Public Health Surveillance: Methods and Application

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July 2004
Definition of Surveillance

Ongoing, systematic collection, analysis, and interpretation of health-related data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those responsible for prevention and control.
Definition-2

Systematic, ongoing
• Collection
• Analysis
• Interpretation
• Dissemination
• Link to public health practice
Purposes of Surveillance

- Assess health status of a population.
- Prioritize public health priorities.
- Assess program effectiveness.
- Stimulate research:
  - Basic
  - Applied
  - Operational
Types of Conditions for Which Surveillance is Used

- Communicable diseases
- Chronic diseases
  - Cancer, Malnutrition
- Occupational injuries
- Other injuries
  - Intentional (suicide, homicide)
  - Unintentional (falls)
- Health effects of toxic exposures
- Personal health practices
  - Smoking, Sexual Behavior, Drug Use, Alcohol


Uses of Public Health Surveillance Systems

- Estimate magnitude of the problem
- Determine geographic distribution of illness
- Portray the natural history of a disease
- Detect epidemics/define a problem
- Generate hypotheses, stimulate research
- Evaluate programs & control measures
- Monitor changes in infectious agents
- Detect changes in health practices and behaviors
- Facilitate planning
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SHIGELLOSIS
1970-2000

Reported Cases per 100,000 Population

Year

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Rate of HEPATITIS A
United States and territories, 2000

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TOXIC-SHOCK SYNDROME (TSS)
United States, 1985-2000

*Includes cases meeting the CDC definition for confirmed and probable cases for staphylococcal TSS. Reporting for fourth quarter 2000 not yet available.
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Outbreak caused by sautéed onions, IL

Outbreak caused by fermented fish/sea products, AK

Outbreak caused by baked potatoes, TX

Laboratory-confirmed cases*
National Notifiable Diseases Surveillance System (NNDSS) data

*Data from annual survey of State Epidemiologists and Directors of State Public Health Laboratories.
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POLIOMYELITIS (paralytic)
United States, 1970-2000

Reported Cases

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Trends in Plasmid-Mediated Resistance to Penicillin and Tetracycline
United States, 1988-1997

Source: Gonococcal Isolate Surveillance Project (GISP)

Note: "PPNG" (penicillinase-producing) and "TRNG" (tetracycline-resistant) N. gonorrhoeae refer to plasmid mediated resistance to penicillin and tetracycline, respectively.
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Women Aged 50 Years or Older Who Reported Having Had a Mammogram Within the Previous 2 Years

Source: CDC, Behavioral Risk Factor Surveillance System.
Percentage of Adults Who Are Obese,* by State

1987

1991

1998

Not Available  <10%  10%-15%  >15%

*Approximately 30 pounds overweight or BMI ≥30.
Approaches to Surveillance

1. Coverage
2. Intensity
3. Standardization
4. Analysis & Interpretation
5. Dissemination
6. Evaluation
Coverage-1

Two Basic Strategies:

1. Universal
   - Choose entire population or a representative sample to monitor for condition of interest.
   - Acute flaccid paralysis (polio)
   - Measles
   - Food Poisoning
   - Bioterrorism agents
Coverage-2

2. Sentinel

• Choose key “location” to monitor for condition of interest.
• “Locations” might include
  • Sites
  • Events
  • Providers
  • Animals/Vectors
• -Choose a “location” that is most susceptible to change.
Two Basic Approaches:

1. **Active**
   Periodic solicitation of case reports from reporting sources such as physicians, hospitals, laboratories, etc.

Eg. Routine search of hospital records for cases of disease x in the discharge listings.
Active Surveillance

**Advantages**
- Can be very sensitive.
- Can collect more detailed information.
- May be more representative.

**Disadvantages**
- Cost.
- Labor intensive.
- Difficult to sustain over time.
2. Passive

Relies on health care providers to report on their own initiative. **Must make this reporting process simple and time efficient.**

Eg. Vast majority of surveillance systems are passive.
Passive Surveillance

Advantages
• Cost.
• Easier to design and carry out.
• Useful for monitoring trends over time.

Disadvantages
• Low sensitivity.
• Amount of data available is limited.
• May not be representative.
1) **Case Definitions**

- Critical decision for surveillance system design. Will impact on the amount, type, and quality of data needed.

- High sensitivity and specificity are desired (what else is new?). Balance between costs and benefits associated with false positive and false negative reports.

- Decide if laboratory confirmation is required (infectious) or if evidence of underlying cause is required (chronic).

- MUST consider false positive rate if a positive notification requires investigation
## Sensitivity & Specificity

<table>
<thead>
<tr>
<th>Detected by System?</th>
<th>Condition Present?</th>
<th>Sensitivity &amp; Specificity</th>
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<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>A/A+C</td>
</tr>
<tr>
<td></td>
<td>True +</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>B/B+D</td>
</tr>
<tr>
<td></td>
<td>False -</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>False -</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>A+C/B+D</td>
</tr>
</tbody>
</table>

Sensitivity = $\frac{A}{A+C}$  
Specificity = $\frac{D}{B+D}$
Hepatitis A Case Reporting by Physicians’ Specialty and by Active:Passive Sample Category Kentucky, 1983

<table>
<thead>
<tr>
<th>Specialty</th>
<th>Active Sample</th>
<th></th>
<th></th>
<th>Rate</th>
<th></th>
<th></th>
<th>Rate</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Cases</td>
<td>Rate *</td>
<td>N</td>
<td>Cases</td>
<td>Rate</td>
<td></td>
</tr>
<tr>
<td>GP/FP Pediatrics Internal Medicine</td>
<td>71</td>
<td>4</td>
<td>5.6</td>
<td>73</td>
<td>2</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>All**</td>
<td>216</td>
<td>14</td>
<td>6.5</td>
<td>216</td>
<td>5</td>
<td>2.3</td>
<td></td>
</tr>
</tbody>
</table>

*Cases per 100 physicians
**Active:Passive reporting rate ratio, adjusted for specialty = 2.8 (95% C.L. = 1.1 - 7.2)
2) **Data Collection**

- Should be driven by policy decisions.
- HIPPA regulations will play a role.
- Standardize forms and processes for data collection.
- KISS (Keep It Simple Stupid (you not them))
- Henderson’s Golden Rule for passive systems:*  
  - Line listing is best  
  - Half a page is okay  
  - One side of one page is maximum.

*Doesn’t always work this way, but emphasizes the need to think carefully about every data item.
3) **Data Processing & Management**

- Common data definitions & dictionary
- Common coding practices
- Identification of responsible party at each reporting location, not the Boss!
- Case definition validation
- Timing of reporting, during investigation or after completion?
- Dates, dates, dates
- Duplicate reporting
- Error corrections and editing loops
Analysis & Interpretation

Common Questions to Address

• Is the condition reported more frequently than expected?
  – To what level?
  – Does this constitute “alert” status?

• Is there a geographic or time cluster of cases?
  – Does this require an investigation?

• Has anything changed in the system to distort the analysis over time?
• Person, place and time are traditional approaches to analysis.
• Must be timely and limited to most important questions.
• Focus must be on consistency over time in style of presentation and criteria for “alert” status.
• Care must be given to interpretations of trends over time, especially in passive systems where actual sensitivity and specificity are not well known.
Dissemination

- Primary users of information must be identified during system design. This should include those who contribute information to the system.
- Regular updating of dissemination lists.
- Involvement of customers in analysis and interpretation, especially if they are primary decision makers for action.
Dissemination-2

- Feedback system for users of the system.
- Set of recommendations BASED ON THE DATA and other circumstances should be included in each report.
Evaluation

Based on fundamental attributes of an effective system:*  
- Timeliness  
- Simplicity  
- Flexibility  
- Acceptability  
- Sensitivity, Specificity, and PPV  
- Representativeness

*Relative importance of each of these attributes will vary depending on the system and the disease.
Summary

- Definition of surveillance
- Uses and purpose of surveillance
- Approaches to surveillance
  - Coverage
  - Intensity
  - Standardization
  - Analysis & Interpretation
  - Dissemination
  - Evaluation