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Measurement Concepts and Introduction to Problem Solving

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Objectives

After listening to, viewing, and studying the lecture materials in this course, you will be able to do the following:

- Describe sources of vaccine coverage, target disease, and cost data
- Explain and apply standard immunization program measurement concepts
- Distinguish alternative theories and methodological approaches to problem solving
Section A

Immunization Program Data: Disease Incidence, Vaccine Coverage, Program Costs
Main Sources of EPI Target Disease Data

**United States**

- U.S. Centers for Disease Control and Prevention (CDC)
- State immunization programs
- All vaccine providers

**Developing world**

- World Health Organization (Geneva)
- WHO Regional Offices
- National ministries of health
- All vaccine providers
Hallmarks of the U.S. Disease-Reporting System

- Decentralized, comprehensive
- Redundant state and federal capabilities
- Fax and online reporting
- Prompt outbreak investigation, feedback (MMWR)
Excerpt of CA Measles-Reporting Form

<table>
<thead>
<tr>
<th>Date Investigation Started</th>
<th>MEASLES (RUBEOLA) CASE REPORT—CALIFORNIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Data</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Sex</td>
</tr>
<tr>
<td></td>
<td>□ Male</td>
</tr>
<tr>
<td></td>
<td>□ Female</td>
</tr>
<tr>
<td>Date of birth</td>
<td>Onset age</td>
</tr>
<tr>
<td></td>
<td>□ &lt; 1 year</td>
</tr>
<tr>
<td>Address (number, street)</td>
<td>City</td>
</tr>
<tr>
<td></td>
<td>ZIP code</td>
</tr>
<tr>
<td></td>
<td>Phone</td>
</tr>
<tr>
<td>Person reporting case, phone number</td>
<td>Date reported to county</td>
</tr>
<tr>
<td></td>
<td>Physician (if any) phone number</td>
</tr>
<tr>
<td></td>
<td>Hospital (if any) phone number</td>
</tr>
<tr>
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<td>Country of birth</td>
</tr>
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<td>□ Hispanic</td>
<td>□ U.S.</td>
</tr>
<tr>
<td>□ Non-Hispanic</td>
<td>□ Other</td>
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<td>□ Unknown</td>
</tr>
<tr>
<td>Race/National Origin</td>
<td>Occupation</td>
</tr>
<tr>
<td>□ White</td>
<td>Social Security number</td>
</tr>
<tr>
<td>□ Black</td>
<td></td>
</tr>
<tr>
<td>□ American Indian/Alaska Native (Aleut, Eskimo)</td>
<td></td>
</tr>
<tr>
<td>□ Unknown</td>
<td></td>
</tr>
<tr>
<td>Asian—Please also check one box below:</td>
<td>Pacific Islander—Please also check one box below:</td>
</tr>
<tr>
<td>□ Chinese</td>
<td>□ Hmong</td>
</tr>
<tr>
<td>□ Japanese</td>
<td>□ Guamanian</td>
</tr>
<tr>
<td>□ Cambodian (Non-Hmong)</td>
<td>□ Hawaiian</td>
</tr>
<tr>
<td>□ Laotian (Non-Hmong)</td>
<td>□ Hawaiian</td>
</tr>
<tr>
<td>□ Other Asian</td>
<td>□ Other Pacific Islander</td>
</tr>
<tr>
<td>□ Filipino</td>
<td>□ Other Pacific Islander</td>
</tr>
<tr>
<td>□ Vietnamese (Non-Hmong)</td>
<td></td>
</tr>
<tr>
<td>Clinical and Lab Data</td>
<td></td>
</tr>
<tr>
<td>Rash</td>
<td>Fever</td>
</tr>
<tr>
<td>□ Yes</td>
<td>□ Yes</td>
</tr>
<tr>
<td>□ No</td>
<td>□ No</td>
</tr>
<tr>
<td>If yes, rash onset date:</td>
<td>If yes, onset date:</td>
</tr>
<tr>
<td></td>
<td>month day year</td>
</tr>
<tr>
<td></td>
<td>month day year</td>
</tr>
<tr>
<td>Duration:</td>
<td>Highest temperature:</td>
</tr>
<tr>
<td>□ 1–2 days</td>
<td></td>
</tr>
<tr>
<td>□ 3 days</td>
<td></td>
</tr>
<tr>
<td>□ 4 or more days</td>
<td></td>
</tr>
<tr>
<td>Origin on body and spread</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Watery or red eyes or photophobia</td>
</tr>
<tr>
<td></td>
<td>□ Hot</td>
</tr>
<tr>
<td></td>
<td>□ Warm</td>
</tr>
<tr>
<td></td>
<td>□ Normal</td>
</tr>
<tr>
<td></td>
<td>□ Unknown</td>
</tr>
<tr>
<td>Ill &gt; 2 days before rash:</td>
<td>□ Yes</td>
</tr>
<tr>
<td></td>
<td>□ No</td>
</tr>
</tbody>
</table>
Hallmarks of Global Disease Reporting System

- Historically incomplete, delayed in many countries
- Exceptions: smallpox, polio, measles (active surveillance + outbreak investigation)
- Steady improvements in recent years
WHO Vaccine-Preventable Diseases Monitoring System

- Includes the following indicators
  - Coverage rate time series by vaccine
  - Annual numbers of cases EPI target diseases
  - Proportion of districts reporting
  - DPT3 dropout rates
- http://www.who.int/vaccines-surveillance/intro.html
Main Sources of Vaccine Coverage Data

- United States
  - State registries

- Developing world
  - World fertility surveys (1972–84, 60 LDCs)
  - Demographic and health surveys (1984–present, ~200 done so far in over 70 countries)
  - Ministries of health, UN statistics
United States National Immunization Survey

- Surveys 78 Immunization Action Plan areas
- Produces annualized coverage estimates for 10 antigens
- Identifies particular high-risk groups
- Telephone survey + provider record check
- Santoli et al (1999) used 1997 NIS to estimate proportion of vaccinations given through Vaccines for Children Program
- Using 1999 NIS data, Luman et al (2001) showed that 75% of incompletely immunized children were only one visit away from completing their immunization schedules
Sources of Immunization-Cost Data

- Administrative record reviews
- Vaccine manufacturers
- Living Standards Measurement Surveys (World Bank, selected LDCs)
- Other surveys
Immunization Costs

- United States
  - Lieu et al (2000) computed the costs of streptococcus pneumonia in a cohort of U.S. children
  - Result: routine immunization against the disease would save $760m/year

- Developing world
  - San Sebastian et al (2001) compared hospital-based to community health worker-based delivery strategies in one region of Ecuador
  - Result: CHWs immunized children more cheaply than hospitals
Two Key Macro EPI Measures

- Equity: does the program reach all groups?
- Sustainability: can high performance be maintained?
Percent Children Ages 12–23m Fully Immunized, DHS Surveys

Equity and Sustainability: Three Latin American Countries
Percent of Children 12–23m Fully Immunized, DHS Surveys

- Burkina Faso 1992/93
- Burkina Faso 1998/99
- Côte d'Ivoire 1994
- Côte d'Ivoire 1998/99
- Kenya 1989
- Kenya 1993
- Kenya 1998

Legend:
- urban
- rural
Some Key Micro-Level Measures

- Efficiency, affordability, cost-effectiveness
- Access (cost, convenience)
- Community demand
- Quality of services
Generating Local Immunization Data

- Surveys can retrieve data from three sources
  - Vaccination cards
  - Parental recall
  - Medical and administrative records
- The veracity of the data varies by context
Local Data

■ United States
   – Bolton et al (1998) compared vaccination card, parental recall, and medical records data for a cohort of 525 Baltimore children
   – Results: parents overestimated and the cards underestimated immunization status

■ Developing world
   – Onta et al (1998) studied administrative EPI data from Nepal
   – Results: district health offices, peripheral health workers routinely inflate vaccination reports

Continued
Later in the course, we will learn more about several methods to generate local data, including:
- Cluster sample surveys
- Lot quality assurance
- Provider databases (CASA Program)
Section B

A Problem-Solving Paradigm
Problem Solving “Paradigm:”

- This is but one approach; use what works for you!
  - Define problem
  - Measure its magnitude
  - Conceptualize its determinants
  - Strategize interventions
  - Implement and evaluate
First Step in Problem-Solving: Define the Problem

- Someone identifies a problem and calls for a solution
- Who selects it and how it is chosen affect both the intervention and its resources
- Why the concern arises and how the problem is defined frame the choice of strategy
“...an expression of trust between patient and provider [that is] strongly shaped by the management practices of [health care] organizations” (Gilson, in press)
Vaccination

“…an expression of trust between patient and provider [that is] strongly shaped by the management practices of [health care] organizations” (Gilson, in press)

“A health input parents choose conditional on their resources and competing wants” (Victor Fuchs, 1996)
“...an expression of trust between patient and provider [that is] strongly shaped by the management practices of [health care] organizations” (Gilson, in press)

“A health input parents choose conditional on their resources and competing wants” (Victor Fuchs, 1996)

“Basic health services, including essential immunization, are a human right” (WHO 2001)
Vaccination

- Which statement is correct?
- All of them, for different reasons
- There are many ways to frame a problem
Alternative Problem Frames

Our children are unimmunized because:
- Funding has been cut (political)
- Parents don’t care (moral)
- Health workers don’t do their job (organizational)
- Disease risk is minimal (epidemiologic)
The Frame Sets the Parameters for the Solution

- **Management frame**
  - *Problem*: low immunization utilization
  - *Solution*: improve quality of services
Economistic frame

- *Problem*: parents not willing to pay
- *Solution*: reduce vaccination costs
Alternative Frames

- **Sociological frame**
  - *Problem*: vaccine coverage low in some communities
  - *Solution*: mobilize target communities
Few problems can be conceptualized in purely logical, factual terms. Problem definition always entails practical value-judgments. Each frame strives to be logical but invariably imposes its particular parameters (theoretical boundaries) and value judgments.
The fact that immunizing children is problematized across disciplines and cultures points to an underlying value judgment that it is important. Given the above, a robust problem-solving approach should be:
- Reflexive, making value judgments explicit
- Evidence-based

In this course, we will use materials drawn from three frames of reference:
- Epidemiological
- Economistic
- Sociological
**Epidemiological Concepts**

**Individual**
- Exposure
- Case
- Risk factors
- Participation

**Population**
- Endemicity
- Prevalence, incidence
- Contextual factors
- Coverage
Step Two: Measure the Magnitude of the Problem

- Defining problems using different frames
  - Taps different dimensions
  - Reveals different measurement approaches
  - Can lead to more robust solutions
Epidemiologic EPI Measures

- No. cases EPI target disease \( \times \) No. inhabitants
- \% communities with \( \geq 80\% \) children 12–23m fully immunized
- No. households with child 12–23m fully immunized \( \div \) No. households with child age 12–23m
- \% health facilities reporting AFP cases weekly
Economic Concepts

- Rationality
- Heterogeneous preferences
- Marginal utility
- Substitutability
- Markets: supply-demand equilibria
Economic EPI Measures

- **Efficiency**
  - $/child vaccinated

- **Cost-effectiveness**
  - $/child 12–23m fully immunized, strategy 1
  - $/child 12–23m fully immunized, strategy 2

- **Viability**
  - $ collected/$ spent on EPI
Economic EPI Measures

■ Equity
  % lowest income quartile fully immunized
  % highest income quartile fully immunized

■ Cost-benefit
  $/immunization against disease x
  $/case EPI target disease x
Sociological Concepts

Individual
- Attributes: Ascribed, attained
- Beliefs: Self-efficacy, perceived vulnerability
- Behaviors
- Reference groups, social networks

Group-level
- Social structure: strata, heterogeneity, inequality
- Institutions, norms
- Collective action
- Communities
Sociological EPI Measures

- % communities with local health committees meeting at least quarterly
- Whether local health committee controls local health resources
- No. volunteer-days contributed for local vaccination activities
- No. consecutive years community has ≥ 80% children 12–23 months fully immunized
Note That Some Concepts Are Operationalized Differently

- Example: sustainability
  - Epidemiologic: program maintains high coverage
  - Economic: program is self-financing
  - Sociological: community reproduces vaccination behaviors, norms
### Low-Income Countries Financing 25% or More of Routine EPI Vaccines*

<table>
<thead>
<tr>
<th>Country</th>
<th>% Financed</th>
<th>Country</th>
<th>% Financed</th>
<th>Country</th>
<th>% Financed</th>
<th>Country</th>
<th>% Financed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burkina Faso**</td>
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<td>Nepal</td>
<td>53</td>
<td>Tanzania</td>
<td>10</td>
<td>Congo</td>
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<td>Uganda</td>
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<td>Zambia</td>
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<td>C. Afr. Rep.</td>
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<td>Lao PDR</td>
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<td>Liberia</td>
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<td>29</td>
<td>Sierra Leone</td>
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<td>Burundi</td>
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<td>Mozambique</td>
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<td>Guinea</td>
<td>25</td>
<td>Malawi</td>
<td>2</td>
<td>Myanmar</td>
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<tr>
<td>Senegal**</td>
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<td>India</td>
<td>98</td>
<td>Lesotho</td>
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<td>Angola</td>
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<td>Somalia</td>
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<td>Côte d’Ivoire**</td>
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<td>Azerbaijan</td>
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<td>Bosnia/Herz.</td>
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<td>73</td>
<td>Sudan</td>
<td>10</td>
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</tbody>
</table>

*The routine vaccines of the expanded programme of immunization (EPI) are diphtheria, measles, pertussis, polio, tuberculosis, and tetanus. Yellow fever is part of EPI coverage in countries at risk in Africa and South America. “Low-income country” in this list represents GNP per capita of $785 or less.
** These countries have benefited from grants from the European Union.

Sources for both lists: Vaccine finance: UNICEF, Income levels: World Bank
Step Three: Conceptualize Problem Determinants

Once framed, a problem is analyzed to identify and conceptualize its determinants.

This process necessarily entails two steps:

- Theorizing
- Making causal inferences
Definition

- **Theory** — “A particular set of propositions, postulates and assumptions devised to explain some set of facts or phenomena”
Examples of Relevant Theories

- Epidemiology
  - Germ theory
  - Epidemic models
- Economics
  - Free market/ consumer choice
  - Human capital model
- Sociology
  - Symbolic interactionism
  - Organizational behavior
  - Collective action
A range of theories can be invoked to solve vaccination program problems, and they generally do not overlap.

What the theories do have in common is the notion of causality:
- For every problem (effect) there must be a cause (which hopefully can be mitigated).
Four Conditions for Causal Inference

1. Association: cause, effect (X,Y) are correlated
2. Time order: cause X must precede effect Y
3. Nonspuriousness: X, not Z, is the true cause
4. Mechanism: X theoretically linked to Y
In practice, identifying a particular cause of immunization program problems is difficult:
- The problems have multiple causes
- Many causes are unobservable

As a result, most empirical research fails to meet all causal inference criteria.

The methodologically strongest are experiments or quasi-experiments that randomize subjects and compare the outcomes of treatment, control groups.

Problem: most programs are full-coverage, so exposure cannot be controlled.
In the next lecture, we will learn more about how problem-solving interventions are designed, implemented, and evaluated.
High-quality immunization data are increasingly accessible

Immunization problems can be framed and measured from several disciplinary perspectives

Theories rarely overlap and causal inferences are rare in problem solving