

Program Science: The Concept and Applications

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CDC Program Science Webinar



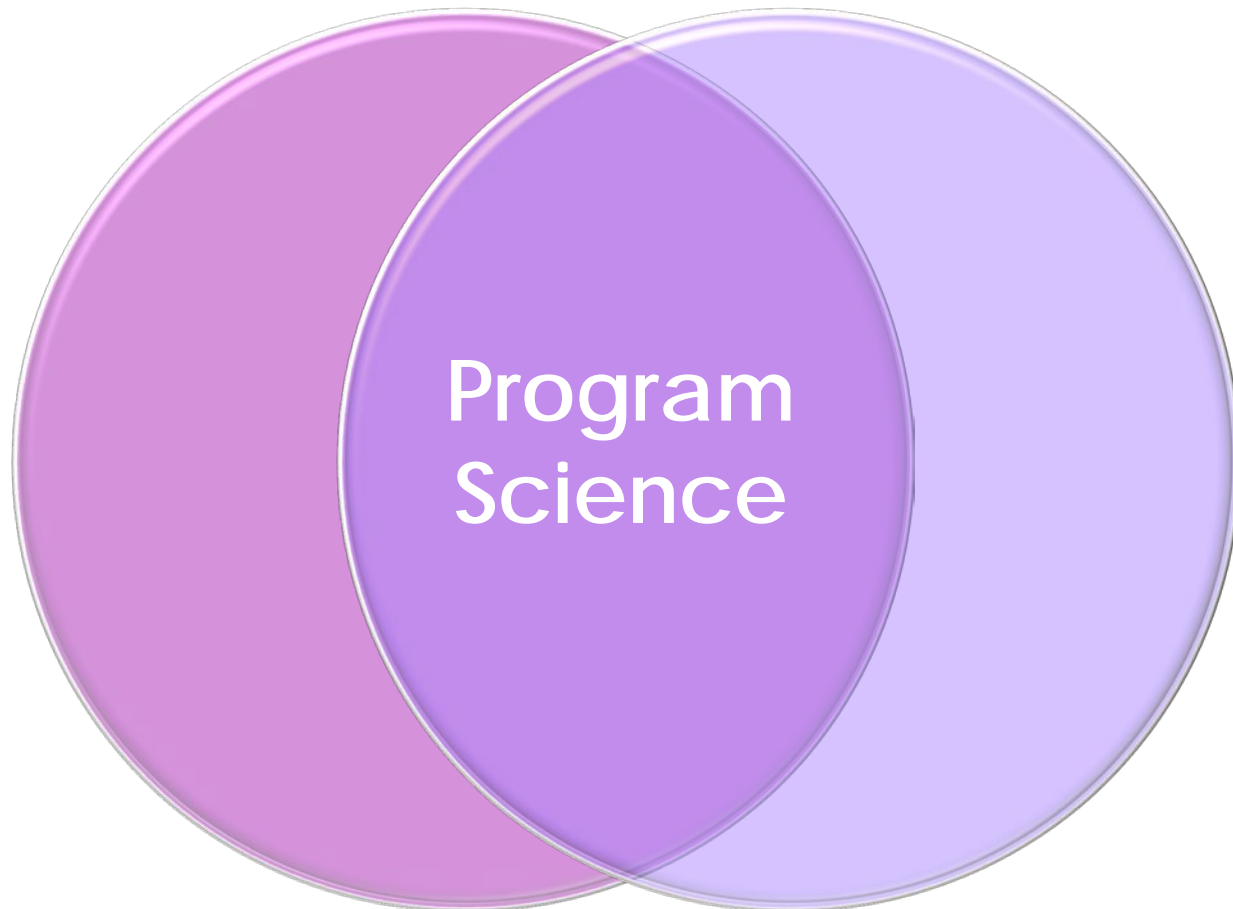
National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention
Division of STD Prevention





Program

Science



Program
Science

Program Science – Rationale

- **How is “program science” different from “implementation science”?**
 - Implementation science, focuses on identifying and scaling up a single “evidence-based” intervention
 - Program science is concerned with the totality of a program, including an appraisal of the epidemic transmission dynamics, setting appropriate prevention objectives by sub-population, selecting and combining interventions and allocating resources between interventions accordingly

Program Science – Rationale

- **How does PS differ from “translational research”?**
 - Translational research focuses on how to get scientific “evidence into practice”. The process tends to focus on single interventions and a unidirectional process of knowledge translation.
 - In addition to focusing on multiple interventions and their interfaces at the population level, program science emphasizes “getting research out of practice” and formulating new hypotheses

Program Science – Rationale

- **How does PS differ from “operations research”?**
 - Operations research focuses on how to optimize the implementation of a particular intervention, not on strategic planning to achieve maximum population-level impact.
 - In addition to optimizing implementation, program science focuses on population impact, which depends on population focus, selection of interventions, interactions between interventions, etc.

Program Science – Rationale

- **Isn't Program Science just the same as good program management?**
 - Program science should result in good program management, but also seeks to develop new insights and knowledge that can be translated to the design and implementation of future programs. New knowledge could emerge in areas such as:
 - Better approaches to appraising epidemics and transmission dynamics
 - Novel approaches to impact evaluation
 - Expanding public health sciences into new fields that address complexity, including new methods for understanding how epidemics emerge and the interfaces between individuals, pathogens, their environments and programs.

Definition:

- Program Science is the systematic application of theoretical and empirical scientific knowledge to improve the design, implementation and evaluation of public health programs.
- Endpoint for Program Science: Population level impact on incidence of infections by optimizing right strategy X right populations X appropriate time X appropriate scale X efficiency.

“Program Science” for HIV/STI Prevention: A Component Model

Spheres of Knowledge

- Epidemiology
- Transmission dynamics
- Policy analysis
- Health systems research

- Efficacy / effectiveness
- Operations research

- Surveillance
- Monitoring/evaluation
- Operations research
- Health systems research

Spheres of Practice

Strategic Planning
Policy Development

Program
Implementation

Program
Management

Intended Outcomes

Choose:

- The best strategy...
- The right populations...
- The right time...

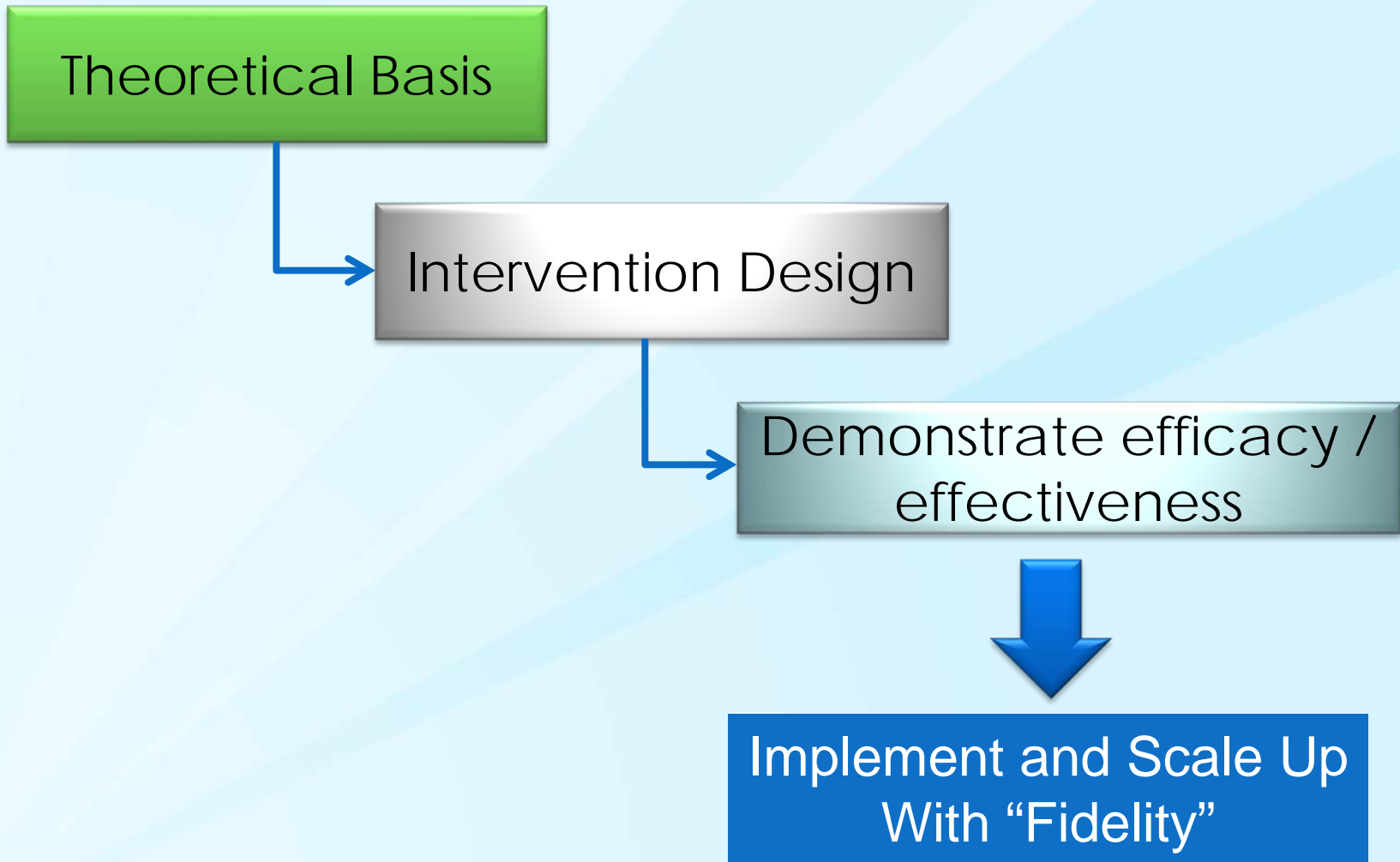
Do:

- The right things...
- The right way...

Ensure:

- Appropriate scale...
- Efficiency...
- Change when needed...

“Research driven” approach to intervention design and assessment



Constraints of “research driven” models

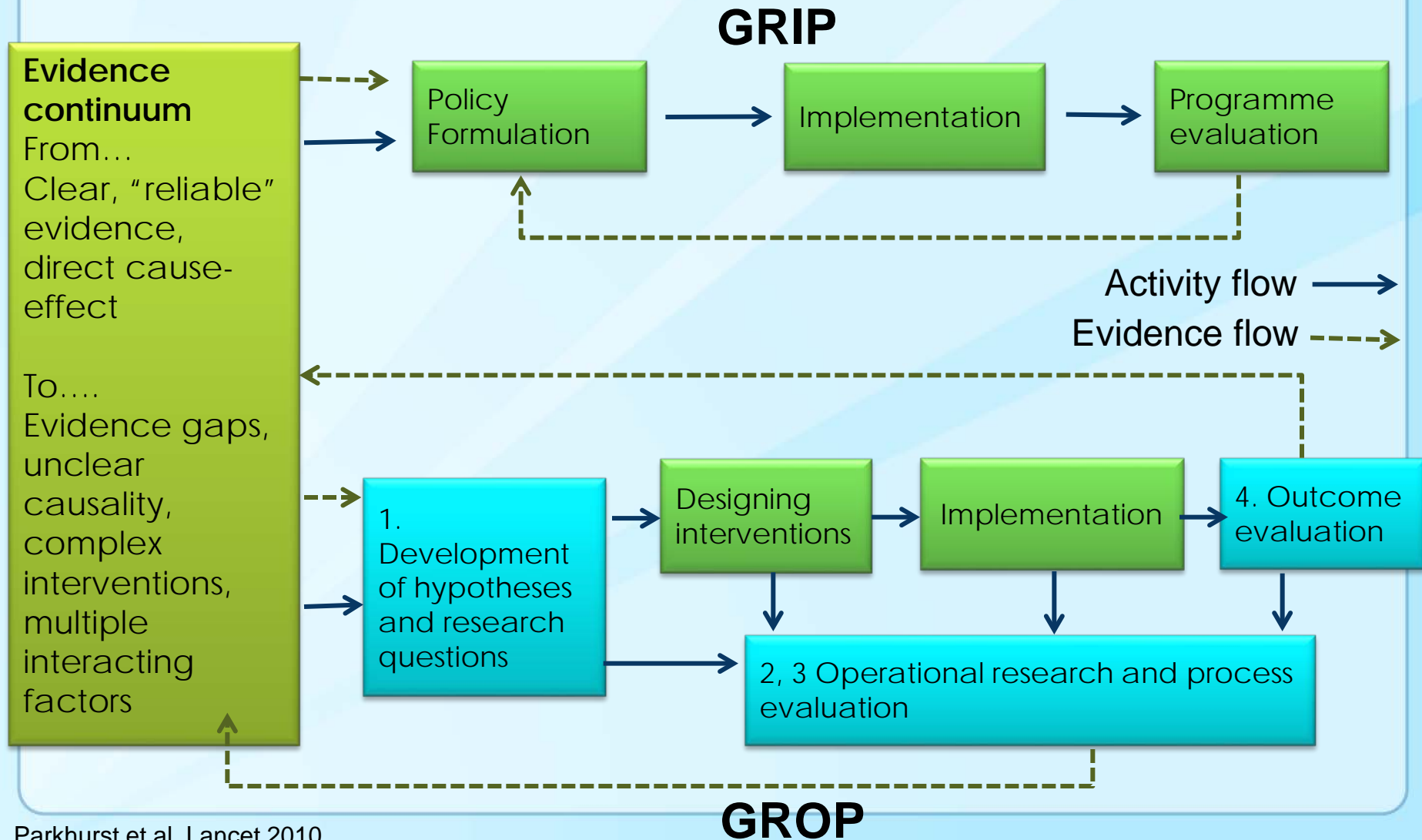
- **Complexity and heterogeneity of transmission dynamics:**
 - Designing and assessing the right intervention for a particular context
- **Secular trends and “co-interventions”:**
 - Isolating a particular intervention or intervention package
- **Cost**
- **Ethics**

Differing Research Paradigms: “GRIP” to “GROP”¹

- “GRIP” – Getting Research Into Policy
- “GROP” – Getting Research Out of Practice

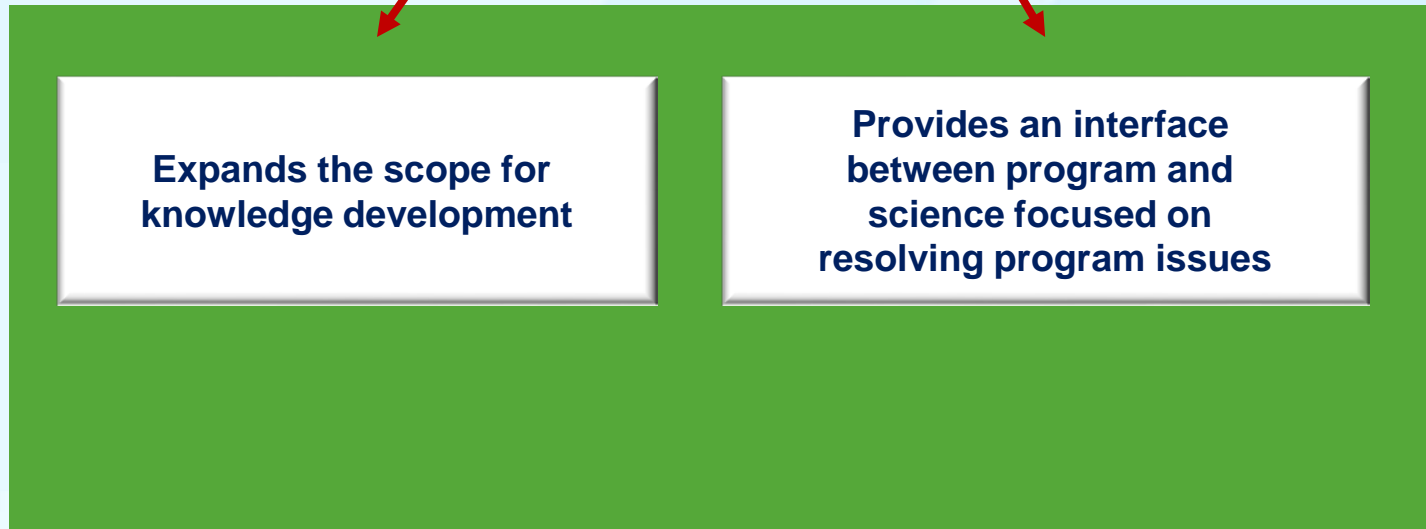
1. Parkhurst J, Weller I, Kemp J. **Getting research into policy, or out of practice, in HIV?** Lancet 2010;375;1414-5.

Pathways of activities and evidence flow into, and out of, policy and practice¹



1. Parkhurst et al. Lancet 2010.

➤ Program Science Framework



Two Needs

- Closing the gap between science and programs
- Recognizing the “systems” nature of transmission; communities; health delivery and prevention

Today's Outline

- Rationale for Program Science as a new scientific focus
- Systems science as the core scientific discipline in Program Science
- Systems science methodologies
- Program Science Initiatives in the U.K.; ECDC; Australia; and North America (U.S. and Canada)

**Program Science – an application
of systems science to STD/HIV
prevention programs.**

Need to incorporate systems science springs from the recognition that

→ traditional research methods, which typically feature narrow problem definitions and linear analytic representations are by themselves insufficient to adequately address the full complexity of our most pressing population health challenges.

Intervention vs. Program

- **Public Health Intervention**

- Specific technological or behavioural modality
- Particular target group(s)
- Focus on effectiveness, fidelity, coverage

- **Public Health Program**

- Multiple components (interventions)
- Resource allocation between components, and sharing across components
- Emphasis on optimizing population level impact

Some Potential Pitfalls in Knowledge Translation in Public Health

- **Knowledge production and synthesis often addresses a single component in a single sphere of knowledge:**
 - Protective efficacy of a vaccine
 - Effectiveness of a specific behaviour change method
- **“Evidence traps” for public health practice:**
 - Focus on single interventions (“magic bullets”)
 - Ignore the epidemiological context
 - Ignore the social, cultural, political, economic context

“Knowledge Translation Bias”

- Inappropriate prioritization of interventions for which evidence has been generated and disseminated, often without regard to context

“We have some evidence in support of this intervention, so let’s do a lot of it”

Systems science offers a complementary approach, capable of addressing more complex, interactive phenomena, while also attending to the practical constraints and opportunities that shape the social, physical, and organizational settings in which responses to those health challenges will occur.

....Systems science involves taking into account the big picture in all its complexity (a system view) while also taking into account the important relationships between components of a system and changes in the system over time.

Growing recognition that... most major threats to the public's health are complex

→ each arises from an intricate mix of behavioral, economic, and social factors interacting with biological factors, over the life span and across an array of settings

Until now these complex problems have been approached

- correlation based analytic methods (e.g. regression)
- useful for identifying linear relationships but limited in their ability to set up and test a web of causal relationships
- used alone they are insufficient for addressing complex problems that are dynamic (change over time) and complex (large number of relationships in the system).

Correlation based analytic methods
are not designed to put all
the pieces together for a big picture view.

Systems Science Methodologies:

- address complex problems
- take into account the big picture
- take into account the context
- allow examination of dynamic interrelationships of variables at multiple levels of analysis simultaneously (causal feedback processes)
- make implicit assumptions about complex phenomena explicit
- expose gaps in knowledge about the problem
- help explain why programs and interventions fail to have their intended effects

Systems Science Methodologies include:

Systems dynamics modeling

Agent based modeling

Discrete event simulation

Network analysis

Dynamic microsimulation modeling

Markov modeling



Connections between a system's structure and its' behavior over time

Unintended and counter intuitive consequences of interventions

Short and long-term effects of policy options

(integrating data from multiple studies and surveillance systems)

Population health as complex adaptive system

- Location
- Life course perspective/ path dependence (chains of consequences)
- Mutual determination
feedback loops (feedback – feed forward)
- Dynamic aspects
- Spatial aspects
- Multilevel aspects
- Interactions between levels

Population health as complex adaptive system (con't)

- Interactions between determinants
- There is heterogeneity and heterogeneity counts
- Variance is important – it is the distribution (not central tendency) and tail of distribution that plays a real big role
- Adaptation to feedback
- Emergence; emergent properties



Need for agent-based modeling

Program Science Approach:

- optimization of the choice of the right strategy for the right populations at the appropriate time;
- implementation of the right things the right way;
- achievement of appropriate scale and efficiency;
- prioritization of key populations (responsible for spread); and
- prioritization of optimal intervention packages

Program Science:

- science base for the strategic planning, implementation, continuous quality improvement, monitoring and evaluation and re-positioning of STD/HIV prevention programs
- integrated science/program activity
- attention to big picture; the whole of the program
- attention to temporal dynamics
- attention to spatial dynamics
- use of non-linear analytic representations and methodologies

Strategic Planning <> Epidemiology and Transmission Dynamics

- **Focused on providing science-based guidance for resource allocation for prevention:**
 - The best strategic approaches
 - The right population focus
 - The right timing of interventions
- **The challenges:**
 - Epidemic heterogeneity
 - Understanding transmission dynamics and classifying epidemics appropriately

Program Science:

- Maximizing population level impact
- Maximizing efficiencies
- Maximizing return on Investment in STD/HIV Prevention

The BIG Picture
Totality of Epidemics
Totality of the Program

- **Variation across space**
- **Identification of Hot Spots**
- **Geographic targeting**

- **Epidemic Phases**
- **Epidemic Trajectories**
- **Tipping Points**
- **Phase Appropriate Intervention Packages**

Temporal Dynamics

- **Life course in context**
- **Path dependence**
- **Mutual determination**

Spatial Dynamics

Current Challenges:

- Defining combination intervention packages that incorporate complex interactions among interventions and context
 - Minimize antagonisms
 - Maximize synergies
- Implementing effective interventions at sufficient scale and intensity relative to the need

Current Challenges:

- Avoiding the scattering of interventions across geographic areas to realize synergies from multiple interventions in one location
- Targeting interventions sufficiently to key populations
 - ✓ especially in concentrated and mixed epidemics



Program Science
(including Evaluation Science)

**Implementation
and Delivery Science**

Clinical Science

**Basic
Science**

HIV/STI Program Science (PS)

Initiative Development Timeline

- 2007-2010: Conceptualization and approach development; CDC – University of Manitoba supported by OAR / NIH
- 2010 – present: Formation of Core Group of Advisors
Willard (Ward) Cates (FHI360); Geoffrey Garnett (BMGF); Marelize Gorgens (WB); King K. Holmes (UW); David Peters (JHSPH); Thomas Quinn (NIH, JHSPH); Charlotte Watts (LSHTM); David Wilson (WB)
- 2010 – present: Initiation of World Bank – CDC – University of Manitoba collaboration
- 2010 – present: Initiation of Country Programs in Asia, Africa, Eastern Europe (The First Program Science Global Network)
- 21 July 2012: World Bank Program Science Conference
(with participation of public health leaders and HIV and STD Prevention Directors from Asia, Africa, Europe, Canada and U.S.)
- January 2012 – Present: Initiation of Country Programs in U.K.; Europe; U.S. and Australia (The Second Program Science Global Network); planning for U.S. – Canada collaborative Program Science initiative

HIV/STI Program Science (PS)

Accomplishments

- Strong country programs established in India, Kenya, Nigeria, Pakistan – others underway in Ukraine, China.
- A Program Science column established in the British journal *Sexually Transmitted Infections*, January 2012.

Future Directions

- Discussions underway regarding initiation of Program Science efforts in South Africa, and Brazil.
- Potential for greater CDC involvement in country PS programs.

Program Science Initiative in the U. K.:

- Program Science approach adopted by the HPA, Spring 2012
- HIV and STI Division
- Interest (intention) among other divisions as well

Program Science Initiative in the European CDC:

- ECDC is initiating efforts to start a second global network on “program science in western industrialized countries” including United States (lead by CDC), Canada (lead by University of Manitoba in collaboration with Public Health Canada), and Europe (lead by ECDC) to provide a platform for theoretical work and sharing of best practice through pilot projects.
- The goal is to provide Program Science technical assistance to member states.
- The project is being initiated in the HIV and STI public health program with the expectation that it will be disseminated to other programs as well.

Program Science Initiative in the U. S.:

- Division of STD Prevention is currently preparing the 2014 – 2019 STD Prevention Funding Opportunity Announcement which outlines the structure of state STD prevention programs for the upcoming funding period.
- The overall structure of the state STD Prevention Programs is being modified to reflect a Program Science framework with emphasis on Assessment, Assurance, and Policy Planning functions
- The new approach reflects a major focus on resource allocation.

2014 STD Prevention Conference: A Program Science Framework

Conference Theme: More STD Prevention for the Money: Maximizing Impact, Efficiency and Return on Program Investments

- i. **Assessment** - prevalence, incidence, trends, concentration, variance and rate-of-change in morbidity, behaviors and services.
- ii. **Program Definition / Prevention Services** –determination of program intervention packages, key populations, issues of coverage, frequency and intensity of interventions, changes in intervention packages including addition and subtraction of interventions.
- iii. **Assurance** - issues of efficiency, effectiveness and impact of program intervention packages; resource allocation and return on investment (ROI) in program interventions.

Domains:

- A. **Clinical and Laboratory**: diagnostic and screening tests and clinical management of STD cases.
- B. **Policy**: national, state and local laws, regulations, procedures and the like that impact STD prevalence and incidence; STD case finding and treatment; and STD surveillance and prevention.
- C. **Evaluation**: process, outcome and impact evaluation of STD surveillance, STD prevention interventions, and STD treatment and prevention services.



Program Science Initiative in Australia:

- Australian public health experts highly interested in the Program Science Initiative.
- Mostly focused on HIV/STI prevention among indigenous populations.

WHAT ABOUT STIs?

Rates of gonorrhoea and chlamydia have increased significantly between 1994 – 1996 to 2006 – 2008 (by 61% and 199% respectively)

Some success in STIs

Syphilis and Donovanosis

Indigenous Populations in Australia, Canada, and New Zealand

- Indigenous people in Australia, Canada and New Zealand comprise 2.5%, 3.8% and 15% of respective countries total population
- Similar public health care systems Australia and Canada with remote and isolated Indigenous communities
- Similar gaps in health disparity
- Similar populations and colonised histories
- Australia comprehensive community controlled health service sector

Methods

- Indigenous status

- ❑ Australia-Aboriginal and Torres Strait Islander

- ❑ New Zealand – Maori

- ❑ Canada – First Nations, Metis and Inuit

- *Canadian data excludes two large provinces Ontario and Quebec (30% of total Indigenous population)

Results: Number and rate of HIV Diagnosis Indigenous Peoples 1999-2008

| Country | Australia | New Zealand | Canada |
|---------------------------|-----------|-------------|--------|
| Non- Indigenous diagnoses | 7589 | 929 | 5838 |
| Age standardised rate * | 26 | 13 | 24 |
| Indigenous diagnoses | 185 | 129 | 1799 |
| Age Standardised rate * | 31 | 23 | 178 |

Initial Meeting

Public Health Agency of Canada/U.S. Centers for Disease Control (CDC)

June 28, 2013

➤ Establish a North American Network



➤ Expand to rest of the Americas

Upcoming meetings / publications

July 2013 ISSTDR – One-day Meeting
Program Science Track



Thank You