The Natural Experiment: Observational Study Design

Ann F. Chou

Center for Implementation Practice & Research Support

CIPRS - HIS 2011- Sept 15-16, 2011

Causality

- Ideally we want studies to show intervention "caused" outcome
- Inherit idea of causation from bench-top research
  - Hold all variables constant between comparison groups except single factor under study
- Temporality crucial
  - If intervention did not precede outcome difficult to argue it "caused" outcome

CIPRS - TUS 2011- Sept 15-16, 2011

Overview of Study Designs

- Experimental – investigator manipulates which groups received "treatment"
- Observational – "natural experiments"
  - Ecologic
  - Cross-sectional
  - Case-control
  - Cohort

CIPRS - EIS 2011- Sept 15-16, 2011

Hierarchy of Evidence

- Randomized Controlled Trial
  - The human experiment
- Cohort
  - Follow people over time to see who gets disease
- Case-control
  - Compare people with and without disease/outcome
- Cross-sectional
  - Survey, snapshot in time
- Ecological
  - Comparing characteristics of groups (e.g., geographical comparisons)
- Case series
  - Clinical observations (no comparison group)

CIPRC - EIS 2011 - Sept 15-16, 2011

Need for Natural Experiment

- Not all studies can be experimental
  - Ethics
  - Cost
  - Time
- Things happen!
  - Collect and analyze data from these “experiments”

CIPHS - EIS 2011- Sept 15-16, 2011

Thalidomide Babies

CIPR FIS 2011- Sept 15-16, 2011

Selection of Study Design

- Dependent on:
  - Research question
  - Amount of information already known about research question
  - Practical considerations (feasibility)
  - Unit of analysis
  - Ethical considerations

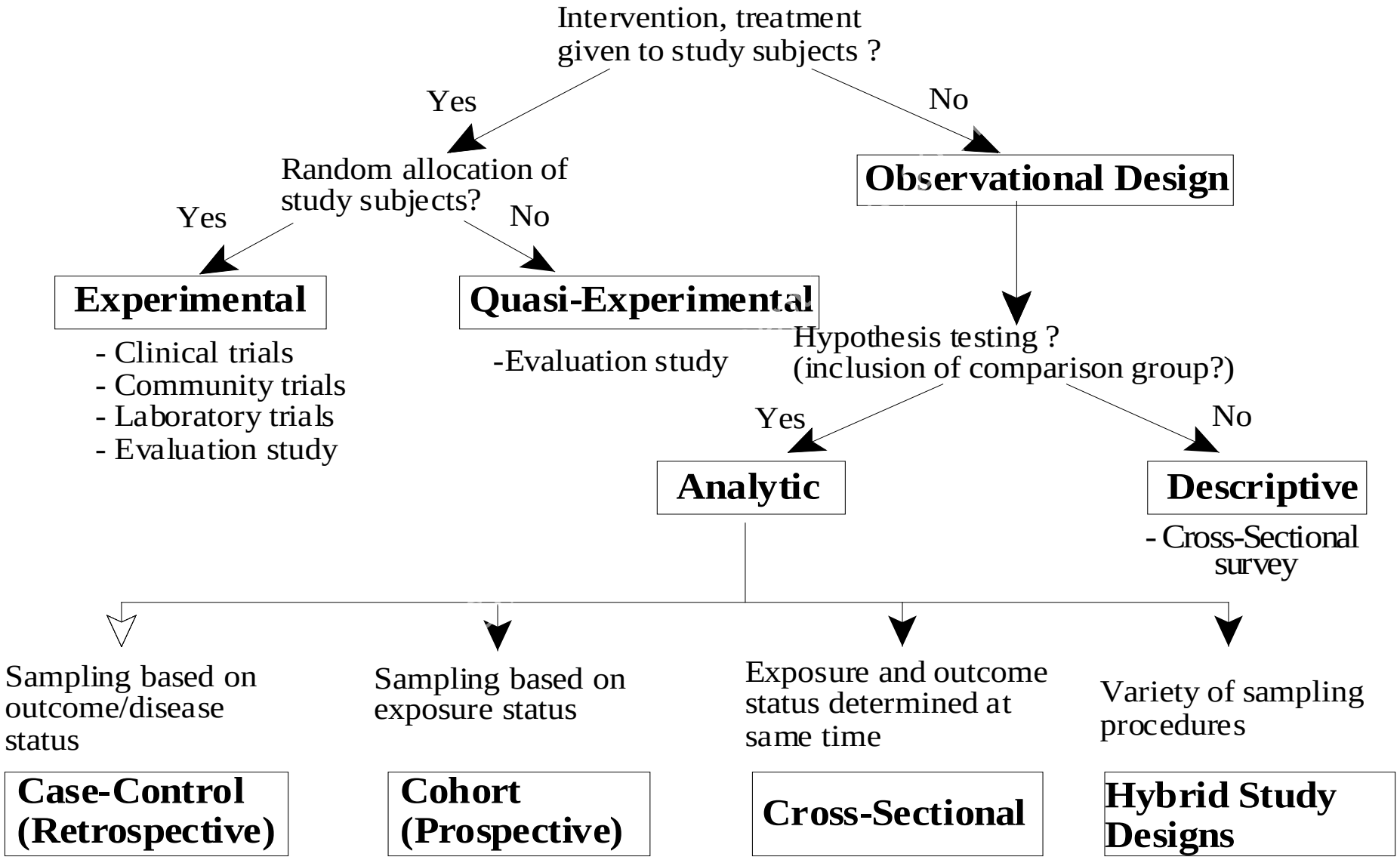
CIPRG - EIC 2011 - Sept 15-16, 2011

Unit of Analysis

- Individual
- Center/Facility

CIPRS - EIS 2011- Sept 15-16, 2011

IDENTIFYING EPIDEMIOLOGIC STUDY DESIGNS



ECOLOGIC

CIPRS - EIS 2011- Sept 15-16, 2011

Ecologic Studies

- Examine exposure-disease association among aggregates of people – usually defined by geographic groupings

<u>Example</u>: patterns of mortality from CHD and per capita cigarette consumption by state in the U.S.

CIPRS - EIS 2011 - Sept 15-19, 2011

CHD Mortality Rates and Per Capita Cigarette Sales by State, 1960

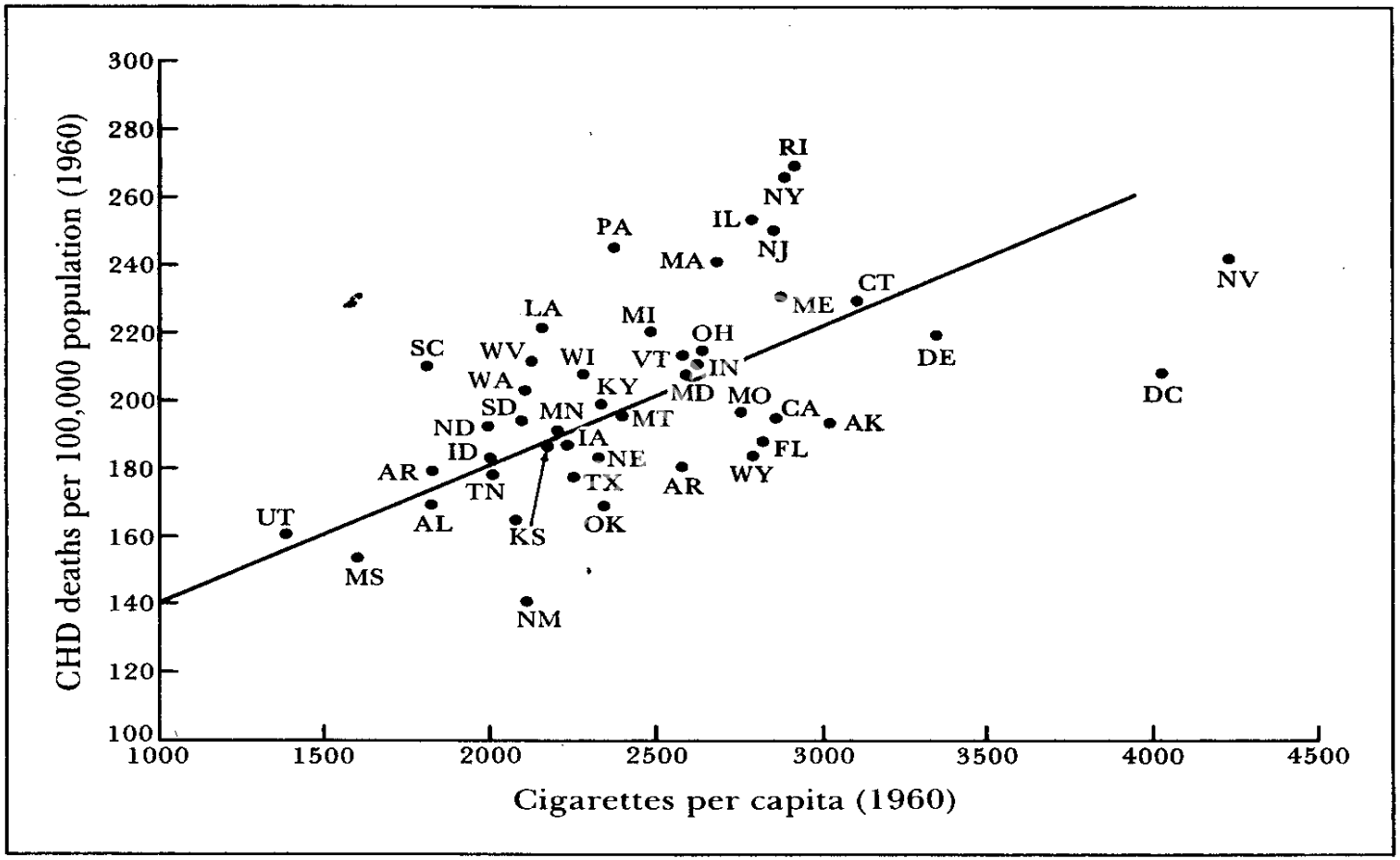


Fig. 5-1. Coronary heart disease mortality rates in the United States by per capita cigarette sales in 1960, by state. (From G. D. Friedman, Cigarette smoking and geographic variation in coronary heart disease mortality in the United States. *J. Chronic Dis.* 20:769, 1967.)

Ecologic Studies

- Unit of analysis is a Group

- Groupings defined by
  - Geographic area (e.g., county, state, country)
  - Time (ecological trend study)

CIPRS - EIS 2011 - Sept 15-16, 2011

Potential Examples of Ecologic Designs in Health Services Research

- Compare rates of late-stage breast cancer and access to mammography screening through Medicaid by state
- Ecologic because
  - Breast cancer affects an individual
  - Medicaid policy at state level, not individual
- If collected insurance status of all women individually, design not ecologic

CIPRS - EEC 2011- Sept 15-16 2011

CASE-CONTROL

CIPBS - EIS 2011- Sept 15-16, 2011

Case-Control Studies

- Selects study population on basis of outcome status
- Case-control study begins with people who have outcome (cases) and compares them to people who don't have outcome (controls)
- Compare odds of past exposure to a suspected risk factor between cases and controls

CIPRS - EIS 2011 - Sept 15-16, 2011

TIME

PRESENT

Begin with:

Outcome
+

Intervention
+ +

No Intervention
+ -

No Outcome
-

Intervention
- +

No Intervention
- -

CIPRS - EIS 2011 - 15-16

Example

Suppose we are interested in investigating an association between childhood cataracts and exposure to rubella virus *in utero*.

- Cases would be children with cataracts
- Controls would be children without cataracts
- For each child we would determine whether or not their mother was exposed to rubella during her pregnancy with that child

CDPRS - EIS 2011- Sept15-16, 2011

CROSS-SECTIONAL

CIPRS - EIS 2011- Sept 15-16, 2011

Cross-Sectional Studies

- a.k.a. Prevalence Study
- Provides "snapshot" of population at a specific point in time
- Looks for coexistence of intervention/exposure and outcome at same point in time
  - Individuals
  - Facilities

CDPHE - EIS 2011 - Sept 15-16, 2011

Uses of Cross-Sectional Studies

- Estimation of magnitude and distribution of a health problem – measures prevalence proportion
- Hypothesis generation
- Intervention planning

CIPRS - EIS 2011- Sept 15-16 2011

Design of a Cross-sectional Study

Begin with:

Defined Population

Gather data on Intervention and Outcome

Four Groups Are Possible

Intervention; Have Outcome ‘a’	Intervention; Do Not Have Outcome ‘b’	No Intervention; Have Outcome ‘c’	No Intervention; Do Not Have Outcome ‘d’

CIPRS - 1 - Sept 16, 2011

Example

- Epidemiology and Control of Antimicrobial Resistance in Hospitals (HSR&D)

CIPRS - EIS 2011- Sept 15-16, 2011

AMR

- The incidence of infection with antimicrobial – resistant (AMR) pathogens has been increasing dramatically in U.S. hospitals in recent years.
- Antimicrobial resistance leads to an increase in morbidity, mortality and health care cost.
- In response to the escalating problem, guidelines have been developed to recommend strategies for AMR control.

CIPRS - ES 2011- Sept 15-16, 2011

Guidelines

- The National Foundation for Infectious Diseases (NFID) and the CDC published a set of strategic goals:
  - Optimize the prophylactic, empiric, and therapeutic use of antimicrobials in hospitals
  - Detect, report, and prevent transmission of antimicrobial-resistance microorganisms

CIPRS - EIS 2011- Sept 15-16 2011

Challenges to Implementation

- Decentralized structure
- Ineffective communication
- Lack of valid and meaningful safety-related measurement data collection methodologies
- Lack of support from leadership and management

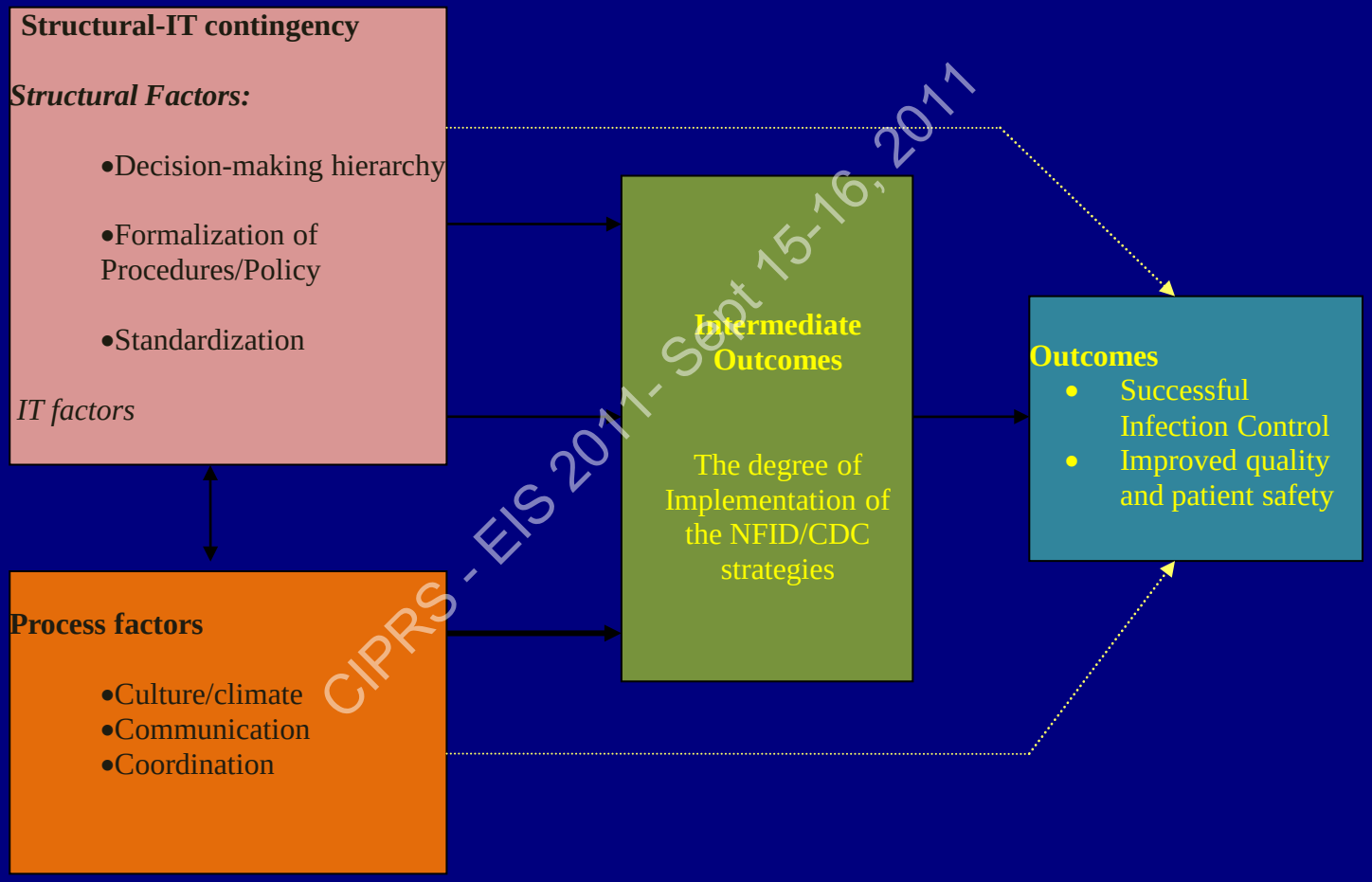
CPRS -EIS 2011- Sept 15-16, 2011

Objective

- To identify organizational factors that facilitate the implementation of the AMR control goals (CDC/NFID strategies)

CIPRS - EIS 2011 - Sept 15-16, 2011

Conceptual Framework



CIPRS - EIS 2011- Sept 15-16, 2011

Summary of Results

	Optimize antibiotic use	Control AMR spread
Formalization	+	+
Centralization	+	+
Standardization	+	+
Coordination	-	+
Culture	+	+
Communication	+	+
IT	+	+

CIPRS - EIS 2011- Sept 15-16, 2011

Conclusion

- Both structural and process factors had a major impact on the implementation of AMR strategies.
- Understanding factors that facilitate implementation can lend important insights into promoting sustainability of AMR control strategies within hospitals.

CIPRS - EIS 2011 - Sept 15-16, 2011

COHORT

CIPRS - EIS 2011- Sept 15-16, 2011

What is a Cohort?

- General term = group of people who share a common experience
  - Persons born in same year – birth cohort
  - Persons who share a common behavior – e.g., cohort of people who love implementation science
  - Persons in the same class – e.g., Attendees at the EIS conference

CIPRS - EIS 2011 Sept 15-16, 2011

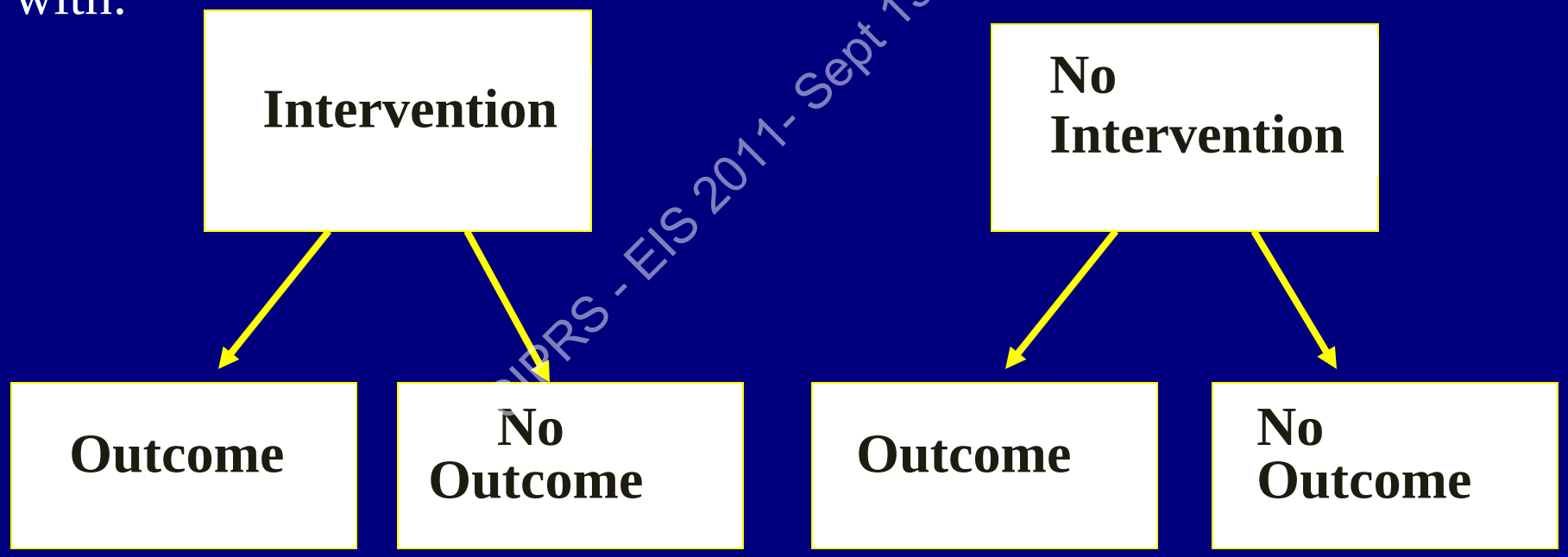
Cohort Studies

- Those in intervention and no intervention groups followed forward in time to determine incidence of outcome in each group
- Incidence of outcome in intervention group compared to no intervention group
- All members of both groups did not experience outcome at the beginning of study

CIPRS - EIS 2011 - Sept 15-16, 2011

Design of a Cohort Study

Begin with:



NPRS - EIS 2011- Sept 15-16, 2011

3 Types of Cohort Study Designs

1. Prospective
2. Retrospective
3. Ambi-directional

CIPRS - EIS 2011- Sept 15-16, 2011

Prospective (Concurrent)

- Investigator collects information on exposure status of study subjects at time study begins and identifies new cases of disease that develop from that time on, until end of follow-up interval

CIPRS - EIS 2011 Sept 15-16, 2011

Cohort Study Designs

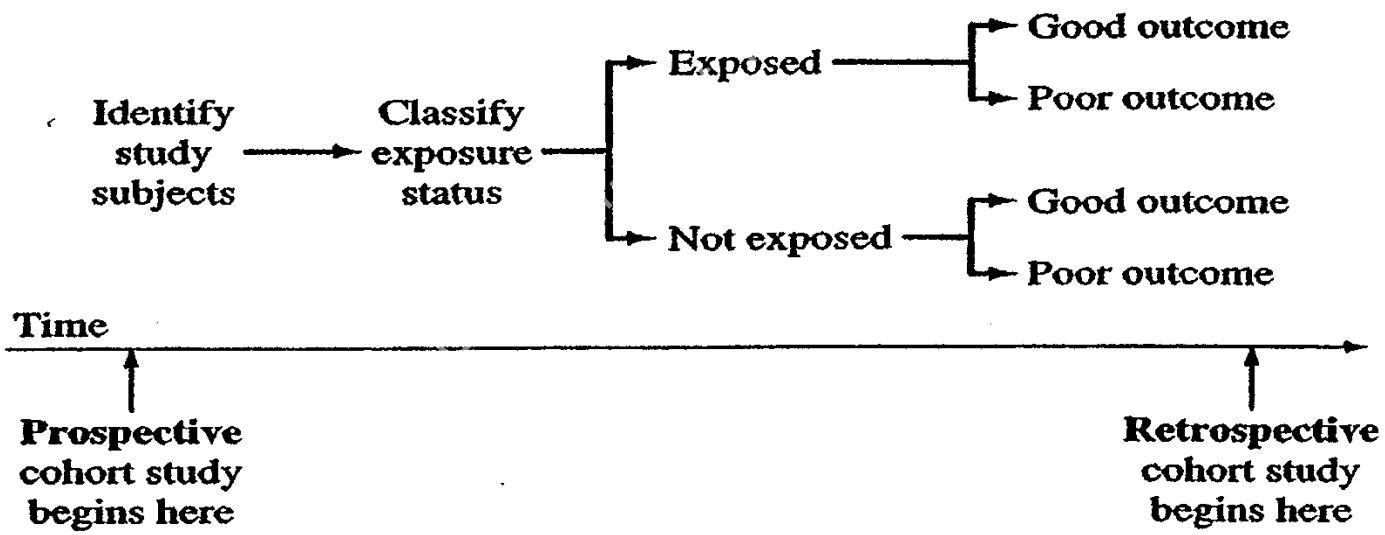


Figure 5–4. Retrospective and Prospective Cohort Studies.

Example: Counseling for Suicide Prevention

- Hypothesis: new mental health counseling helps prevent veteran suicide
- Population: all veterans returning from Iraq or Afghanistan suffering from post-traumatic stress disorder
- Outcome: behavior indicative of suicidal ideation
- Intervention: new mental health counseling

CIPRS - EIS 2011 Sept 15-16, 2011

Counseling for Suicide Prevention (cont.)

- All veterans returning from Iraq and Afghanistan diagnosed with PTSD identified
- Veterans seeking care from providers using new counseling technique assigned to intervention group
- Veterans seeking care from providers using traditional counseling technique assigned to no intervention group
- Both groups followed to see how many in each group express suicidal ideation

CIPRS - ES 2011- Sept 15-16, 2011

Example

- Multi-VISN Quality Improvement in HIV Screening (QUERI)

CIPRS - EIS 2011- Sept 15-16, 2011

Background

- Identifying and treating asymptomatic HIV-infected individuals can be highly cost-effective with the vast reduction in morbidity and mortality, and has transformed HIV infection into a chronic disease rather than an acute condition.
- Full treatment benefits are not being realized as 25% of approximately 1.2 million HIV-infected persons are unaware of their status.
- Within the VA, despite frequent opportunities to achieve early diagnosis, only 30–50% of VA patients with documented risk factors for HIV infection have been tested.
- In addition to provider/patient factors , organizational barriers may impede disease identification and treatment.

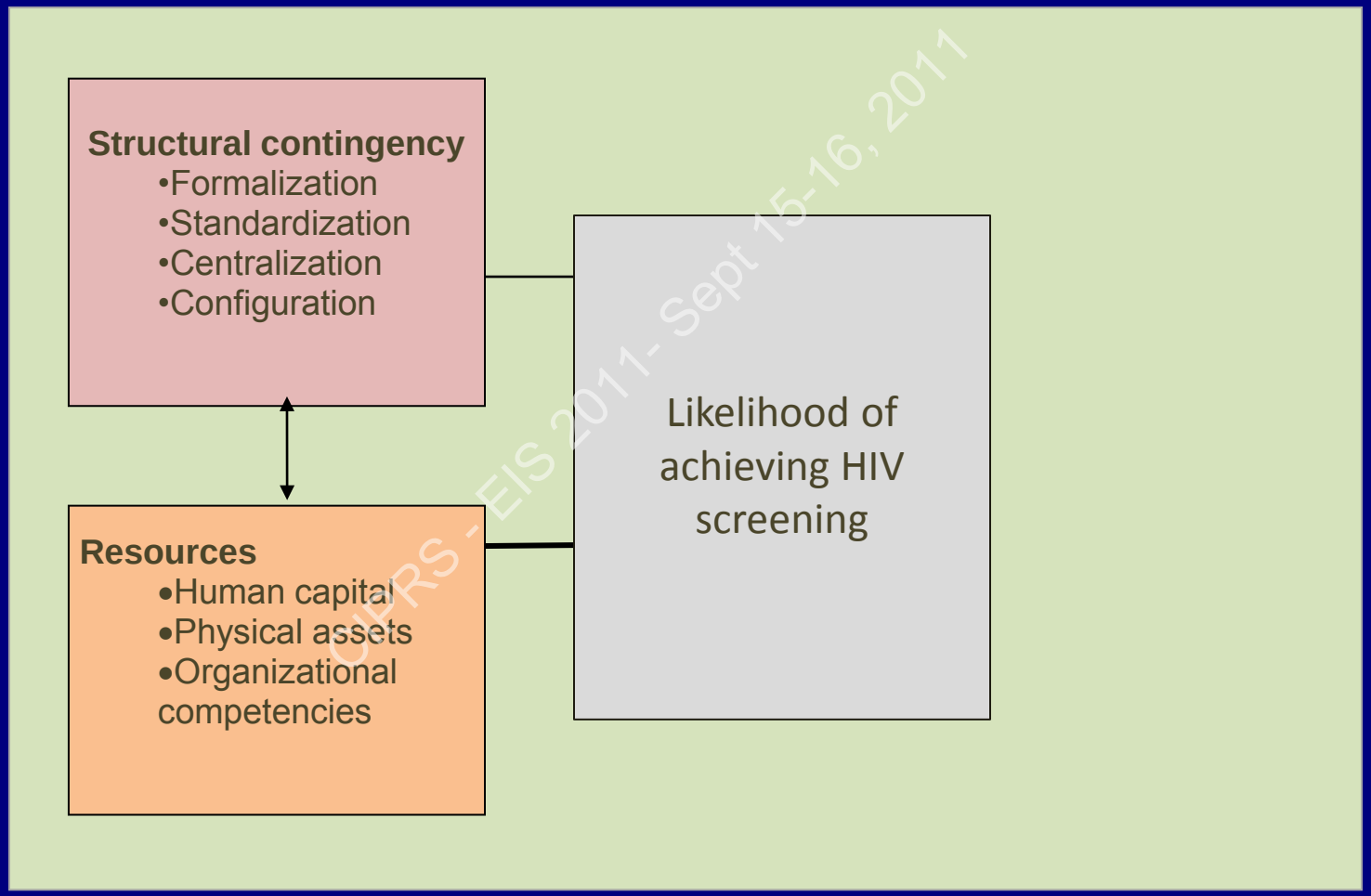
CIPRS - EIS 2011 - Sept 15-16, 2011

The Sample

- Three groups of facilities were included to study HIV screening, varied by resource levels.
  - NATIONAL: A national team provided assistance to 3 sites with social marketing and academic detailing to promote clinical reminders, audit/feedback, provider education, and organizational change.
  - LOCAL: 7 sites received local assistance where they received audit-feedback reports
  - CONTROL: 4 sites
- Facility characteristics – factor scores describing the extent to which a facility has: communication and cooperation; quality improvement process; IT system (CPRS); competing demands; resource sufficiency in personnel/finances, clinical staff, support staff, space/equipment, and patient care.

CIPHS - EIS 2011 - Sept 15-16 2011

Conceptual Framework



CPRS - EIS 2011- Sept 15-16, 2011

Findings

- Patients receiving care from facilities where resources were provided from either the national and local level reported higher likelihood of getting tested.
- Organizational characteristics that were positively associated with likelihood of screening were resource sufficiency in personnel and financial support , support staffing , physical assets, patient care support, competing demands and job-related stress.

CBRS - EIS 2011- Sept 15-16, 2011

Retrospective (non-concurrent)

- Investigator determines exposure status from information recorded at some time in past, and outcome is determined from that point in past up until present (i.e., follow-up period has already occurred)

CIPRS - PIS 2011- Sept 15-16, 2011

Example

- Investigate association between atypical antipsychotic drugs and risk of ischemic stroke, Gill et al. conducted a retrospective cohort study among older adults with dementia receiving atypical (exposed) or typical antipsychotics (not exposed) between 1997-2002

CMRS - EIS 2011- Sept 15-16, 2011

Example

- Exposure information (dispensed atypical or typical antipsychotics) was obtained from Ontario Drug Benefit Database
- Study initiated in 2004 and patients followed until either admitted to hospital with ischemic stroke, stopped taking antipsychotics, died or study ended (2002)
- Incidence of admission to hospital for stroke was compared in two groups

CIPRS - ECS 2011- Sept 15-16, 2011

Ambi-directional

- Cohort and exposure status identified from past records, followed into present, then followed into future
  - Most often used when additional follow-up time is needed

CIPRS - EIS 2011- Sept 15-16, 2011

In Summary

- Most health services research is observational and cross sectional in nature
  - Causality difficult to show because of endogeneity and other biases
    - Omitted variables bias
    - Selection
    - Reverse causality
    - Measurement error
- Value in conducting observational studies

CIPHS - EIS 2011- Sept 15-16, 2011

References

- Campbell, D. T., and Stanley, J. C. Experimental and Quasi-experimental Designs for Research. Chicago: Rand McNally, 1966.
- Abadie A, Drukker D, Herr JL, Imbens GW. Implementing matching estimators for average treatment effects in Stata. The Stata Journal (2004) 4, Number 3, pp. 290–311
- Wooldridge, J. M.: Econometric Analysis of Cross Section and Panel Data. MIT Press, Cambridge, Mass., 2002.
- Trochim, William M. The Research Methods Knowledge Base, 2nd Edition. Internet WWW page, at URL: http://www.socialresearchmethods.net/kb/ (version current as of 12/07/10).

CIPRS - HIS 2011 - Sept 15-16, 2011