

Public Health Surveillance: Some of the Basics

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Public Health Surveillance

"...the ongoing systematic collection, analysis, and interpretation of outcome-specific data for use in planning, implementation, and evaluation of public health practice"

- Thacker SB, Berkelman RL. Public Health Surveillance in the United States. *Epidemiol Rev* 1988;10:164-90.

National Communicable Diseases Surveillance

- Reporting by states to federal government (e.g., CDC) is generally voluntary
- Every state does communicable disease surveillance slightly differently
 - Different reportable diseases
 - Different reporting processes
 - Different technologies

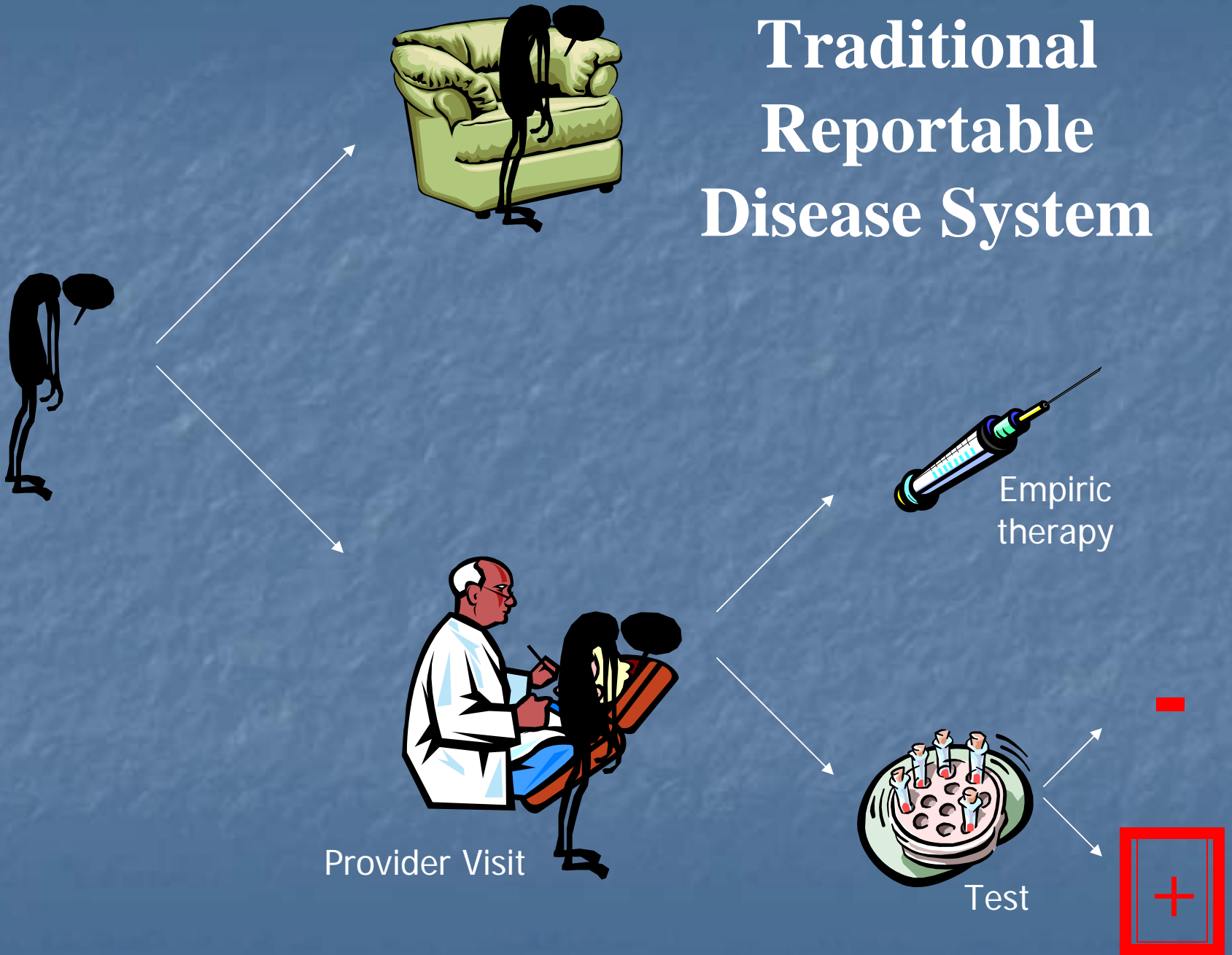
National Communicable Diseases Surveillance (cont'd)

- Attempts have been made to standardize communicable diseases surveillance
 - Standard Case Definitions (CSTE)
 - List of "Nationally Notifiable Diseases" (CSTE)
 - NETSS
 - NEDSS

Communicable Diseases (CD) Surveillance Systems

- “Traditional” Reportable Diseases Systems
 - Laboratory-based Surveillance
 - Provider reporting
- Surveillance for Outbreaks
- Influenza: Sentinel Provider Surveillance
 - Sentinel Providers
 - Sentinel Laboratories
 - Pediatric Hospitalizations and Deaths
 - Healthcare Workers Hospitalized with Pneumonia
- “Prevalent” Communicable Disease Surveillance
 - Hepatitis Registry
 - Immunization Registry and Surveys

Traditional Reportable Disease System



Attributes of MD's Traditional Reportable Diseases Surveillance

- Generally passive rather than active
- Communicable diseases are undoubtedly underreported (i.e., not very sensitive)
- Simple, flexible, and well-accepted
- Relatively timely
- Positive predictive value varies by disease
- Representativeness varies by disease

Privacy and Public Health Surveillance

- Reporting is required; an individual may not “block” the reporting of required information
- Reporting not precluded by “HIPAA”
- However, Maryland statutes protect confidentiality of surveillance information
- Re-release of individual-level surveillance information restricted

CD Reporting: Assessment

■ Strengths

- 'Routine' reporting from medical laboratories and from ICPs highly reliable
- Recognition of need to report and when to report is increasing

■ Weaknesses

- Physician reporting continues to be spotty
- Public health agencies at times are difficult to contact; procedures may be confusing

Interpreting Surveillance Data

- Severity of disease
 - more serious diseases
 - More serious manifestations of common diseases
- Public awareness of disease
- Provider awareness of disease
- Health care financing issues
- Lab testing patterns
- Availability of new lab tests
- New interventions (e.g., new vaccines)
- Changes in case definitions

Sensitivity/Specificity

Disease Present

Case definition or Test results	Disease Present		
	Yes	No	
positive	TP	FP	All persons with positive tests or meeting case definition
negative	FN	TN	All persons with negative tests or not meeting case definition
	All persons with disease	All persons without disease	

Interpreting Test Results

Sensitivity: Probability test=positive if patient=positive
 $(TP/TP+FN) \times 100$

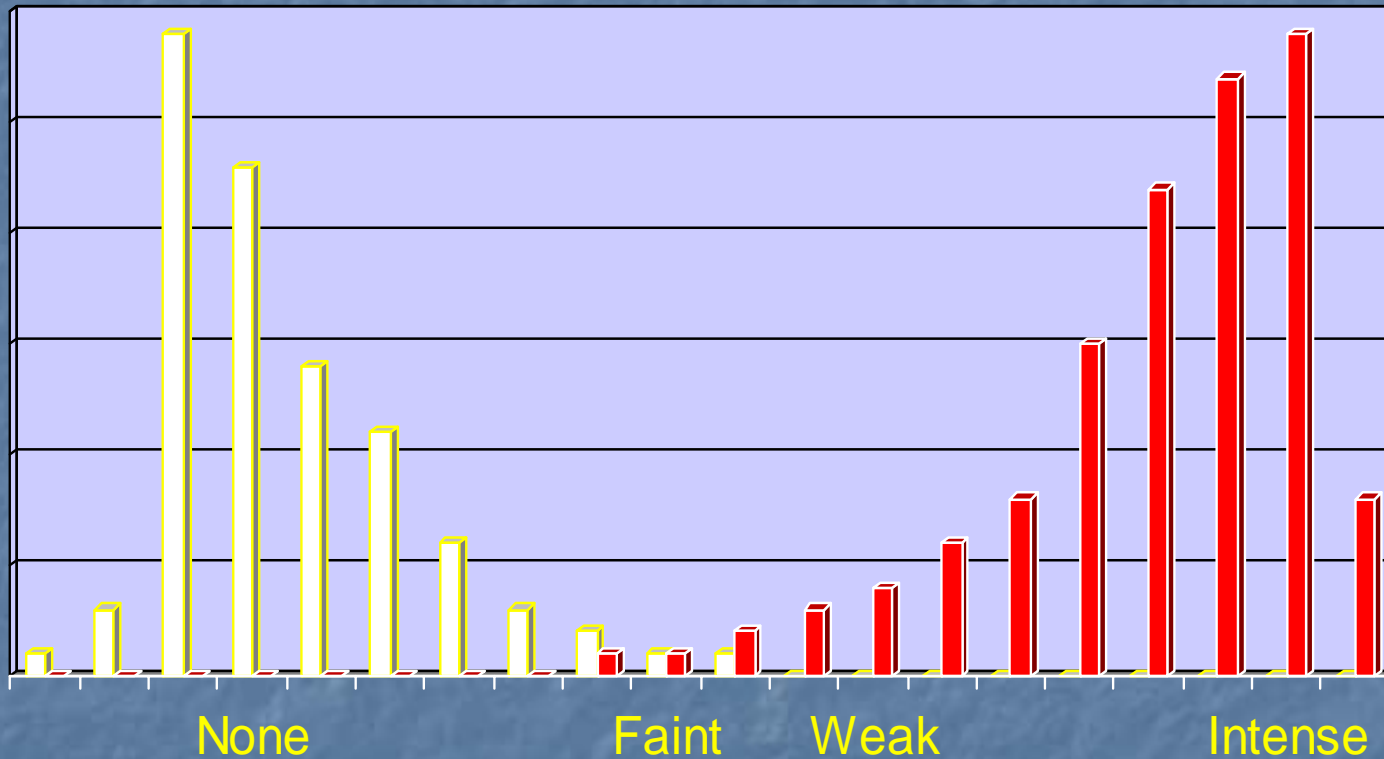
Specificity: Probability test=negative if
patient=negative
 $(TN/FP+TN) \times 100$

Predictive value:

Probability patient=positive if test=positive

Probability patient=negative if test=negative

Hypothetical Test Results



Test Result (Color)

■ No Disease ■ Disease

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RM(AAM), Microbiolo
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Hygiene

Method Sensitivity

- The *analytical* sensitivity of a method refers to the lowest concentration of analyte that can be reliably detected.
- The most common definition of sensitivity is the analyte concentration that will result in a signal two or three standard deviations above background.

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Predictive Value

- How predictive is this test result for this particular patient?
- Determined by the sensitivity and specificity of the test, *and* by the pre-test likelihood that the disease is present in the patient being tested (or the prevalence of disease in the population being tested).

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Example: Test 1,000 persons

Test sensitivity = 90% Specificity = 99.6%

prevalence of
condition in
population = 10%

positive	90	4
negative	10	896
	100	900

True 90
positive:

False 4
positive:

Positive predictive
value:

$$90/94 = 96\%$$

Example: Test 1,000 persons

Test Sensitivity = 90% Specificity = 99.6%

prevalence = 10%

True positive: 90

False positive: 4

Positive predictive value: $90/94 = 96\%$

prevalence = 0.4%

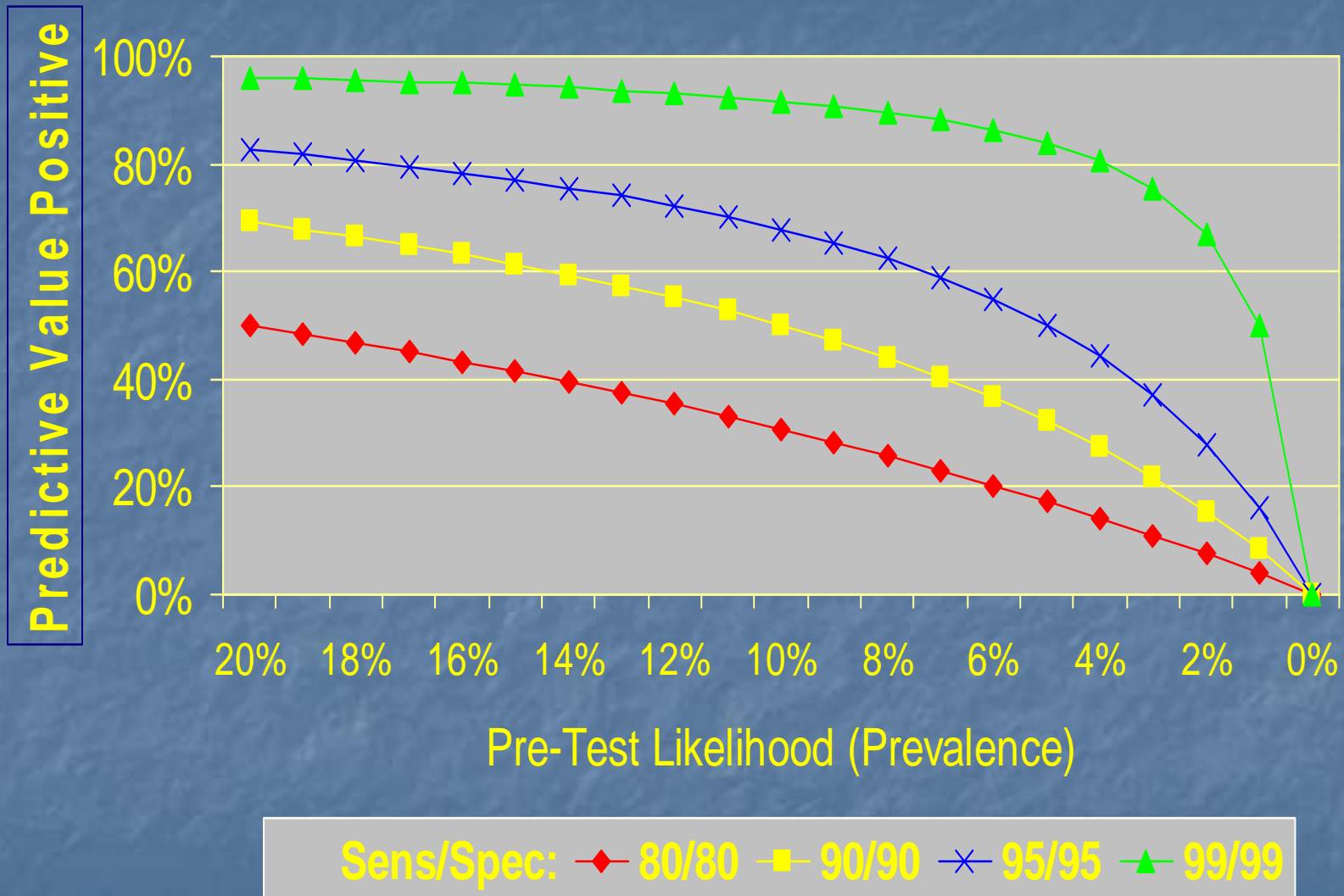
True positive: 4

False positive: 4

positive:

Positive predictive value: $4/8 = 50\%$

Predictive Value Positive



John Pfister, MS, RM(AAM), Microbiologist/Epidemiologist
Wisconsin State Laboratory of Hygiene

Test Efficiency and Predictive Values

$$TE = \frac{TP + TN}{\text{Total No. of Tests}} \times 100$$

$$PV_{\text{Neg}} = \frac{TN}{TN + FN} \times 100$$

$$PV_{\text{Pos}} = \frac{TP}{TP + FP} \times 100$$

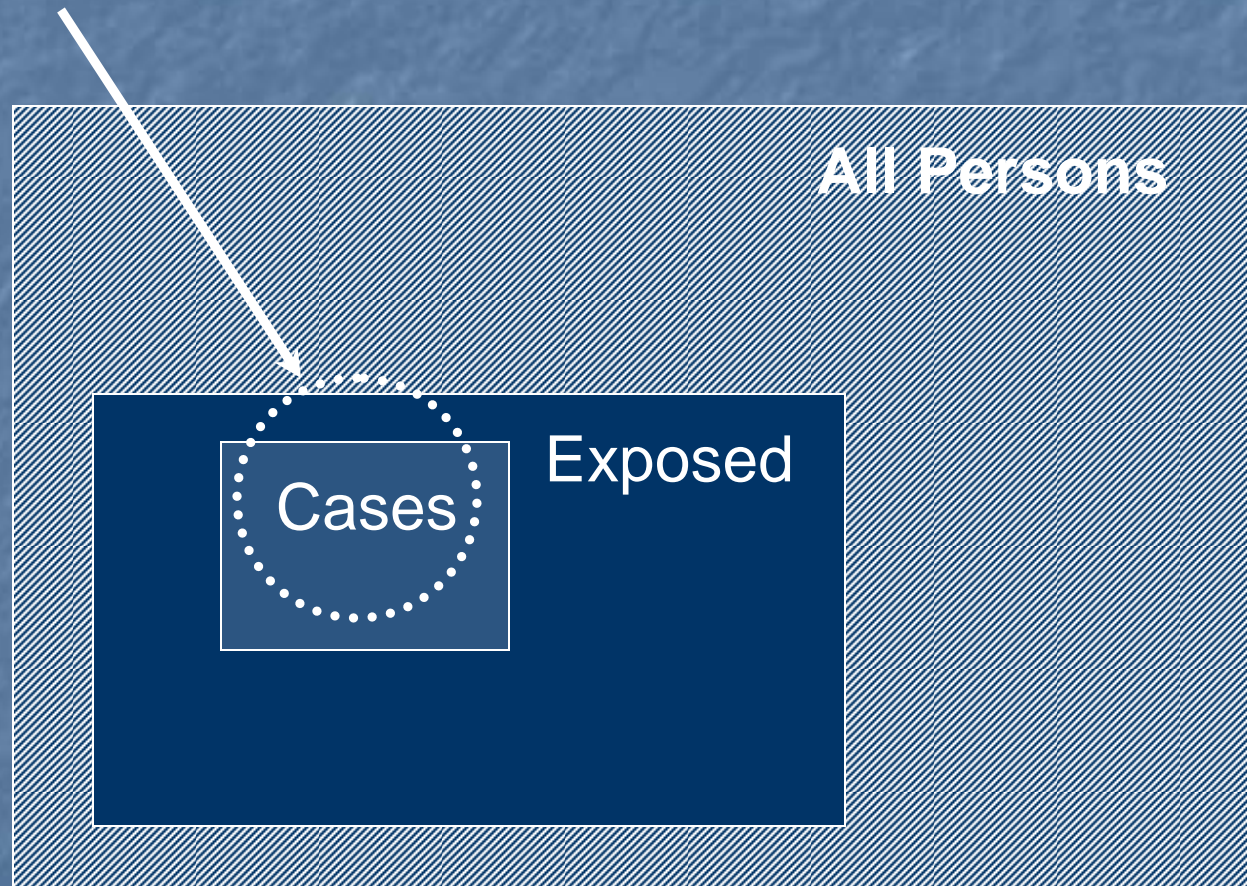
Case Definition: How Specific?

- **Low specificity:**
 - "Any person with a cough or a flu-like illness now or in the last week, who was in Baltimore City from Sep.1- 30."
 - Will pick up true cases & lots of non-cases (especially in flu season)
- **High specificity:**
 - "Any person who went to a health care facility in the last two weeks for evaluation of cough and fever, with lab-confirmed *Bacillus anthracis*."
 - Likely to pick up some true cases but fewer non-cases.

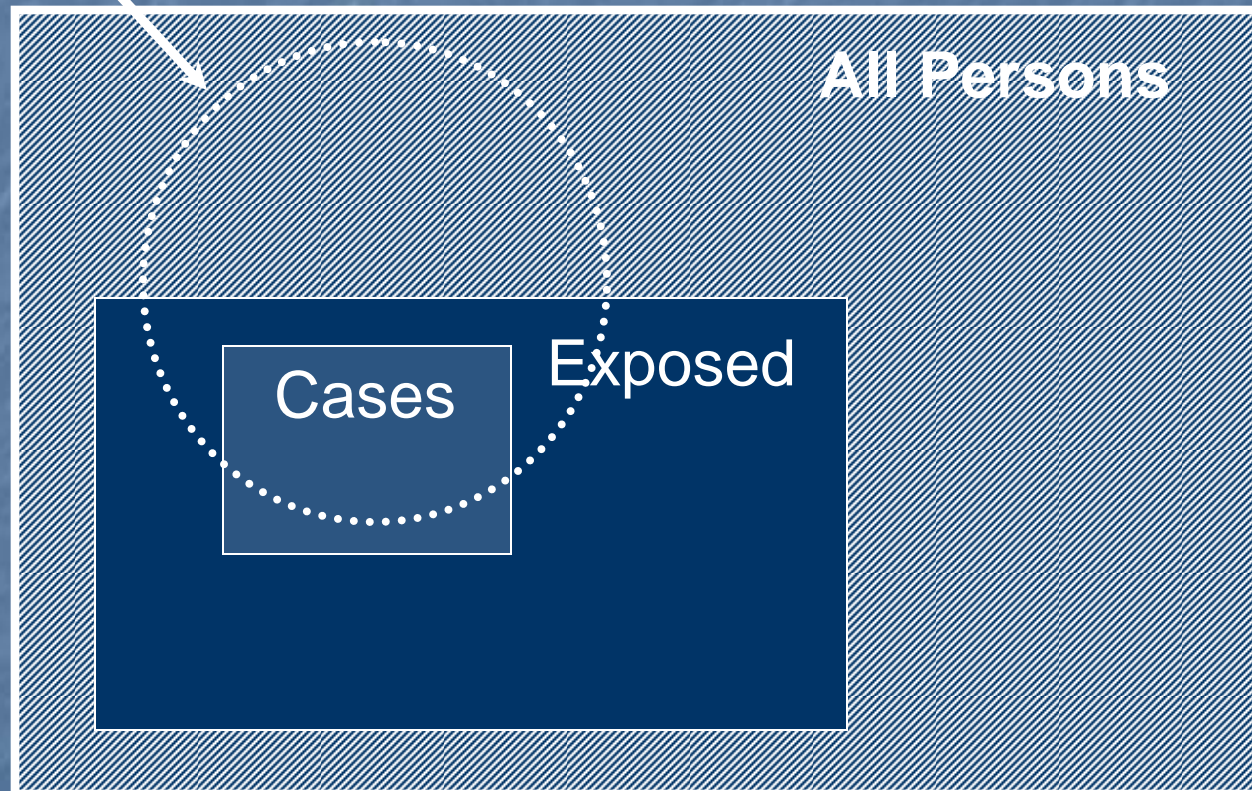
Case Definition: How Specific?

- Pro (*highly specific*):
 - Useful to focus on those cases most useful for analysis
 - Less likely to cause panic
 - May target help to those persons most in need
- Con (*highly specific*):
 - Risk of missing many ill persons, or missing early or mild cases
 - May bias analysis against more recent cases; may miss lesser risks for exposure
 - May be misleading about real extent of BTI event

High Specificity Case Definition



Low Specificity Case Definition



How are Public Health Surveillance Data Used?

- Detect outbreaks
- Monitor trends
- Identify subgroups at increased risk
- Monitor effectiveness of interventions

Each Report Generates a Case Investigation

- Usually performed by local health department staff
- Missing information collected
 - Core demographic and clinical information
 - Supplemental information
- Guides implementation of individual control measures

CD Reporting Pathway

Centers for Disease Control and Prevention
Atlanta, GA

MD Department of Health
and Mental Hygiene
Baltimore, MD

Local Health Departments
(23 counties,
Baltimore City)

Physicians and other
Healthcare Providers

Acute and Non-Acute
Healthcare Facilities
in Maryland

Clinical Laboratories



Federal Enhancements Disease Surveillance System:

- Emerging Infections Program
- Syndromic Surveillance
 - BioSense
 - ESSENCE
- Environmental Detectors
 - BioWatch
 - BDS
 - Guardian

What Are “Emerging” Infections?

New, reemerging, or drug-resistant infections whose incidence in humans has increased within the past two decades or whose incidence threatens to increase in the near future

From IOM “Emerging infections: microbial threats to health in the United States” (1992)

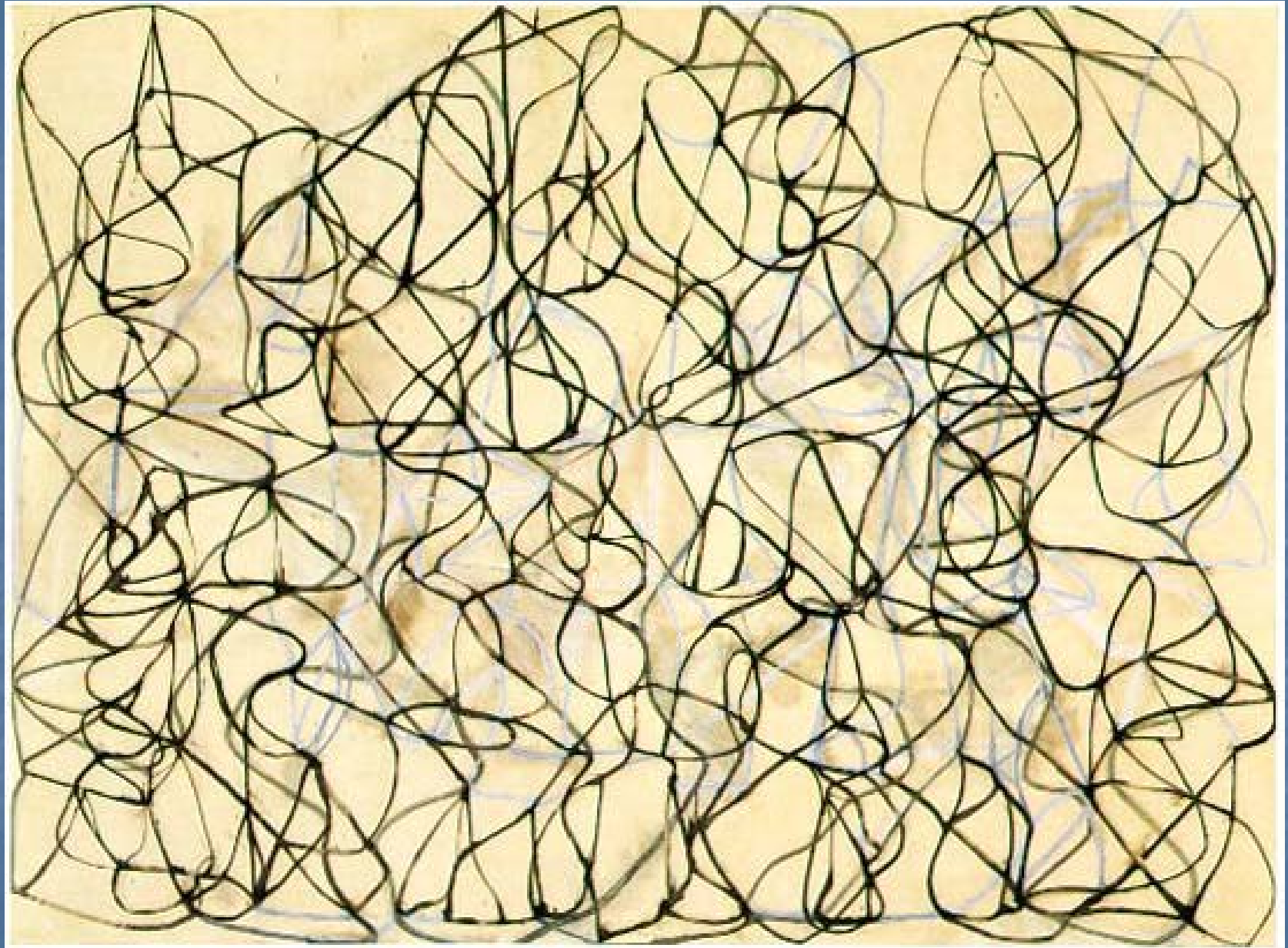
EIP Sites



■ EIP

Syndromic Surveillance Systems

- Syndromes rather than specific diagnoses
- Information available rapidly
- Designed to detect and/or monitor outbreaks
- Funded partly by federal PH Preparedness and Response Cooperative Agreement
- Usefulness and cost-effectiveness not established



Bio Sense

- CDC syndromic surveillance
- Near real-time
- Data streams from DoD and Veterans' Affairs Ambulatory clinics + LabCorps
- Analytical results for each state and metro area (maps, graphs and tables)
- Accessible to State and local users

BioSense and ESSENCE: Syndromes

- 11 syndromes + Specific Infection
 - Botulism-Like
 - Fever
 - Gastrointestinal
 - Hemorrhagic Illness
 - Localized Cutaneous Lesion
 - Lymphadenitis
 - Neurological
 - Other
 - Rash
 - Respiratory
 - Severe Illness and Death

Electronic Surveillance System for Early Notification of Community- based Epidemics (ESSENCE): Syndromes

- Developed by DHMH, VDH, DCDOH
- Non-hierarchical structure for chief complaints
- Coding is NOT mutually exclusive (I.e. one cases can be coded to multiple syndromes)

ESSENCE: Data sources

- All ED visits occurring during the previous day are electronically sent to JHU/APL and DHMH
- Transmission: Daily
- Latency: approximately 7 hours to 2 days

ESSENCE: Other data sources

- OTC data (3 major chains in MD)
- Outpatient visits
 - Military
 - Civilian
 - Elderly
- HMO call triage data

ESSENCE: Future directions

- Include other sources of syndromic surveillance data
 - School absenteeism
 - Private physician visits
 - Poison control center data
 - Death certificate/OCME data
 - Veterinary data
 - Nurse Hotline calls

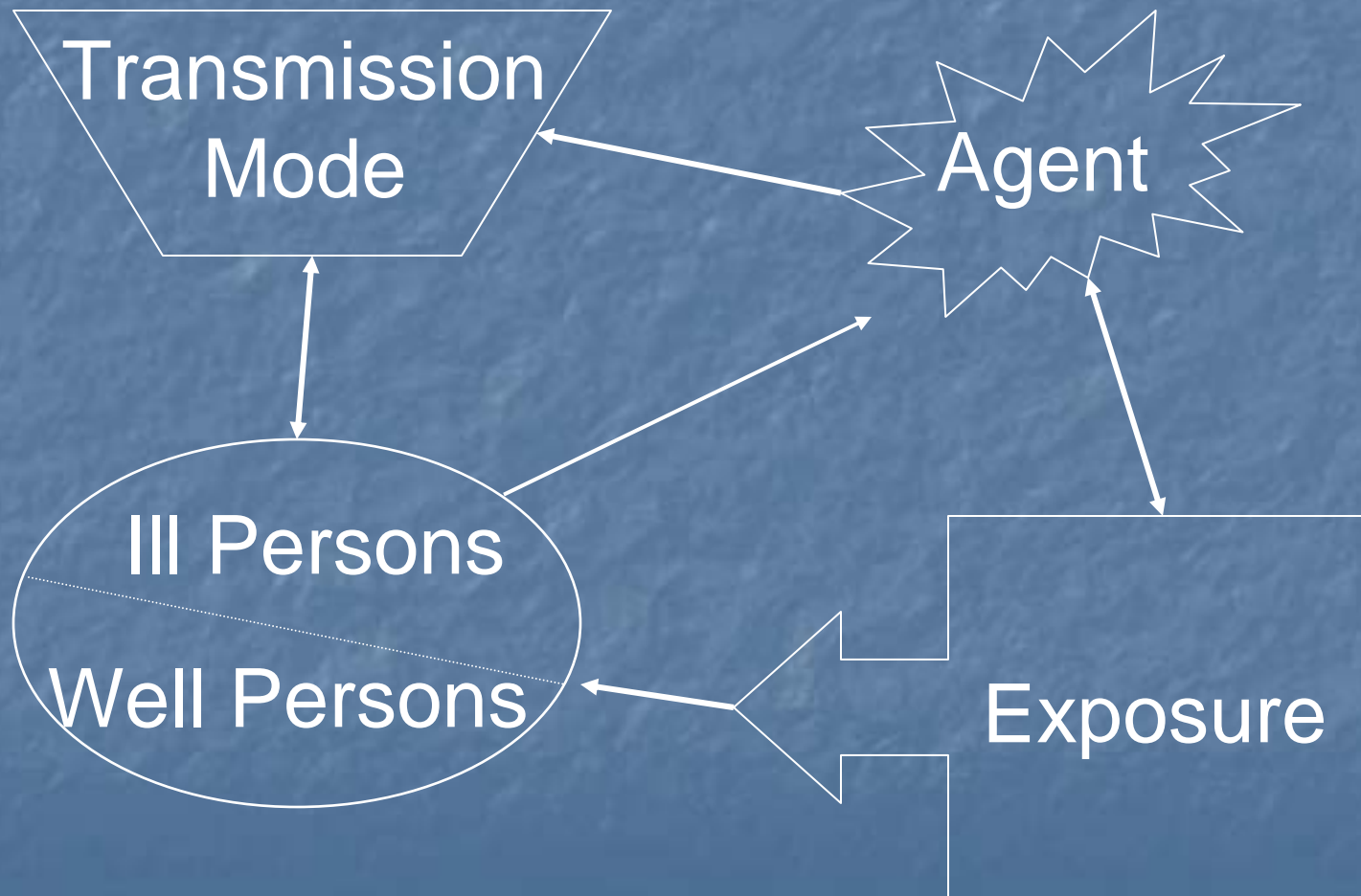
Environmental Detectors

- Free standing “sniffers” in strategic locations:
 - BioWatch: outdoors in NCR and Baltimore Metro area
 - DHS program, MD/VA/DC provide response component
 - Recent transition from federal laboratory to NCR LRN
 - Guardian: outdoors in DoD facilities
 - Limited coordination due to security concerns
 - US Postal Service BioDetection System (BDS): Mail sorting facilities (5 in MD)
 - Integrated response with USPS, USPIS, FBI, CDC, etc

Chain of Transmission

- Agent
- Source for agent
- Portal of exit from host
- Suitable mode of transmission
- Portal of entry suitable to agent
- Susceptible host

Interaction of Knowledge = Interdependence of Timing



Disconnecting the links

- Sometimes, the findings of an epidemiological investigation lead to **corrective** actions. Future episodes of transmission can be **prevented**.
 - Example: Notification to public of risk factors and symptoms for self-referral for care
 - Example: Use post-exposure prophylaxis to stop infections in those who were exposed

Data! Analysis! *Action!*

The sooner we know what is happening, the sooner the following steps could be taken:

- Take control of available resources
- Issue a public health alert on risk factors and personal protection
- Administer antibiotics/vaccines
- Initiate law enforcement activities

Training

Diagnosis of Biological Agents:

- Anthrax
- Botulism toxin
- Plague
- Tularemia
- Smallpox
- Viral Hemorrhagic fevers
- Signs and Symptoms
- Triage and Treatment
- Dispensing for management of biologic terrorist attack
- Medication Information
- Recognize adverse reactions
- Special Populations requiring alternative therapies

Programs

- Laboratory Response Network (LRN) – FBI, CDC, DoD
- Biohazard Detection System (BDS) - USPS
- BioWatch Program - DHS
- Food Emergency Response Network (FERN) – USDA, FDA, CDC
- Biomonitoring (pesticides) - DHMH, Community Health Administration
- Water/Environmental Chemistry Surge Capacity Laboratory - EPA Region III Lab (Fort Meade)

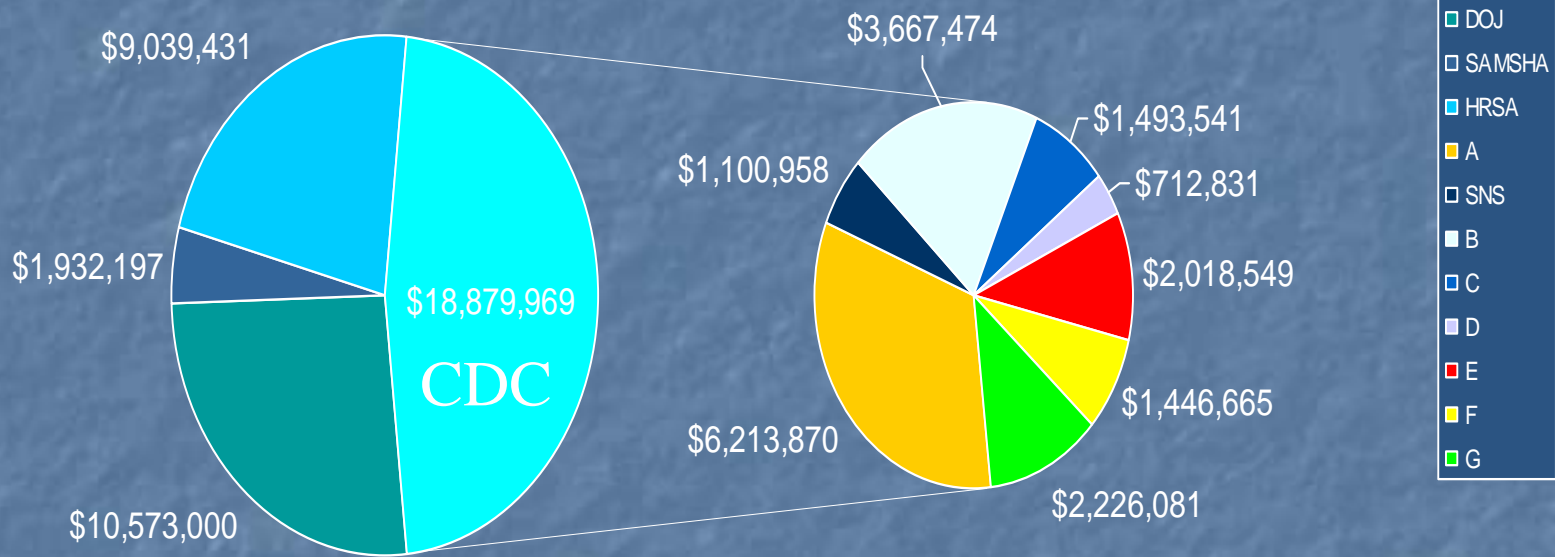
History - Accomplishments

- Fall 2001 anthrax attacks – Tested 3,400 suspected anthrax samples from State of MD, FBI, DOC, NCI, NIH, NSA, USPS
- November 2003 – Anacostia Naval Station
- February 2004 – Confirmed ricin in Dirksen Senate Office Building
- March 2005 – Pentagon anthrax scare – V Street postal facility testing
- September 2005 – Mall event (suspected tularemia)
- Hosted half-dozen workshops and trainings for Sentinel Labs, Level 3 Labs, and first responders

Tularemia on the Mall

- BioWatch issues
 - Significance
 - Of environmental detector
 - Of lab findings
 - Delay
 - Communications
- Human and animal surveillance
- 2 week event

2004 Federal BT Funding



Cost Benefit of Preparedness

- **March 2005 Pentagon Event (anthrax)**
 - 8 people 8 hours to setup 56 samples (0 positives)
 - Additional 25 hours to evaluate and workup cultures
 - Estimated \$150.00 /sample for supplies and materials
 - In following 2 weeks, received 6 additional samples for *Bacillus anthracis* and 2 for SEB (Staphylococcal enterotoxin B)
- **September 2005 Mall Event (tularemia)**
 - received 16 samples for *Francisella tularensis*, 2 samples for *Bacillus anthracis*, 2 for *Brucella* sp. Only positive was a *Brucella melitensis* from an imported food source.
 - minimum of 150 hours to workup all the samples
- To maintain enough media at all times to process 25 samples for *Bacillus anthracis*, *Clostridium botulinum*, *Brucella* sp., *Francisella tularensis*, or *Yersinia pestis* costs approximately \$25,000.00/year.
- If no BSL-3 laboratories, could not perform testing (routine or otherwise) for West Nile Virus (WNV), Eastern Equine Encephalitis virus (EEE) or *Bacillus anthracis*, *Clostridium botulinum*, *Brucella* sp., *Francisella tularensis*, and *Yersinia pestis*.