



Public Health Surveillance

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Outline

- Public Health Surveillance
 - Considerations
 - Case Surveillance
 - Syndromic Surveillance
- Evolving Technologies for Public Health Surveillance



Definition of Public Health Surveillance



“The ongoing, systematic collection, analysis, and interpretation of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those who need to know.”

~Ehrenkranz, NJ Am J Med 1981

Uses of Public Health Surveillance Data

DETECT

- Illness and injuries
- Outbreaks and epidemics

CHARACTERIZE

- Magnitude, trends, populations at risk
- Assess healthcare utilization

MONITOR

- Study etiology, natural history, risk factors
- Track and manage cases

RESPOND

- Implement interventions; target resources
- Evaluate prevention and control measures

**In public health,
we can't do
anything
without
surveillance.
That's where
public health
begins.**

— David Satcher, MD, PhD
Director, CDC 1993-1998



Implementing Public Health Surveillance

Define Objectives

- Intended use, audience, actions

Identify Strategies

- Authority, data sources, inclusion criteria, data management

Plan Analysis and Dissemination

- Measures, presentation

Evaluate and Refine

- Valid, timely, complete, efficient



Surveillance Methods and Data Sources

- Case reporting (clinical, lab, epi)
- Lab test result reporting
- Registries (e.g., cancer, exposures, vaccine)
- Vital registration (deaths, births)
- Syndromic surveillance (emergency department, urgent care, EMS)
- Vector surveillance
- Risk factor and disease prevalence surveys
- Environmental monitoring (air pollution, weather)
- Genomic surveillance (host and pathogen genomes)
- Secondary data (claims, social media, mobility)

Methods and data sources should be determined by the public health need

Case-Based Surveillance

- Case definitions establish the events of interest
 - Clinical criteria – signs and symptoms
 - Laboratory criteria – test results
 - Epidemiologic linkage – contact with a known case
 - Death-related criteria – primary or underlying cause of death
 - Other – age groups, settings (e.g., work-related), geographic areas, etc.
- Automating detection and classification can
 - Increase completeness
 - Improve timeliness
 - Reduce burden

Case-Based Disease Surveillance Data



Problems

- ICD-9 / ICD-10 diagnosis codes
- Problem description
- Signs and symptoms



Patients

- Patient age
- Sex
- Socio-demographics
- Geographic



Health Care Services

- CPT procedure codes
- Hospitalizations



Lab Tests and Results

- Panel and test name
- Value, units, reference ranges
- LOINC



Vaccines

- Vaccines administered
- Dose, units, quantities, strength
- History



Medications

- Prescriptions/administrations
- Dose, units, quantities, strength



Risk Factors

- Behaviors
- Travel
- Environmental
- Genetic

Traditional Case Report

Patient first name _____ Patient last name _____ Date of birth (MM/DD/YYYY): ____/____/____



.....PATIENT IDENTIFIER INFORMATION IS NOT TRANSMITTED TO CDC.....

Human Infection with 2019 Novel Coronavirus Case Report Form

Reporting Jurisdiction	Case state/local ID
Reporting Health Department	CDC 2019-nCoV ID
Contact ID ^a	NNDSS loc. rec. ID/Case ID ^b
^a Only complete if case-patient is a known contact of prior source case-patient. Assign Contact ID using CDC 2019-nCoV ID and sequential contact ID, e.g., Confirmed case CA102034567 has contacts CA102034567 -01 and CA102034567 -02. ^b For NNDSS reporters, use GenV2 or NETSS patient identifier.	

Interviewer Information

Name of Interviewer: Last: _____ First: _____	Telephone: _____ Email: _____
Affiliation/Organization: _____	

Case Classification and Identification

<p>What is the current status of this person?</p> <p><input type="checkbox"/> Lab-confirmed case* <input type="checkbox"/> Probable case</p> <p>If probable, select reason for case classification:</p> <p><input type="checkbox"/> Meets clinical criteria AND epidemiologic evidence with no confirmatory lab testing*</p> <p><input type="checkbox"/> Meets presumptive lab evidence[‡] AND either clinical criteria OR epidemiologic evidence</p> <p><input type="checkbox"/> Meets vital records criteria with no confirmatory lab testing</p> <p>*Detection of SARS-CoV-2 RNA in a clinical specimen using a molecular amplification detection test</p> <p>[‡] Detection of specific antigen in a clinical specimen, OR detection of specific antibody in serum, plasma, or whole blood indicative of a new or recent infection</p>	<p>Under what process was the case first identified? (check all that apply)</p> <p><input type="checkbox"/> Clinical evaluation <input type="checkbox"/> Routine surveillance</p> <p><input type="checkbox"/> Contact tracing of case patient <input type="checkbox"/> Other, specify: _____</p> <p><input type="checkbox"/> EpiX notification of travelers. If yes, DGMQID: _____</p> <p><input type="checkbox"/> Unknown</p> <p>Report date of case to CDC (MM/DD/YYYY): ____/____/____</p> <p>Date of first positive specimen collection (MM/DD/YYYY): ____/____/____ <input type="checkbox"/> Unknown <input type="checkbox"/> N/A</p>
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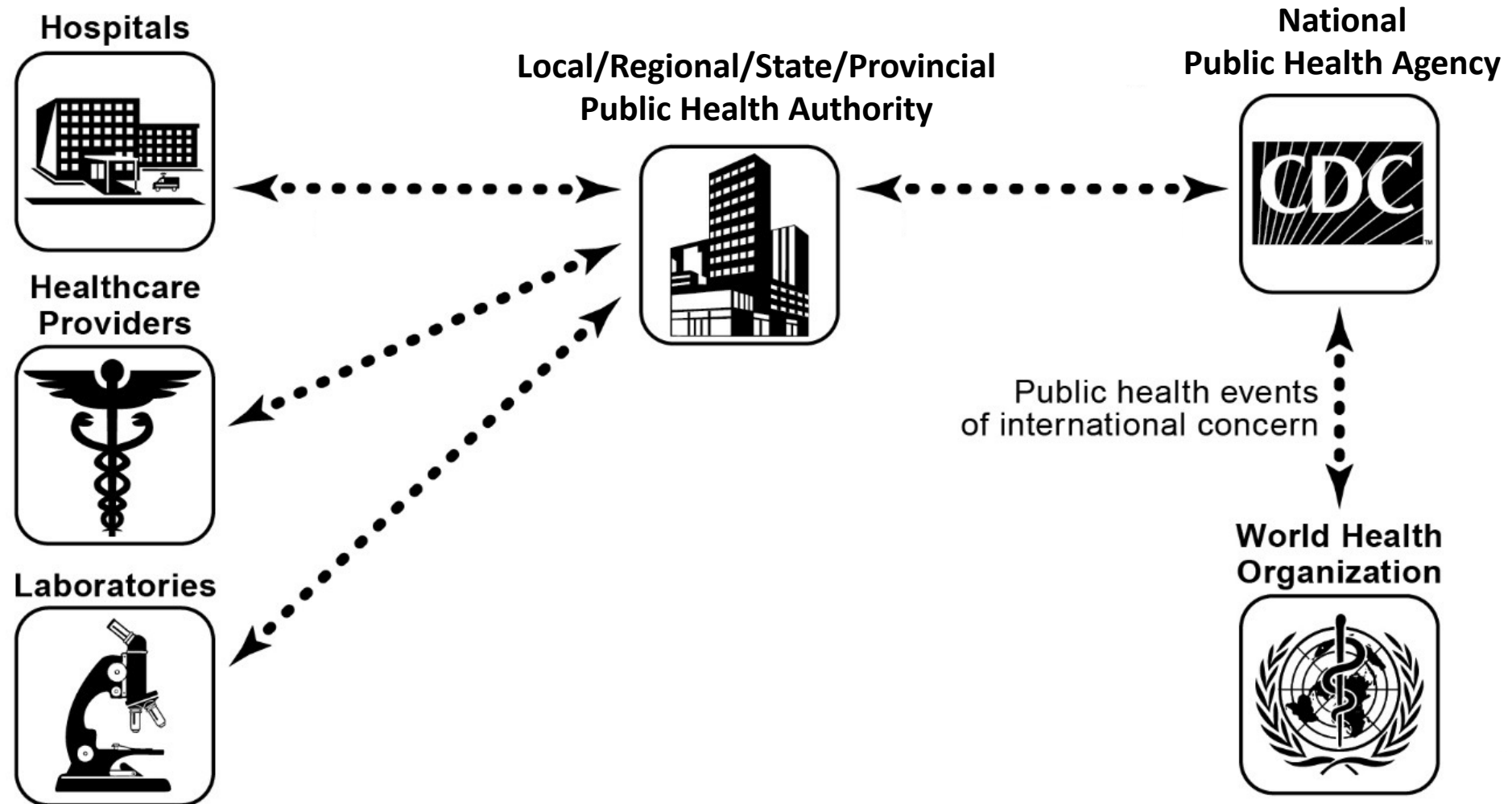
Hospitalization, ICU, and Death Information

<p>Was the patient hospitalized?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unknown</p> <p>If yes, admission date 1 ____/____/____ (MM/DD/YYYY) discharge date 1 ____/____/____</p>	<p>If hospitalized, was a translator required?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unknown</p> <p>If yes, specify which language: _____</p>	<p>Was the patient admitted to an intensive care unit (ICU)?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unknown</p> <p>If yes, admission date 1 ____/____/____ (MM/DD/YYYY) discharge date 1 ____/____/____</p>
<p>Did the patient die as a result of this illness?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unknown If yes, date of death (MM/DD/YYYY): ____/____/____ <input type="checkbox"/> Unknown date</p>		

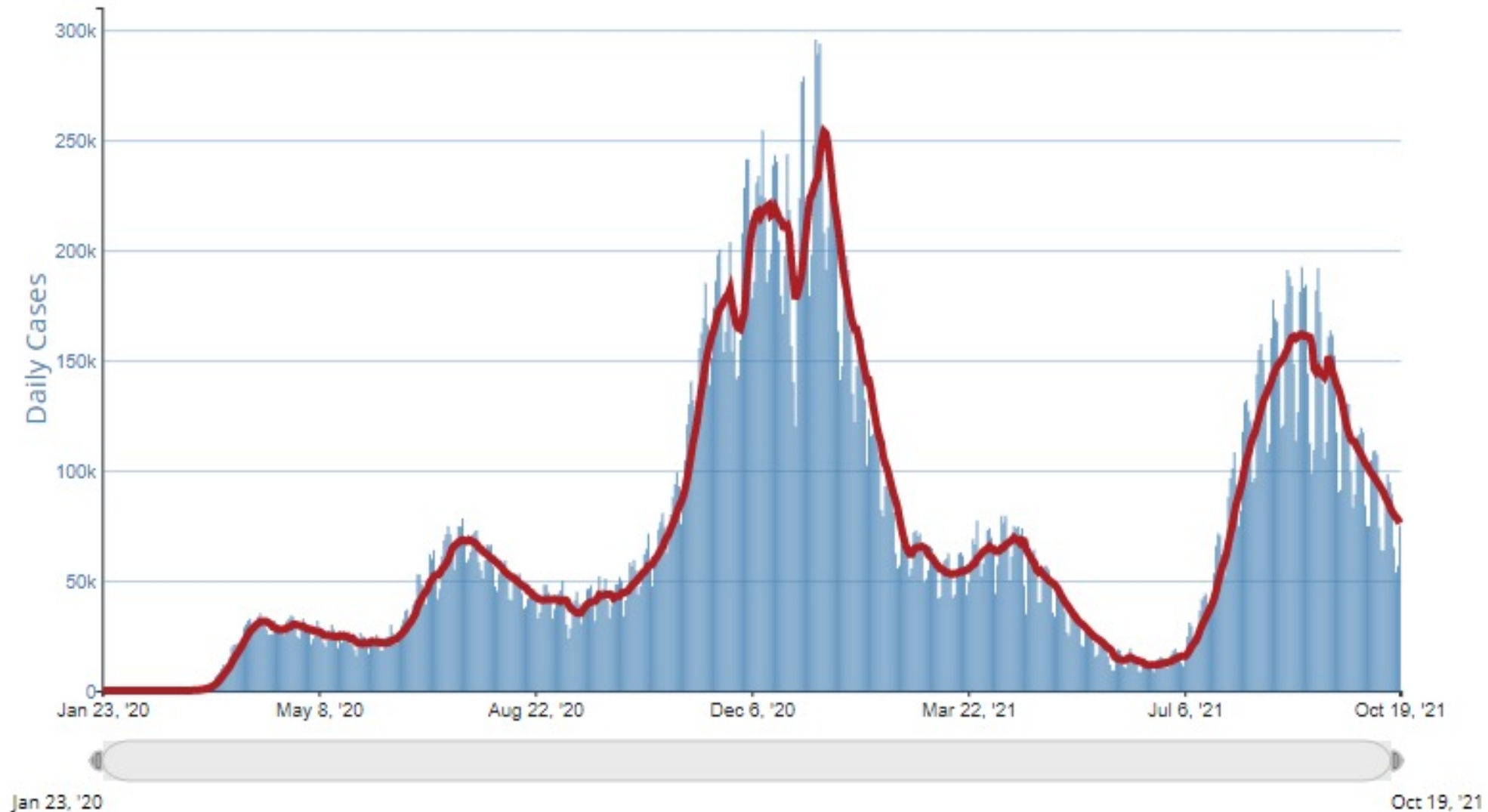
Case Demographics

<p>Date of birth (MM/DD/YYYY): ____/____/____</p> <p>Age: _____ Age units (yr/mo/day): _____</p> <p>State of residence: _____ County of residence: _____</p> <p>Does this case have any tribal affiliation? <input type="checkbox"/> yes</p> <p>Tribe name(s): _____ Enrolled member? <input type="checkbox"/> yes</p>	<p>Sex:</p> <p><input type="checkbox"/> Male <input type="checkbox"/> Other</p> <p><input type="checkbox"/> Female <input type="checkbox"/> Unknown</p> <p>If female, currently pregnant?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unknown</p>	<p>Ethnicity:</p> <p><input type="checkbox"/> Hispanic/Latino</p> <p><input type="checkbox"/> Non-Hispanic/Latino</p> <p><input type="checkbox"/> Unknown</p>	<p>Race (check all that apply):</p> <p><input type="checkbox"/> Black <input type="checkbox"/> White <input type="checkbox"/> Asian</p> <p><input type="checkbox"/> American Indian/Alaska Native</p> <p><input type="checkbox"/> Native Hawaiian/Other Pacific Islander</p> <p><input type="checkbox"/> Unknown <input type="checkbox"/> Other, specify: _____</p>
<p>Which would best describe where the patient was staying at the time of illness onset?</p> <p><input type="checkbox"/> House/single family home <input type="checkbox"/> Hotel/motel <input type="checkbox"/> Nursing home/assisted living facility <input type="checkbox"/> Rehabilitation facility <input type="checkbox"/> Mobile home</p> <p><input type="checkbox"/> Apartment <input type="checkbox"/> Long term care facility <input type="checkbox"/> Acute care inpatient facility <input type="checkbox"/> Correctional facility <input type="checkbox"/> Group home</p> <p><input type="checkbox"/> Homeless shelter <input type="checkbox"/> Outside, in a car, or other location not meant for human habitation <input type="checkbox"/> Other (specify): _____ <input type="checkbox"/> Unknown</p>			

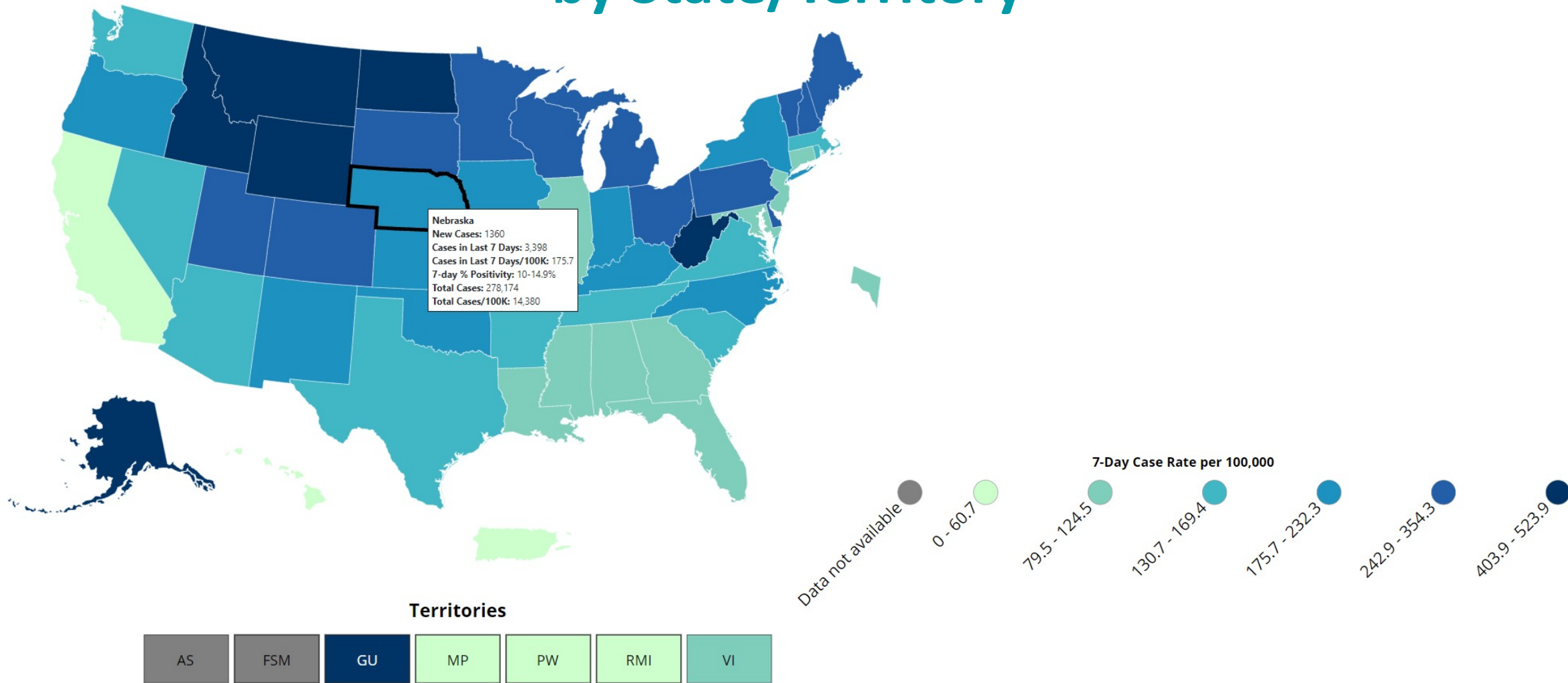
Case-Based Disease Surveillance



Daily Trends in COVID-19 Cases in the United States



United States COVID-19 7-Day Case Rate per 100K by State/Territory





COVID-19 Weekly Deaths per 100,000 Population by Race/Ethnicity, United States

March 01, 2020 - October 23, 2021*



Jurisdiction
US

3/7/2020 10/23/2021

Cases

Sex

Age - All Groups

Pediatric Case Proportions

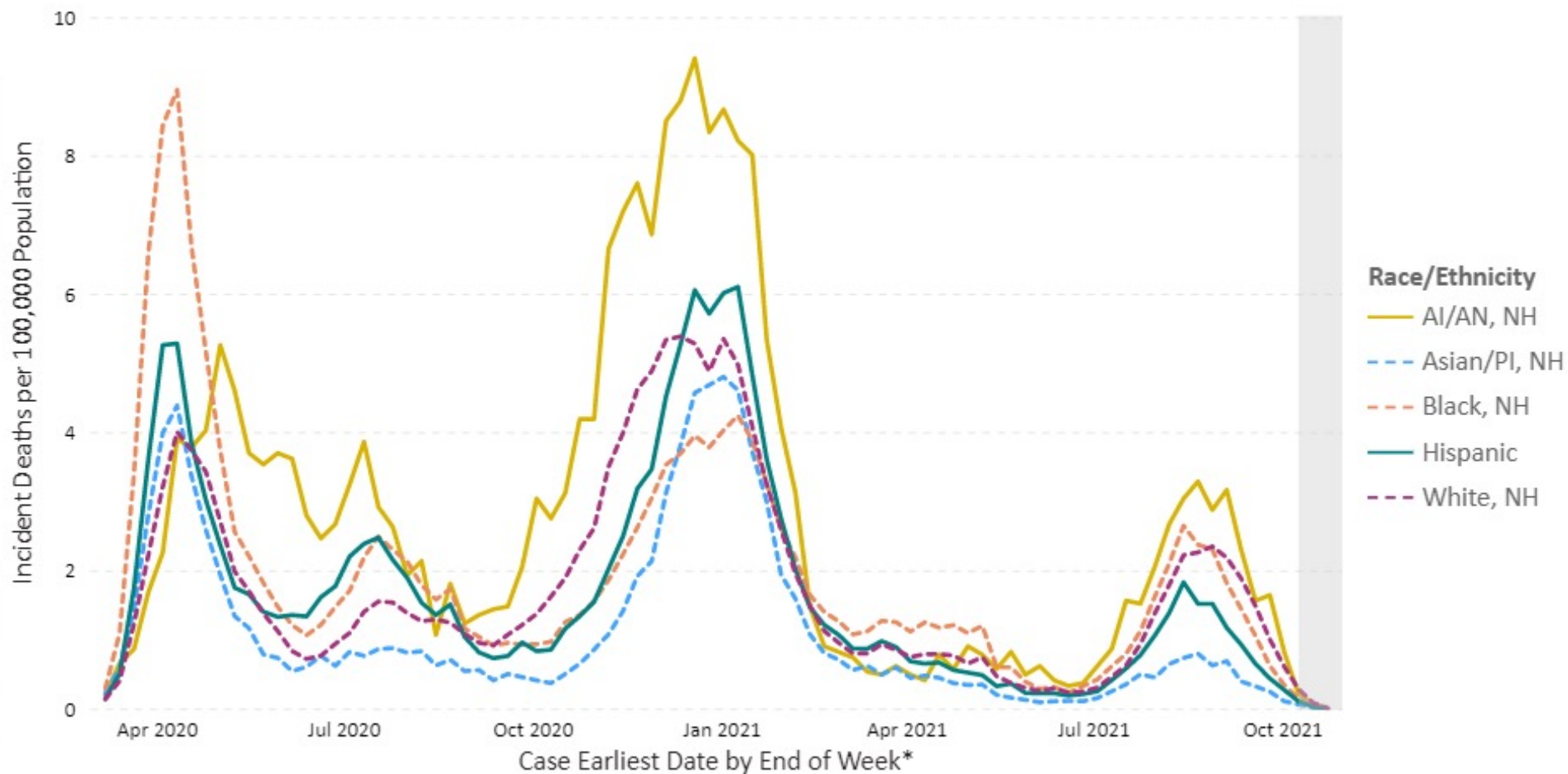
Race/Ethnicity

Deaths

Sex

Age - All Groups

Race/Ethnicity



US: The most recent line level case record was reported during the week ending on Oct 23, 2021. Percentage of deaths among reported cases - 1.64%. Percentage of deaths reporting race by date - 81.17%.

US territories are included in case and death counts but not in population counts. Potential two-week delay in case reporting to CDC denoted by gray bars. AI = American Indian, AN = Alaska Native, NH = Non-Hispanic, PI = Pacific Islander. Excludes cases with unknown or multiple races.

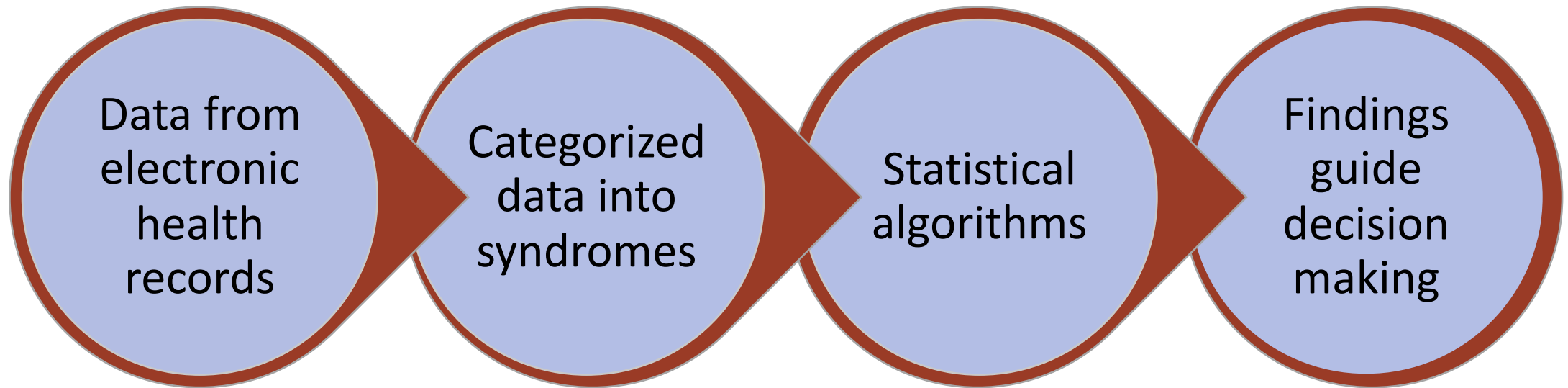
*Case Earliest Date is the earliest of the clinical date (related to illness or specimen collection and chosen by a defined hierarchy) and the Date Received by CDC. The date for the current week extends through Saturday.

Last Updated: Oct 21, 2021

Source: CDC COVID-19 Case Line-Level Data, 2019 US Census, HHS Protect; Visualization: Data, Analytics & Visualization Task Force and CDC CPR DEO Situational Awareness Public Health Science Team

Syndromic Surveillance

Automated Data Collection and Syndrome Detection



- Define new syndromes for new questions
- Useful when other data are not available
- Integrate with other data for more complete picture

Syndromic Surveillance

Early alerts for many different health events



Emerging infectious diseases and outbreaks



Mass gatherings and their situational needs



Chronic diseases and their complications



Environmental conditions and their impact



Injury issues (drownings, overdoses)



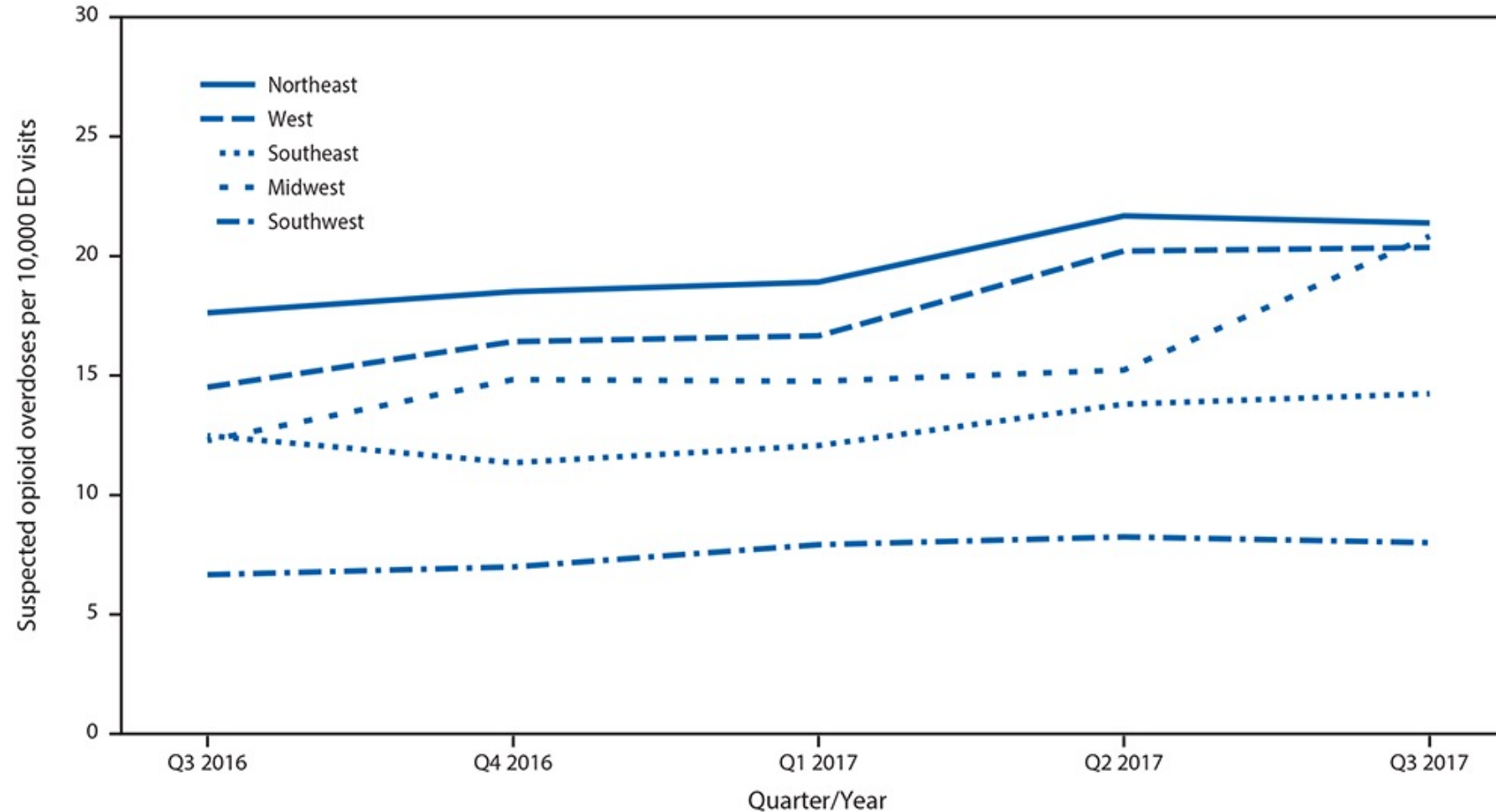
Natural and manmade disaster response needs

Shared Syndrome Definitions

Opioid v2 ESSENCE code

(,^narc^n,or,^naloxo^n,or,^[/]T40.[012346][X09][14]A^,or,^[/]T40[012346][X09][14]A^,or,^[/]F11.12[0129]^,or,^[/]F11.22[0129]^,or,^[/]F11.92[0129]^,or,^[/]F1112[0129]^,or,^[/]F1122[0129]^,or,^[/]F1192[0129]^,or,^[/]965.0[0129][:/]^,or,^[/]9650[0129][:/]^,or,^[/]E850.[012]^,or,^[/]E850[012]^,or,^295174006^,or,^295175007^,or,^295176008^,or,^295165009^,or,^242253008^,or,^297199006^,or,^295213004^,),or,(,(,^poison^,or,^verdo[se][se]^,or,^over dose^,or,^overose^,or,^nodding^,or,^ nod ^,or,^snort^,or,^in[gj]est^,or,^intoxic^,or,^unresponsiv^,or,^loss of consciousness^,or,^syncop^,or,^shortness of breath^,or,^short of breath^,or,^altered mental status^,) ,and, (^her[io][oi]n^,or,^ hod ^,or,^speedball^,or,^speed ball^,or,^dope^,or,^opioid^,or,^op[iu][ui]m^,or,^opiate^,or,^opate^,or,^op[iu][ui]m^,or,^opum^,or,^methadone^,or,^suboxone^,or,^oxyco^,or,^oxyi^,or,^ oxy ^,or,^percoc^,or,^vicod^,or,^fent^,or,^hydrocod^,or,^morphin^,or,^cod[ei][ie]n^,or,^codene^,or,^oxymor^,or,^dilaud^,or,^hydromor^,or,^tramad^,or,^suboxin^,or,^ buprenorphine^,or,^Abstral^,or,^Actiq^,or,^Avinza^,or,^Butrans^,or,^Demer[oa]^,or,^Dolophine^,or,^Duragesic^,or,^Fentora ^,or,^Hysingla^,or,^Methadose^,or,^ Morphabond^,or,^Nucynta^,or,^Onsolis^,or,^Oramorph^,or,^Oxaydo^,or,^Roxanol^,or,^Sublimaze^,or,^Xtampza^,or,^Zohydro^,or,^Anexsia ^,or,^Co- Gesic^,or,^Embeda ^,or,^Exalgo^,or,^Hycet^,or,^Hycodan^,or,^Hydromet^,or,^Ibudone^,or,^Kadian^,or,^Liquicet^,or,^Lorcet^,or,^Lortab^,or,^Maxidone^,or,^ MS Contin ^,or,^Norco ^,or,^ Opana ^,or,^Oxycet^,or,^Palladone^,or,^Percodan^,or,^Reprexain^,or,^Rezira^,or,^Roxicet^,or,^Targiniq^,or,^TussiCaps^,or,^ Tussione ^,or,^Tuzistra^,or,^Vicoprofen^,or,^Vituz^,or,^Xartemis^,or,^Xodol^,or,^Zolvit^,or,^Zutripro^,or,^Zydone^,or,^Ultram^,or,^[/]F11.[129]0^,or,^[/]F11[129]0^,),),andnot,(^no loss of consciousness^,or,^denie[sd] loss of consciousness^,or,^negative loss of consciousness^,or,^denies any loss of consciousness^,or,^denies her[io][oi]n^,or,^deny her[io][oi]n^,or,^denied her[io][oi]n^,or,^denying her[io][oi]n^,or,^denies drug^,or,^deny drug^,or,^denied drug^,or,^denying drug^,or,^denies any drug^,or,^with dra^,or,^withdra^,or,^detoxification^,or,^detos^,or,^detoz^,or,^dtox^,or,^ oxy sat ^,or,^ oxy state ^,or,^oxy high^,or,^oxy low^,or,^oxy mask ^,or,^oxy given^,or,^given oxy ^,or,^oxy clean^,or,^low oxy ^,or,^high oxy ^,or,^placed on oxy ^,or,^pulse oxy ^,or,^oxy deep cleaner^,or,^not enough oxy ^,or,^oxy level^,or,^sedat ^,or,^received fentanyl^,or,^administered fentanyl^,or,^given fentanyl^,or,^fentanyl en route^,or,^fentanyl enrnt^,or,^fent en route^,or,^fentanyl given^,or,^fentynl given^,or,^gave fent^,or,^gave fentanyl^,or,^given fentanly^,or,^mcg fentanyl^,or,^mcg fent^,or,^mcg of fent^,or,^fentanyl 75^,or,^fentanyl 50^,or,^50 fentanyl^,or,^fentanyl 100^,or,^100 fentanyl^,or,^fentanyl 150^,or,^intranasal fent^,or,^milligram fent^,or,^milligram of fentanyl^,or,^ fenton ^,or,^fent pta^,or,^fentanyl pta^,or,^fentynl 100 ^,or,^fentynyl 100^,or,^fentynal 50^,or,^fentynl 50^,or,^fent 50^,or,^fent 100^,or,^fent 150^,or,^diffently^,or,^received fent ^,or,^recieved fent ^,or,^ given 50 ^,or,^ given 100 ^,or,^ given 150 ^,or,^ gave 50 ^,or,^ gave 100 ^,or,^ gave 150 ^,or,^ doses of fent ^,),)

FIGURE 1. Quarterly rate* of suspected opioid overdose, by U.S. region† — 52 jurisdictions in 45 states, National Syndromic Surveillance Program, July 2016–September 2017^s

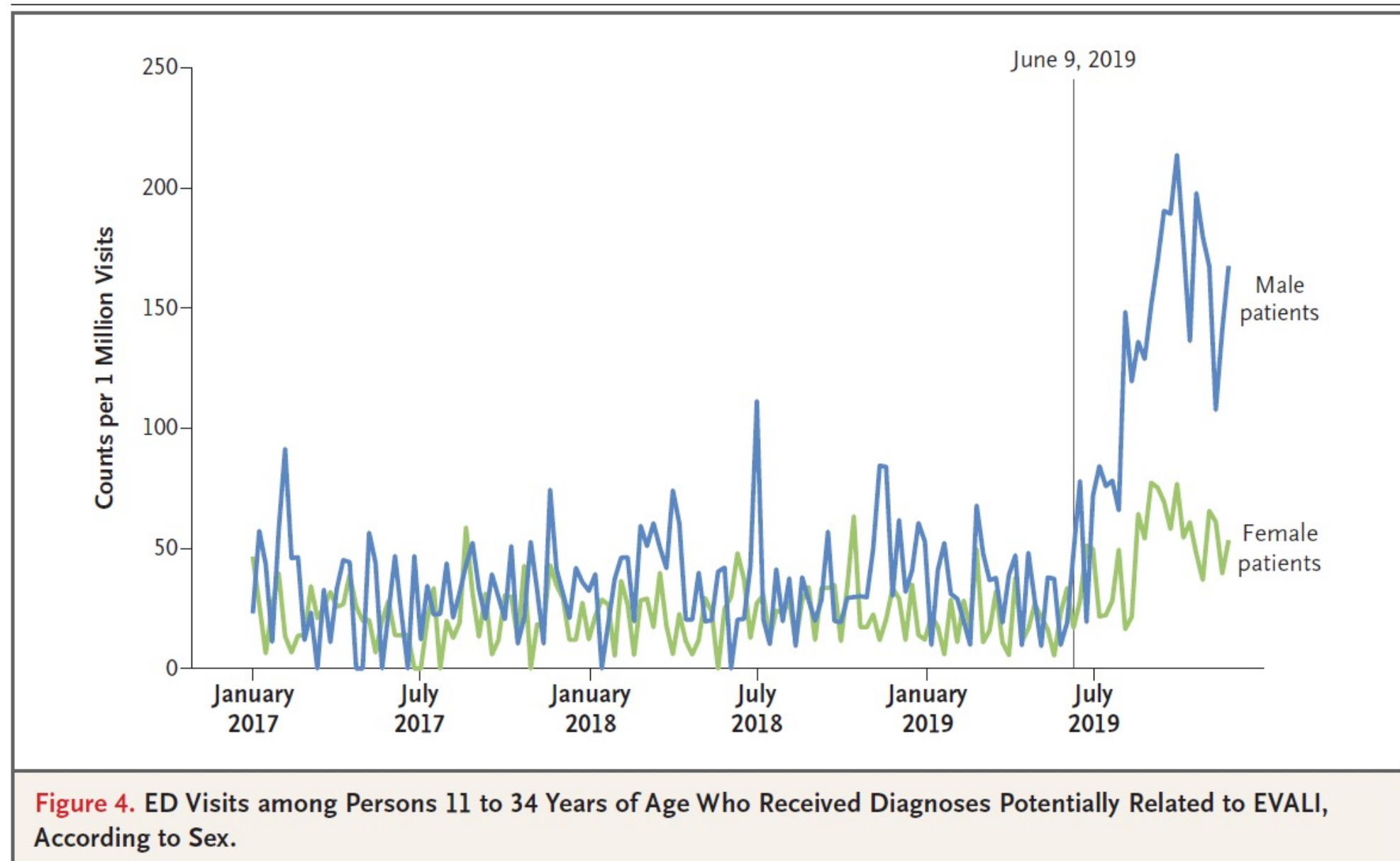


Abbreviation: ED = emergency department.

* Per 10,000 ED visits.

Vital Signs: Trends in Emergency Department Visits for Suspected Opioid Overdoses — United States, July 2016–September 2017

MMWR Weekly / March 9, 2018 / 67(9);279–285



United States Trends in Emergency Department (ED) Visits

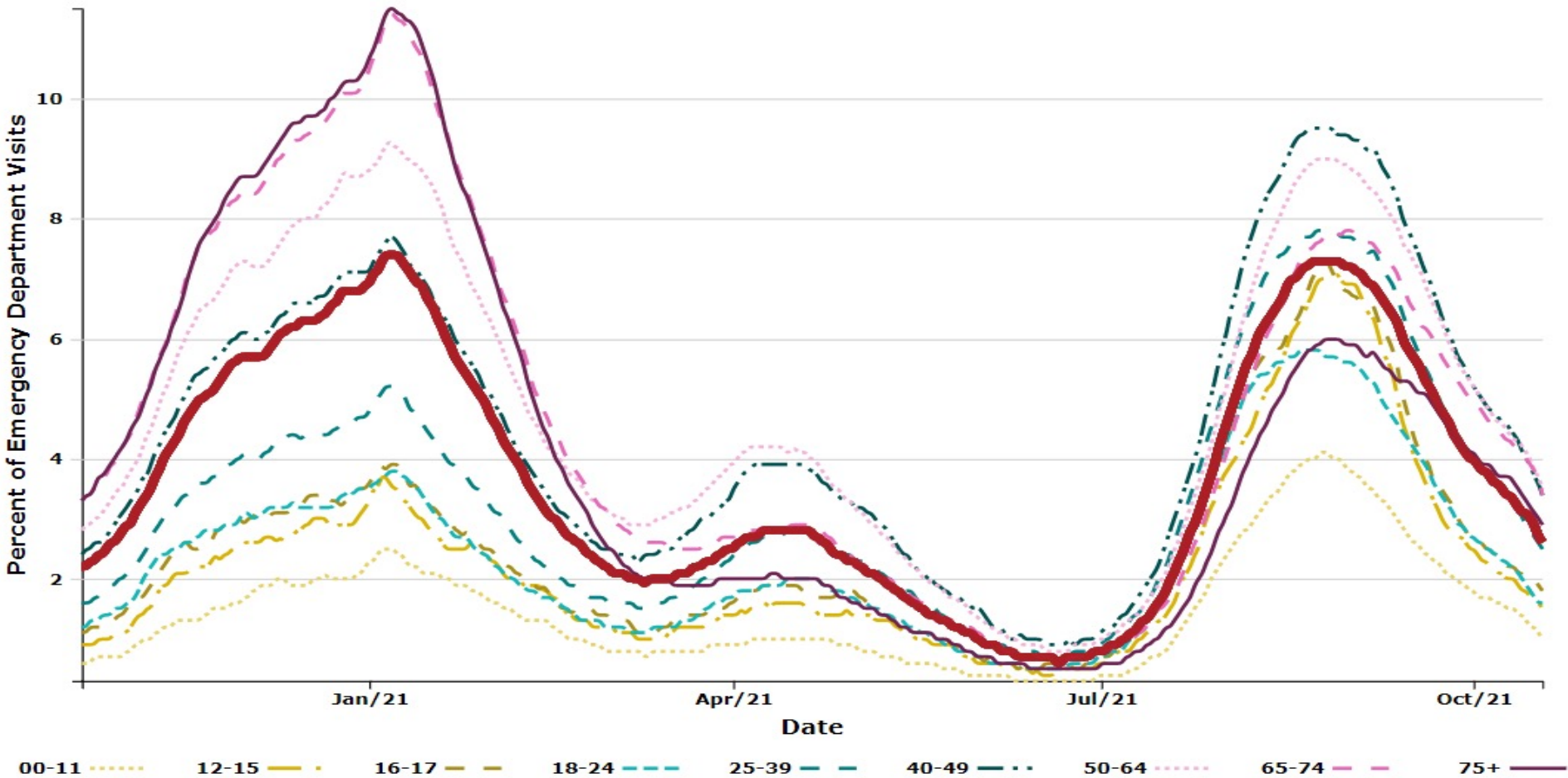
[View Footnotes and Download Data](#)

United States

View: ☐ All Ages Combined ☒ Separate by Age Group

☒ 7-Day Moving Average for all Ages

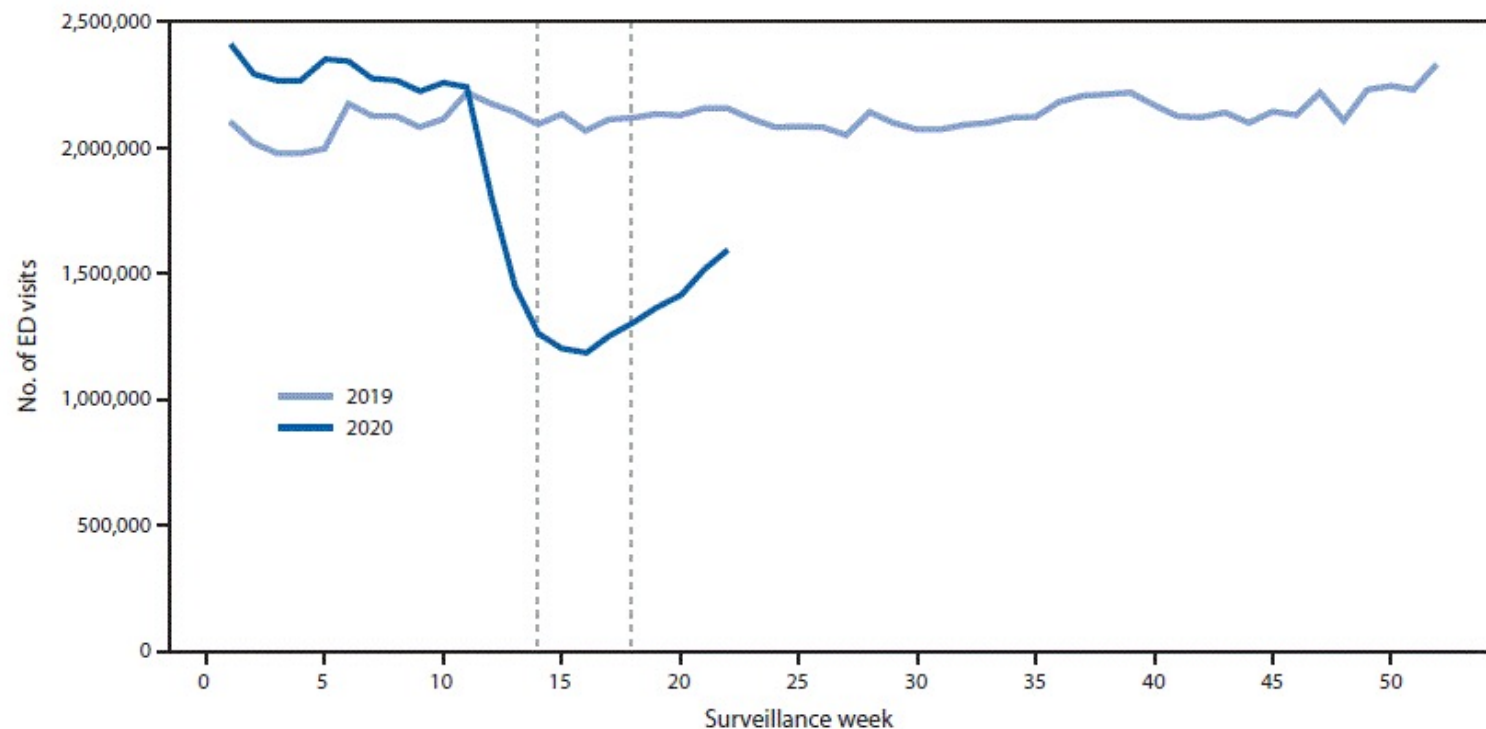
Percentage of Emergency Department visits with Diagnosed COVID-19 in United States, by Age Group



Impact of the COVID-19 Pandemic on Emergency Department Visits — United States, January 1, 2019–May 30, 2020

MMWR Weekly / June 12, 2020 / 69(23);699–704

FIGURE 1. Weekly number of emergency department (ED) visits — National Syndromic Surveillance Program, United States,* January 1, 2019– May 30, 2020[†]



* Hawaii, South Dakota, and Wyoming are not included.

[†] Vertical lines indicate the beginning and end of the 4-week coronavirus disease 2019 (COVID-19) early pandemic period (March 29–April 25, 2020) and the comparison period (March 31–April 27, 2019).

Public Health Reports Supplement on Syndromic Surveillance: July/August 2017

- Injuries/illness due to extreme weather events
- Medical needs after Hurricane Sandy (dialysis, oxygen)
- Underreporting of rabies exposures
- Drug overdoses and illnesses (opioids, synthetic cannabinoids, street drugs)
- Mass gathering surveillance (sports, religious, and political events)
- Unreported suspect meningococcal cases or unnecessary prophylaxis
- Ebola surveillance during the West African outbreak
- Suicide-related emergency department visits
- Veterans Affairs: Influenza-related telephone triage (real-time data)



Surveillance Challenges



Proliferation and Lack of Standards

- Many surveillance systems and activities
- Little harmonization across diseases; many data collection formats



Surveillance System Silos

- Unrealized interoperability, shared services, and efficiencies
- Local/regional/national public health: many systems/requirements



Innovation and Resources

- Slow adoption of new technologies
- Insufficient workforce with the right skills in the right places



Health Information Technology and Policies

- Electronic Health Records; expanding data standards
- Data sharing

Public Health Digital Transformation

As public health becomes more connected, there is an expectation of shorter time for data collection and analysis.

1850s



1950s



Today



Birth of **classic “shoe leather” epidemiology**, used by John Snow to combat the 1854 London cholera outbreak.

Refinement of classic epidemiology methods by fieldworkers. **Largely manual** collection, analysis, and presentation.

Automated data streams between hospitals and public health departments are critical. **Solutions are expected cheaper and faster.**

What's New in Data Sources

Lifestyle / Mind and Body

You Could Soon Be Able to Send Data from Your Fitbit Straight to Your Doctor

How Companies Scour Our Digital Lives for Clues to Our Health

An emerging field, digital phenotyping, tries to assess people's well-being based on their interactions with digital devices.

SundayReview | NEWS ANALYSIS

The Age of Big Data

Text messaging service could help reduce opioid relapses

SINGAPORE

Wastewater testing surveillance sites for Covid to double by next year

POLICY & ETHICS

Can the U.S. Get 1 Million People to Volunteer Their Genomes?

Open Source Data

What's New in Data Capture and Exchange?

- Mobile technology, Internet panels
- Vocabulary/Terminology Standards
 - ICD9/10, LOINC, SNOMED, USCDI*
- Content Standards
 - Health Level 7 International (HL7) standards
 - HL7 Clinical Document Architecture
 - Fast Healthcare Interoperability Resources (FHIR)
- Privacy Preserving Record Linkage (PPRL)



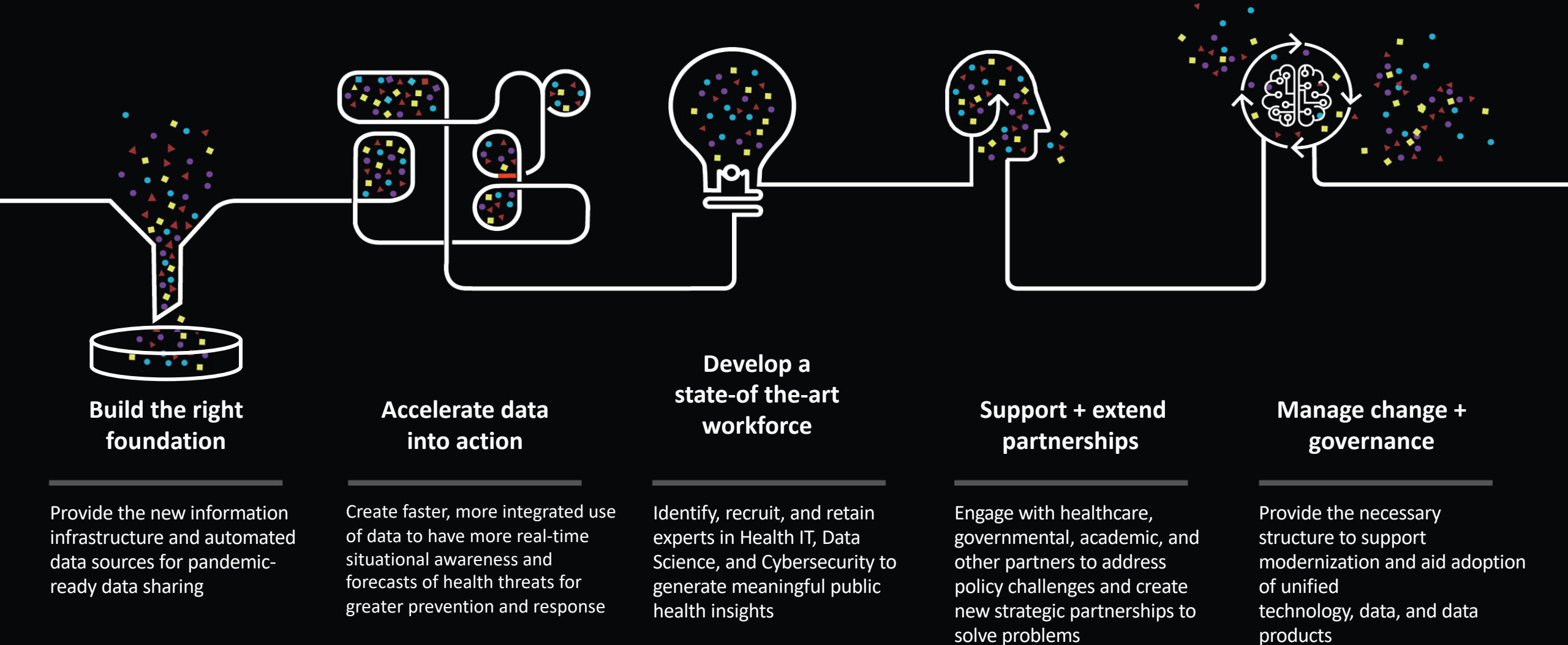
*USCDI - United States Core Data for Interoperability (USCDI)

What's New in Data Storage, Analysis, and Visualization?

- Big data (volume, complexity, velocity) – cloud, data lakes
- Analytic tools – analysis (SAS, R), coding (Python, Java), queries (SQL, Hadoop)
- Machine Learning, Natural Language Processing, Artificial Intelligence
- Data integration platforms – DCIPHER, SEDRIC
- Visualization tools – Tableau, R Shiny, Power BI
- Analysis and visualization platforms



Modernization Priorities



Questions?

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

