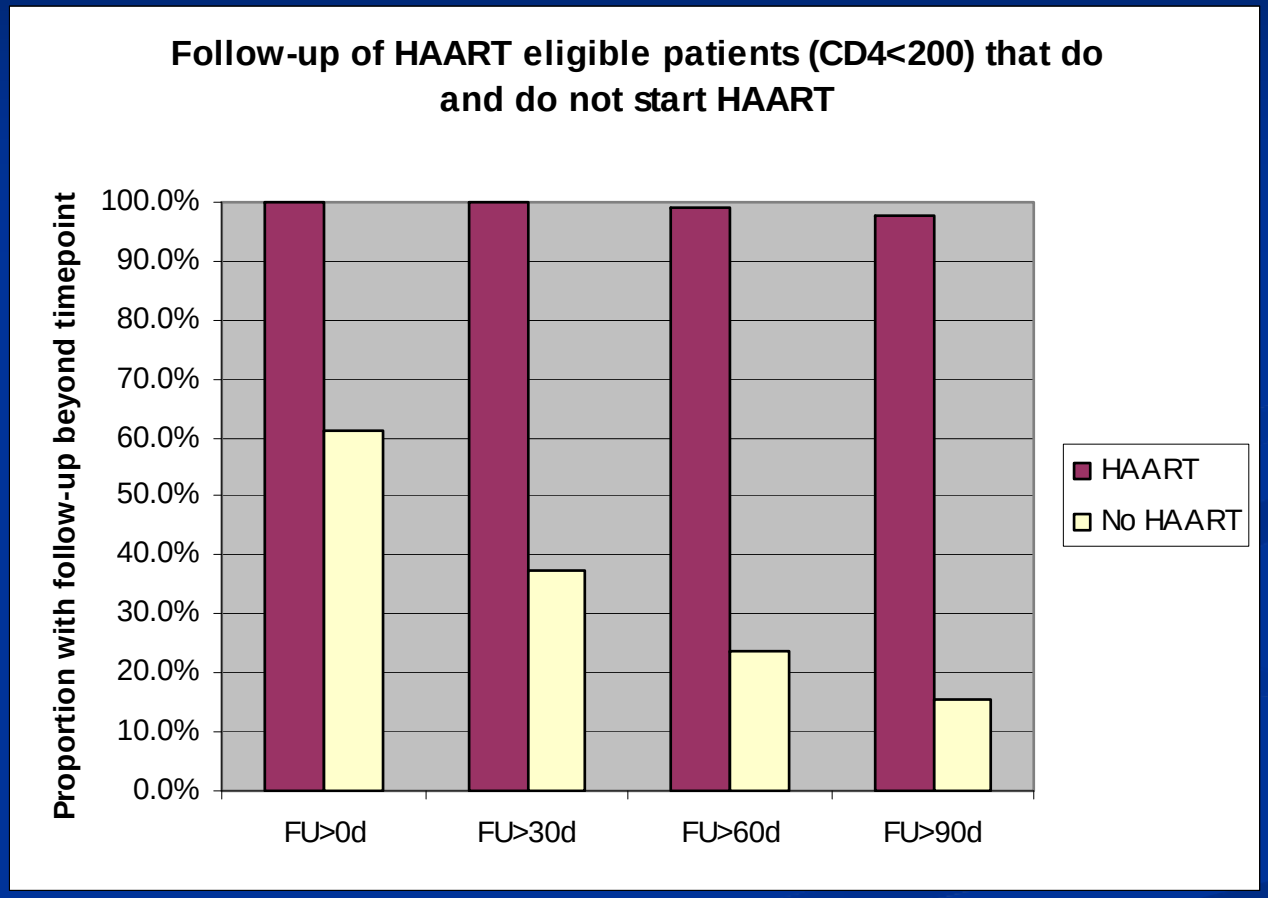
Using programmatic data: Where are patients lost?



Using programmatic data: What are priorities to address?



Why do HAART-eligible patients not start ARVs (step 4)?



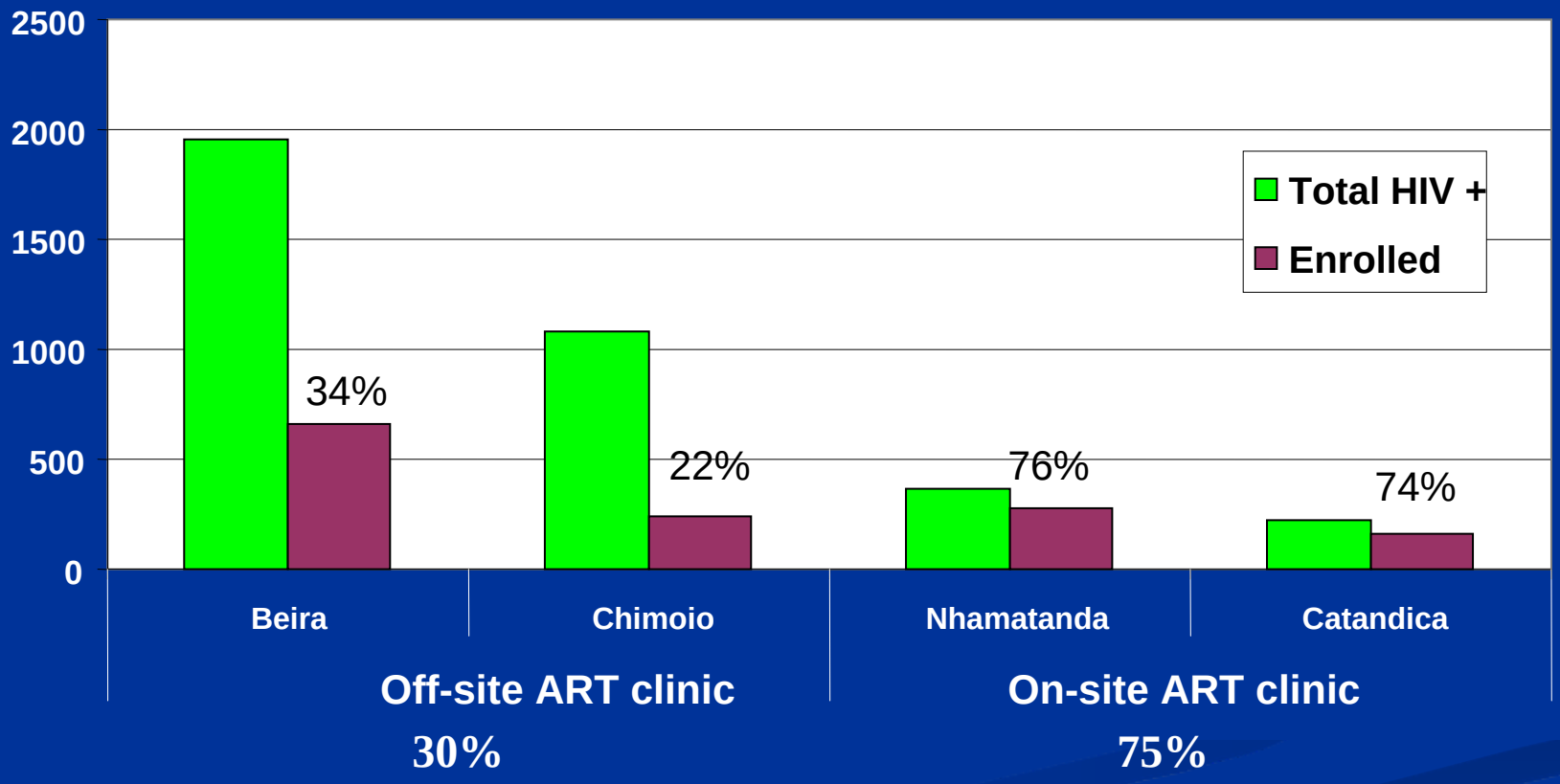
- Poor follow-up also reported as reason for not starting HAART in other studies
  - *Giordano TP et al, Factors Associated with the Use of Highly Active Antiretroviral Therapy in Patients Newly Entering Care in an Urban Clinic. JAIDS, 32:399-405.*

Improving rates of starting ARVs in HAART-eligible patients

- Reasons for poor follow-up
  - Pre-HAART procedure too cumbersome
  - Dissatisfaction with services
  - Trouble paying transportation costs
  - Poor understanding of clinic procedures
  - Stigma of going to HIV clinic
  - Death

- Potential solutions
  - Change workflow around HAART-eligible patients
  - Improve counseling
  - Improve relationship between patients and health care workers
  - Decentralize ARV services

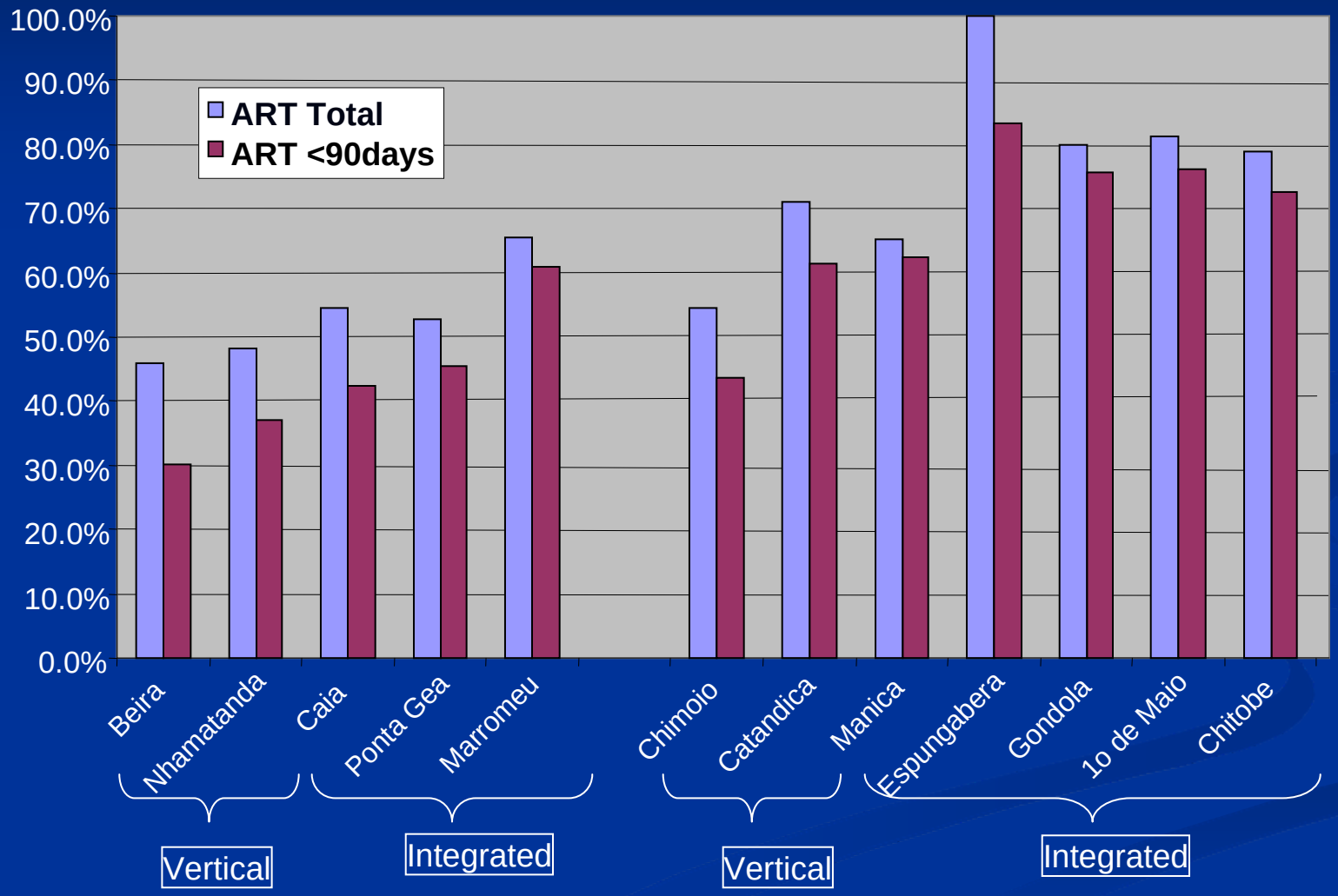
Number of HIV+ pregnant women enrolled at ART site <30 days after HIV testing



On-site ART vs. Off-site ART clinic: OR 7.2

(CI 5.9-8.8, p<0.001)

ART-eligible starting ART (Total and ≤90 days), Sofala and Manica, 2004-2007



Total stated on ART:

Vertical 50% vs. Integrated 65% ($p<0.001$)

ART <90 days:

Vertical 37% vs. Integrated 59% ($p<0.001$)

N=9,193

Thank you