Centers for Disease Control
Early Aberration Reporting System

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EARS
EARLY ABERRATION REPORTING SYSTEM

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Introduction

- Describe development / purpose of EARS
- Provide Case Definition for Aberration
- Review Aberration Detection Methods used in EARS
- Provide Recommendations for Sites
- Provide Examples from EARS

EARS Background

- Developed by EPO and NCID
  - Several methods developed previous to EARS
  - EPO provided initial support for EARS
  - NCID took over the support of EARS
- Aberration Detection Methods
  - Suite of available aberration detection methods
  - Developed by both CDC and Non-CDC collaborators
- Primary Purpose
  - Providing aberration detection methods to local health departments that have been validated using several alternative data sources

EARS Background

- Currently used by many health department agencies for bioterrorism surveillance
  - States
  - Counties
  - Cities
- Also used at several public events
  - Democratic Convention 2001
  - Super Bowl 2001
  - World Series 2001

Define Aberration Detection

- Case Definition for Aberration
  - Change in the distribution or frequency of health events when compared to historical data.
  - This May or May not be an outbreak
  - This May or May not be of public health interest

Principles and Practice of Public Health Surveillance (2002)

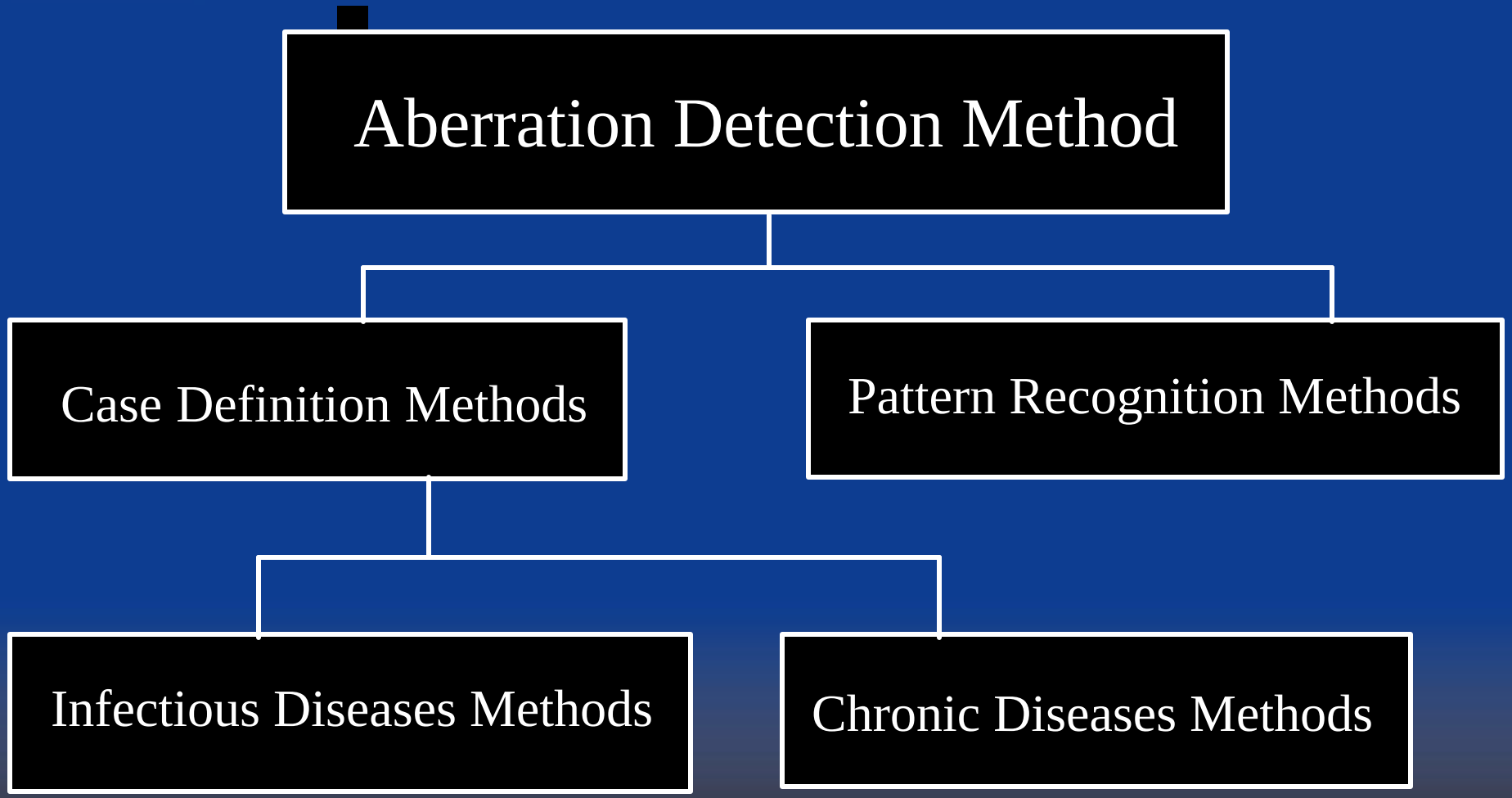
Why is this case definition important?

- Validation of models requires a fair comparison across methods and data sources
- Data entry errors
  - Would not be considered a false positive according to our definition
  - Source of aberration is identified and understood
  - Important issue in evaluating sensitivity and specificity
- Other similar events should be modeled and understood as well

Important characteristics of aberration detection methods

- High Sensitivity
- Necessary communication among staff
- Need to notify appropriate authorities
- When do you follow-up on aberrations???

Review of Literature



Infectious Disease Methods

- Long Term Implementation
  - Extended baseline methods (3-5 years)
  - Limited baseline methods (7 days - 3 years)
- Short Term Implementation
  - Implementation expected for less then 30 days such as political conventions
  - No initial baseline available (1-6 days)

Long Term Implementation Extended Baseline Methods

- Historical Limits Method (Stroup et.al. 1989)
- Seasonaly Adjusted CUSUM (Hutwagner et.al. 1997)
- Log Linear Regression (Farrington et.al. 1996)
- Compound Smoothing (Stern et.al. 1999)
- Cyclical Regression (Simonsen et.al. 1997)

Long Term Implementation Summary

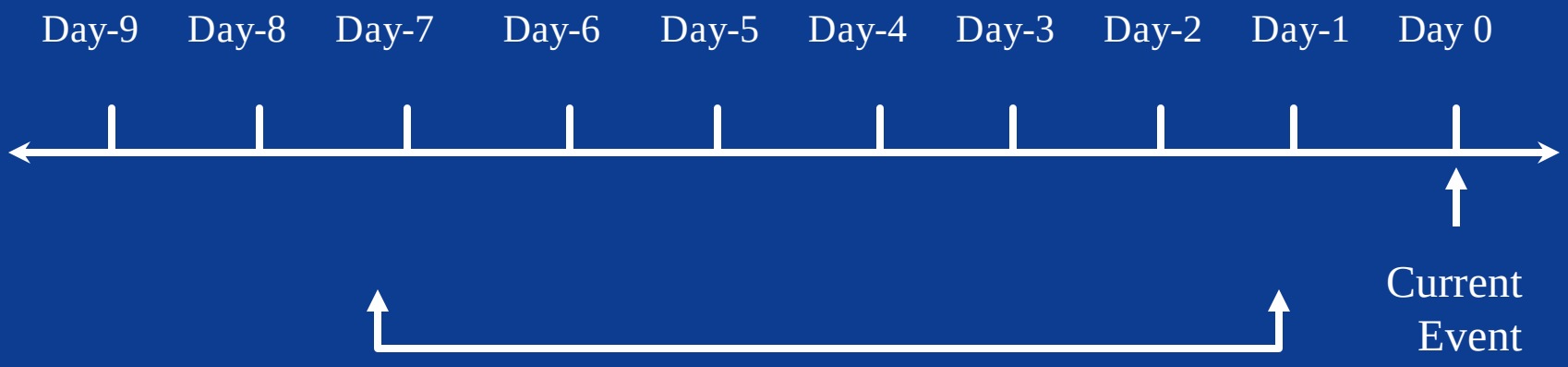
- Validation of Methods
  - Selected 2 Methods for Implementation
    - Historical Limits Method
    - CUSUM Method
  - Methods complement each other
  - CDC has 5+ experience problem solving with these methods
- EARS will implement additional methods
  - Needs to further validate methods

Long Term Implementation Limited Baseline Methods

- C1-MILD
- C2-MEDIUM
- C3-ULTRA

$$2 > \frac{CUSUM_{-1} + \text{Current Count} - (\text{Baseline Mean} + \text{Baseline Std Dev})}{\text{Baseline Std Dev}}$$

Timeline for Implementation



Short Term Implementation
No Available Baseline

- P Chart
- 2X2 Tables (chi square)
- Moving Average Chart
- CUSUM

Summary of Methods Available in EARS

- Historical Methods
  - Historical Limits
  - Seasonality adjusted CUSUM
- CUSUM Methods
  - C1-MILD
  - C2-MEDIUM
  - C3-ULTRA
- Drop In Surveillance Methods
  - P Chart
  - 2x2 Tables (Chi Square)
  - Moving Average Chart
  - CUSUM

Why Does Industry Continue To Use Quality Control Methods?

- First developed P-Charts in 1920's
- Stoumbos et al. The State of Statistical Process Control as We Proceed into the 21st Century, Journal of the American Statistical Association in 2000
- CUSUM and P-Chart methods continue to be among the most important and widely used quality control tools in statistics
- Applied in manufacturing, engineering, environmental science, biology, genetics, epidemiology, medicine, finance, law enforcement and athletics

Implementation Of Methods Based on Time

Time	Implementation of Method
Event	Implement emergency surveillance
Day 1	P-Chart
Day 2-6	P-Chart, CUSUM
Day 7+	C1-MILD, C2-MEDIUM, C3-ULTRA
3 Years +	Multiple methods depending on data source

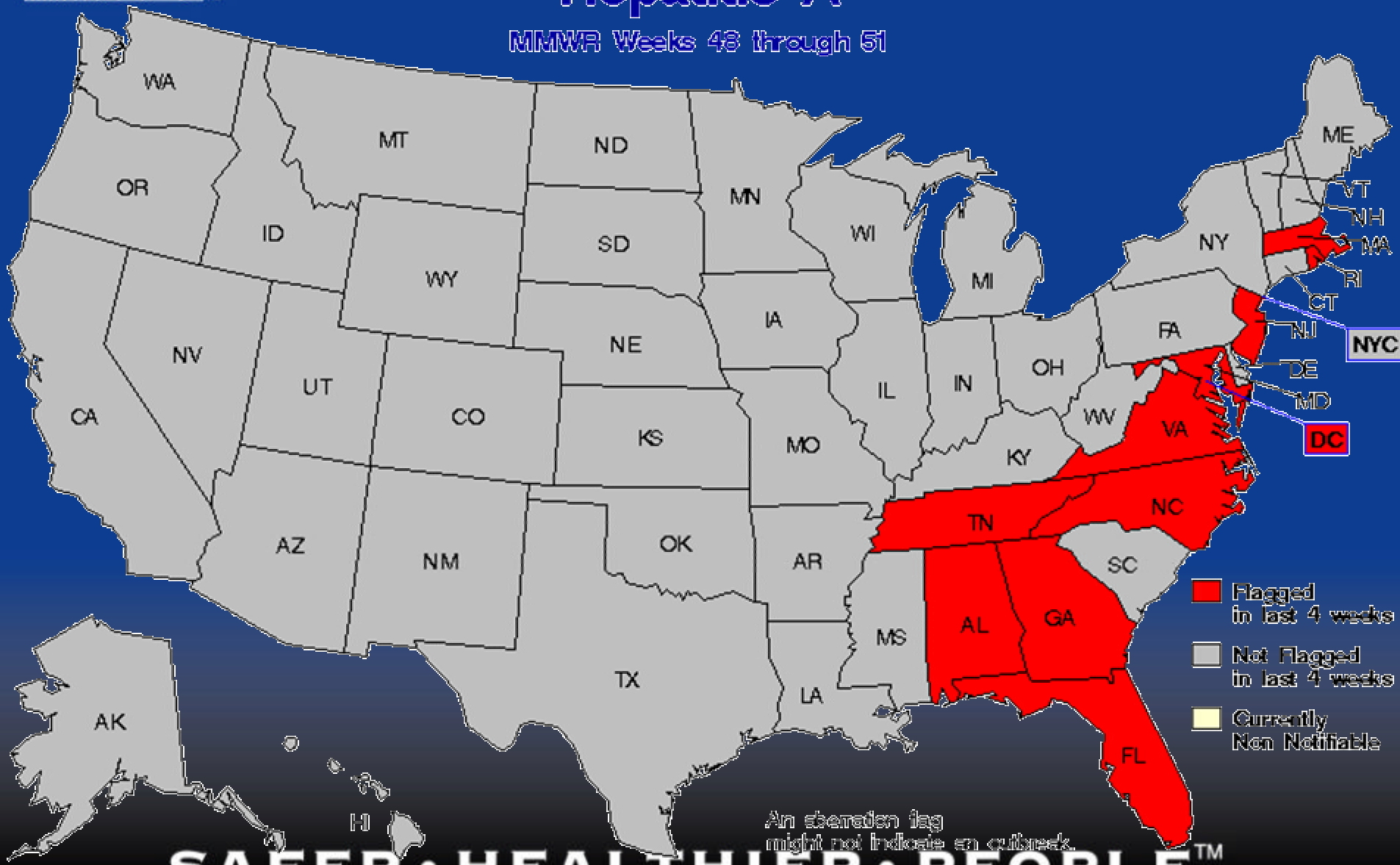
EARS Drop In Surveillance Real Time Applications

- Foodborne outbreaks
- Respiratory illness
- Data entry errors
- Bioterrorism ??

Aberration Detection

Hepatitis A

MMWR Weeks 48 through 51



An aberration flag might not indicate an outbreak.

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Aberration Detection

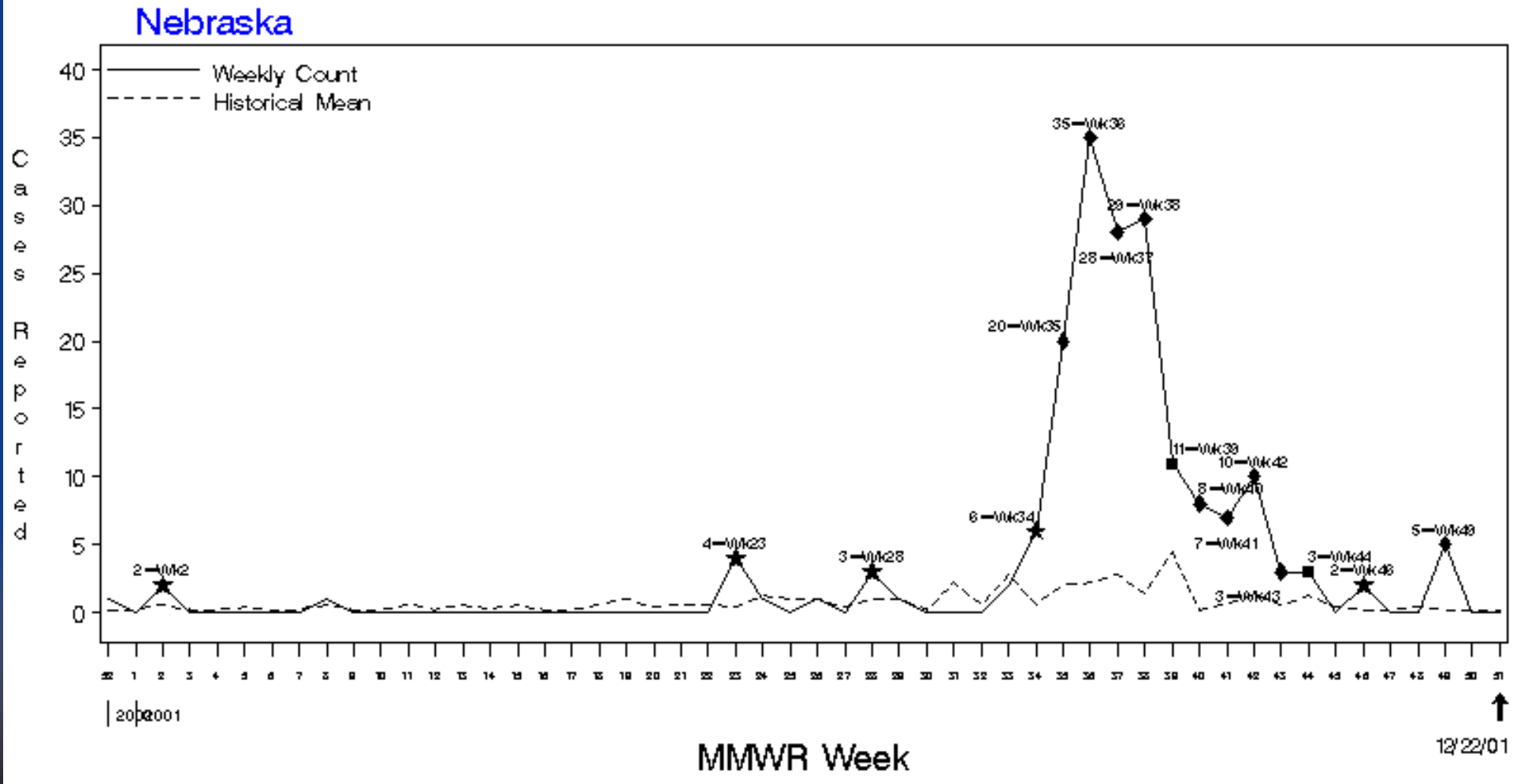
All USA

Flagged Events for MMWR Weeks 48 through 51

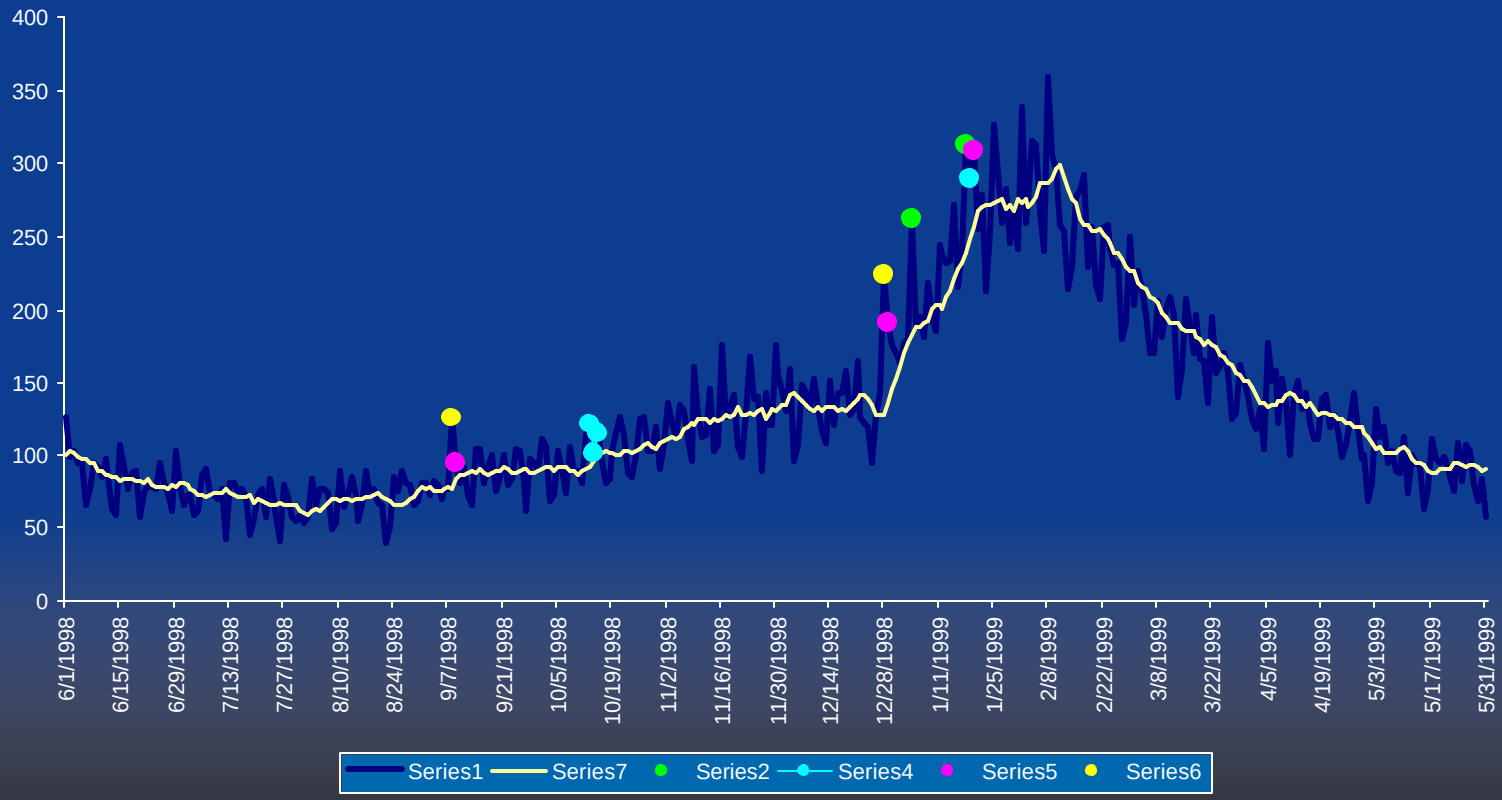
Event	Week	Count (YTD)						CUSUM		Detection Flags
		1996	1997	1998	1999	2000	2001	Mean	STD	
Anthrax	48	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (16)	0.20	0.20	CUSUM Hist Limits
Botulism (Foodborne)	50	0 (24)	0 (27)	0 (14)	0 (22)	0 (18)	1 (27)	0.20	0.20	CUSUM
Botulism (Infant)	49	1 (68)	2 (68)	0 (57)	0 (84)	0 (79)	2 (82)	0.60	0.89	CUSUM
Botulism (Other/Wound)	51	0 (21)	1 (19)	0 (27)	0 (36)	0 (18)	1 (21)	0.20	0.45	CUSUM
Brucellosis	50	1 (94)	2 (74)	1 (55)	2 (70)	2 (62)	3 (93)	1.60	0.55	CUSUM
Cholera	48	0 (3)	0 (6)	0 (13)	0 (5)	0 (8)	1 (4)	0.20	0.20	CUSUM
Cyclosporiasis	48	0 (0)	3 (85)	1 (54)	0 (56)	0 (51)	3 (124)	0.80	1.30	CUSUM
	49	0 (0)	2 (87)	1 (55)	0 (56)	0 (51)	3 (127)	0.60	0.89	CUSUM
Ehrlichiosis Hum Granu (HGE)	48	0 (0)	0 (75)	2 (104)	12 (180)	2 (199)	15 (206)	3.20	5.02	CUSUM
Ehrlichiosis Hum Mono (HME)	48	0 (0)	0 (24)	0 (19)	3 (77)	2 (98)	3 (93)	1.00	1.41	CUSUM
	51	0 (0)	0 (24)	0 (19)	0 (84)	1 (101)	1 (99)	0.20	0.45	CUSUM
Enceph (St.Louis)	50	0 (0)	0 (12)	0 (24)	0 (4)	0 (3)	1 (3)	0.20	0.20	CUSUM
	51	0 (0)	0 (12)	0 (24)	0 (4)	0 (3)	1 (4)	0.20	0.20	CUSUM

Aberration Detection

Cryptosporidiosis



Influenza Mortality Daily State Level



FAQ
What Happened with Anthrax in NYC ?

- **Our methods did not detect anthrax in NYC**
- **Why did this happen?**
  - We monitored Hospital EDs
    - Case definition for Inhaled Anthrax
  - 6 of 7 patients went to private physicians
    - Reported cutaneous anthrax
    - No one was monitoring this outcome at the time
- We believe our methods will detect these outcomes if they occur
  - New case definitions have been added

Summary of EARS

- Aberration Detection Methods
  - Suite of available aberration detection methods
  - Developed by both CDC and Non-CDC colleagues
- Primary Purpose
  - Providing aberration detection methods to local health departments that have been validated using several alternative data sources
- We have brought EARS CDs to distribute