CHORDS: Distributed query of electronic health record systems for surveillance and research

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UNIVERSITY OF NORTHERN COLORADO

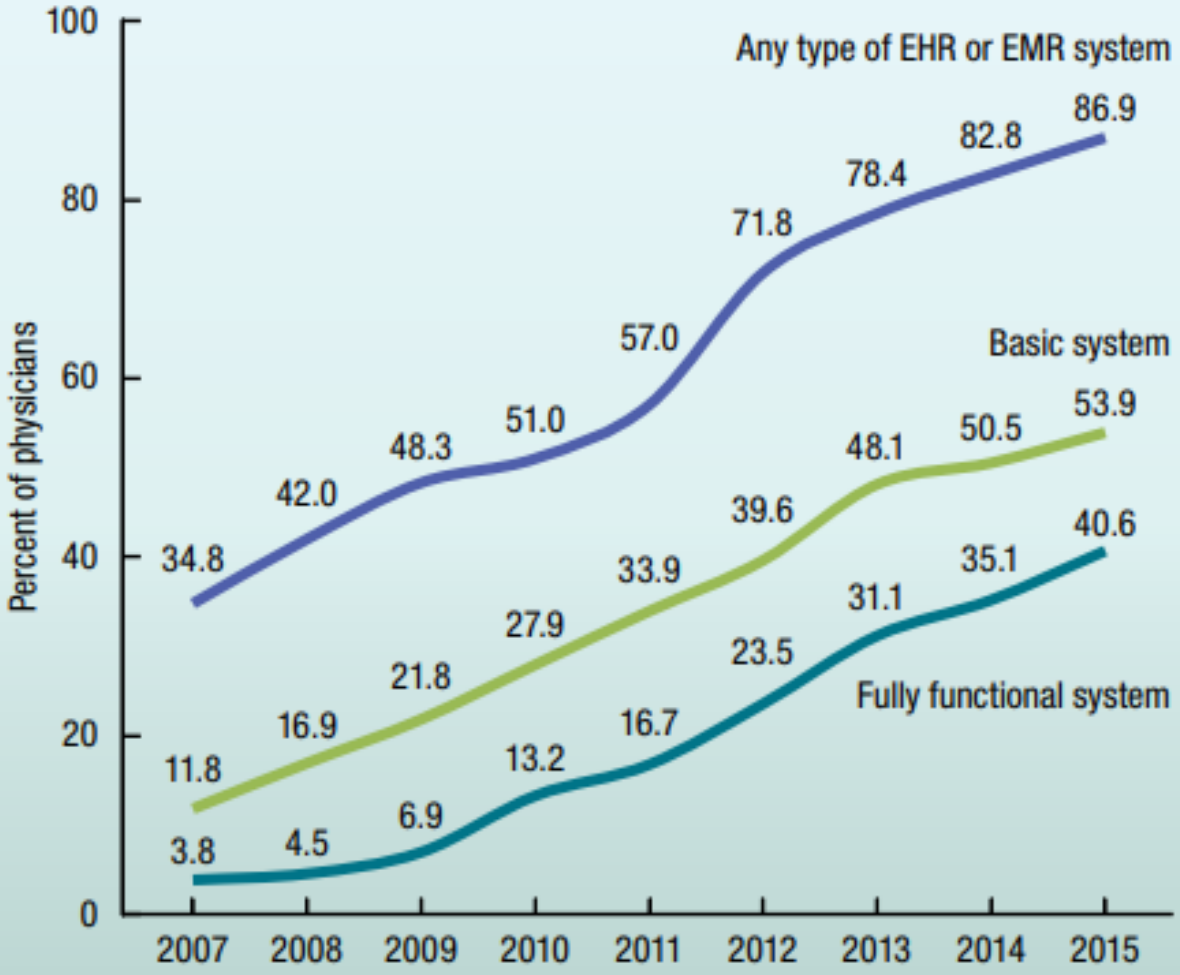
Objectives

- Learners will be able to:
  - Describe benefits & issues with Electronic Health Record data: access, standards, cost, speed, complexity, privacy, security.
  - Describe how Distributed Query addresses issues
  - Explain how CHORDS' geographic population focus differs from most distributed query research networks
  - Describe recent/upcoming improvements: coverage, linkage, weighting
  - Access CHORDS for research or surveillance
  - Learn from a researcher

Preventive Medicine Objectives (Clinical Informatics)

- *PC2: Community Health: To monitor, diagnose, and investigate community health problems.*
  - CI2-A: Use informatics and health IT as a tool for prevention on a community level.
- *PC4: Policies and Plans: Develop policies and plans to support individual and community health efforts.*
  - CI4-B: Assess challenges of data management on a patient and population level and discuss the ethical challenges of applying big data to address health problems on an individual and population level (Public Health Essential Service # 6).
- *PC6: Descriptive Epidemiology: Able to characterize the health of a community. & PC7: Analytic Epidemiology: Able to design and conduct an epidemiologic study.*
  - CI6: Apply available data sources to characterize the health of a community (Public Health Essential Service # 2).

Office-based physicians with an electronic health record or electronic medical record (EHR or EMR) system: United States, 2007–2015



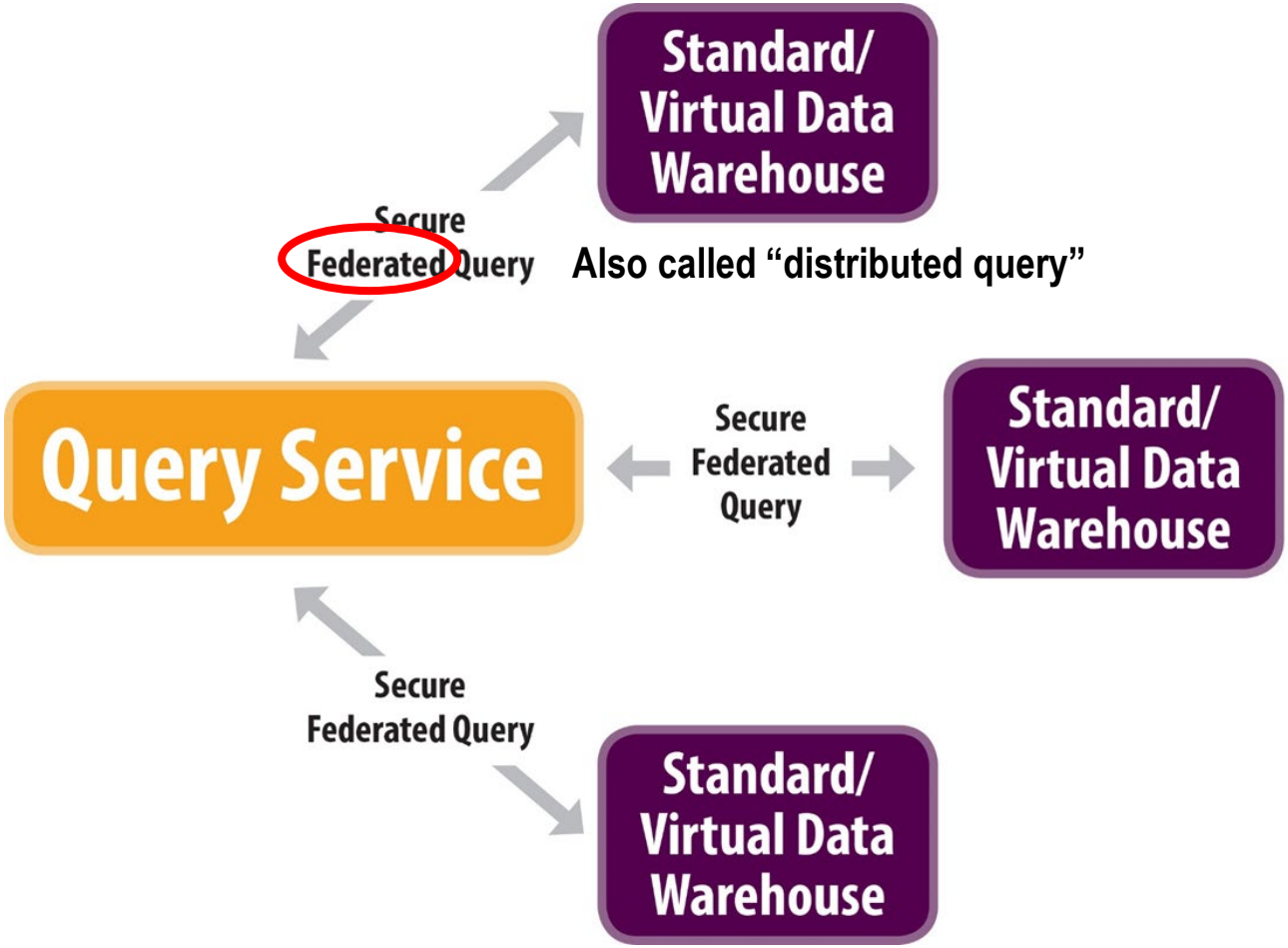
SOURCES: NCHS, National Ambulatory Medical Care Survey and National Electronic Health Records Survey, 2007–2015.

CHORDS is a network conceived in 2011 that uses electronic health record (EHR) data to support public health evaluation, monitoring and research efforts.

Privacy & Security

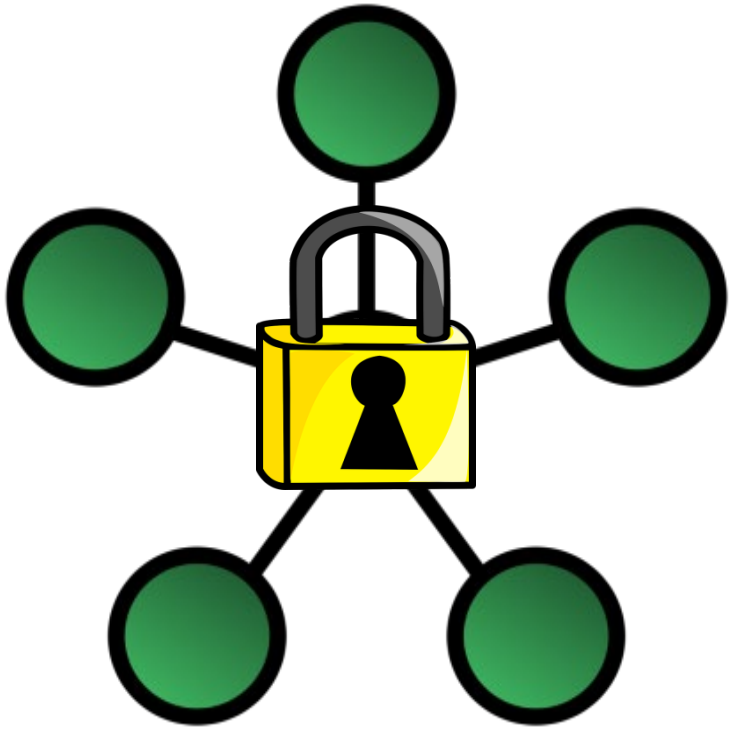
- HIPAA: if too much data about individuals…
  - Consent needed for Research
  - Consent needed for non “authorized public health”
- Risk of theft or misuse of Protected Health Information (PHI)
- Result: Studies lack patients who don’t consent (bias – excludes those hard-to-reach or convince)
- Result: Difficult to perform research or surveillance across multiple institutions

Privacy & Security: What if we exchanged only a limited data set?



Privacy & Security
Distributed Data + Aggregated Results

- PopMedNet open source software
- Patient *data remains secure* in each provider's Virtual Data Warehouse
- Data partners *retain control* over their patients' data
- *Aggregated* data is shared
- *No trace-back* to individual patients



How is CHORDS Different?

- *Shared* infrastructure for public health and research
- *Low cost per query* compared to population surveys, cohort studies
- Consciously *includes* providers serving populations underrepresented in private tertiary care
- *Integrates* primary care, inpatient, ED and mental health center data
- Continuously growing and reusable

Mini-Sentinel

pcornet®

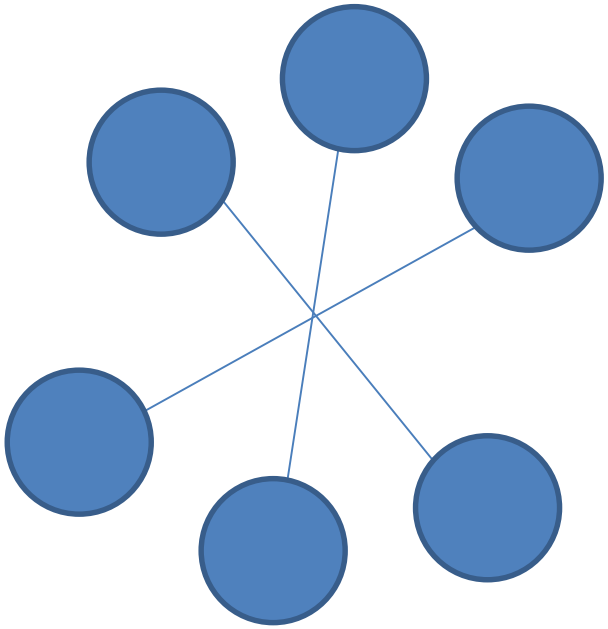
health care systems research network

NYC Health Primary Care Information Project

OCHIN

How CHORDS differs from most distributed query networks

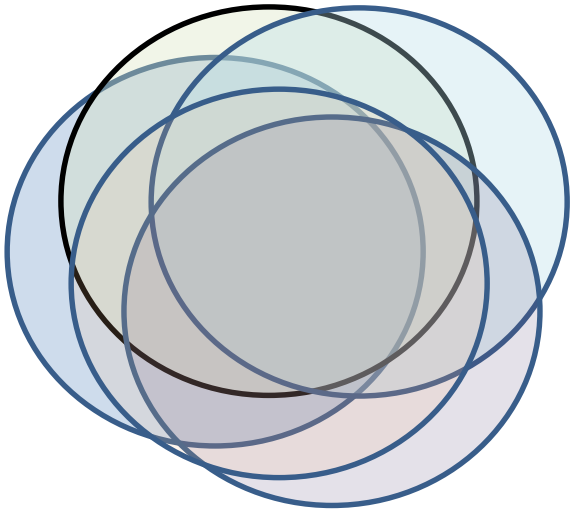
‘Typical’ e.g., pcornet®



Appropriate for Clinical Epi, e.g.,
“Individual risk factors for hepatitis?
How many cases improve with Drug X”?

Local Focus CHORDS

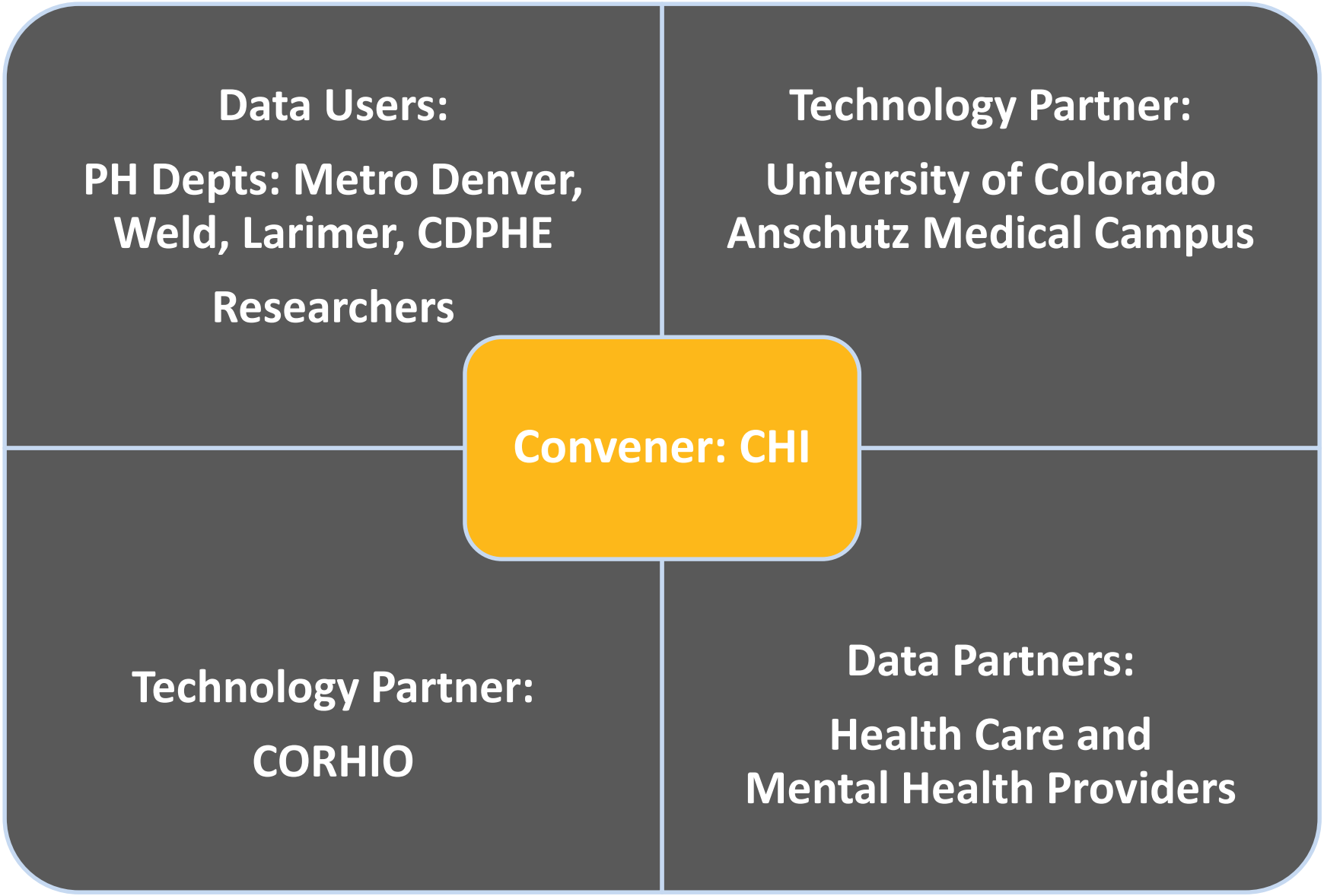
Harmonizing Information for a Healthier Colorado



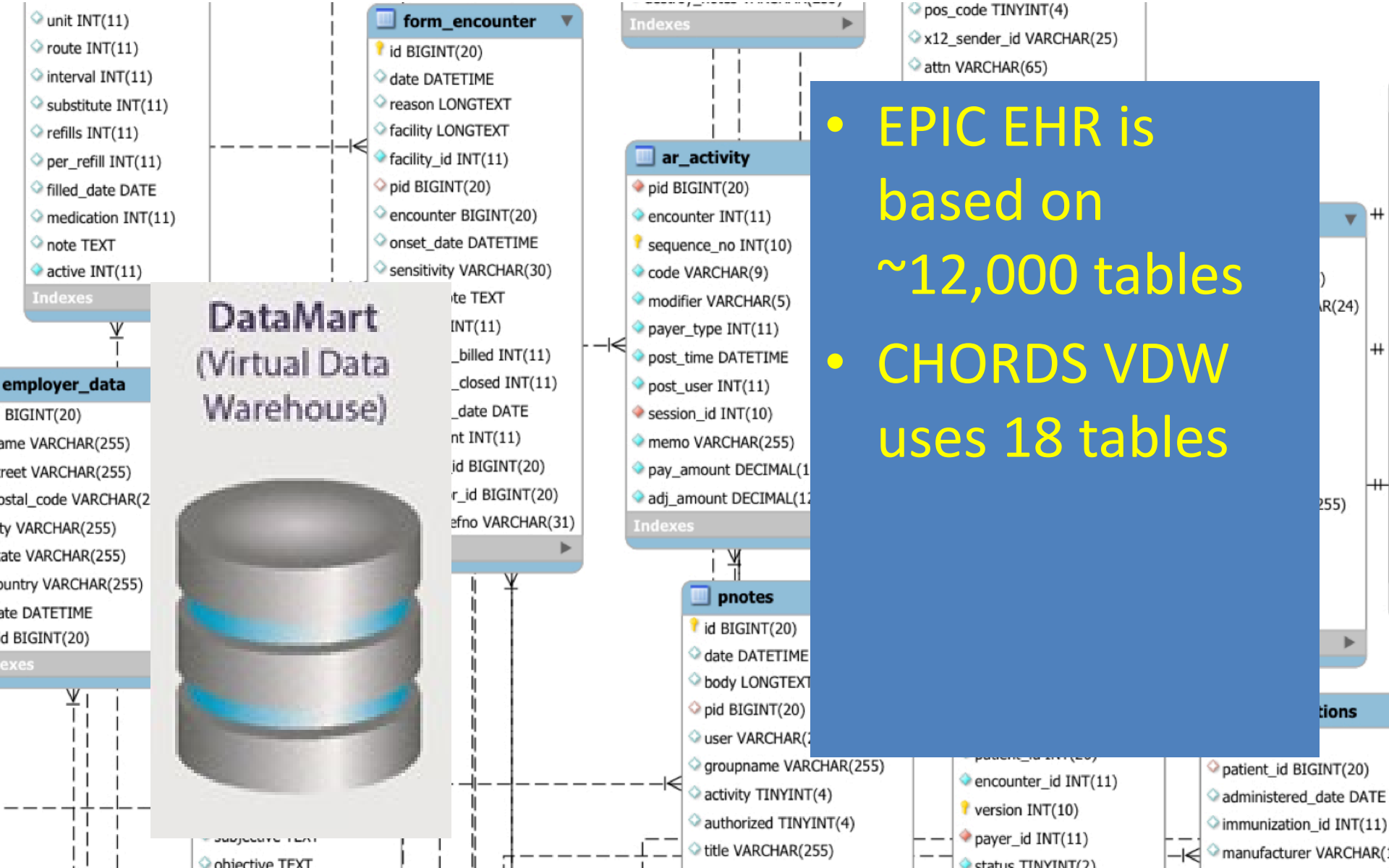
Appropriate for Public Health Epi, e.g.,
“Prevalence of hepatitis?
Associated with which neighborhoods?
What distribution patterns?
Changing over time?”

Other geo-centric networks include MDPHNET (MA), NYC Primary Care Information Project

Participating Institutions



Complexity:
From Word Salad to Data Model



- EPIC EHR is based on ~12,000 tables
- CHORDS VDW uses 18 tables

CHORDS Data Model | Available Data

- Benefits (e.g., benefit category (e.g., Medicaid, commercial/private))
- Diagnoses (e.g., ICD-9/-10 codes)
- Encounters (e.g., encounter setting, encounter date)
- Laboratory Results (test type, date of test, result –current reporting includes lipids, glycemic, alcohol, hep C, TB, cardiovascular, allergic)
- Patient Demographics (e.g., age, gender, race, ethnicity)
- Patient Residence and Community Factors (e.g., census tract of residence, American Community Survey socioeconomic data)
- Prescribing (e.g. written prescriptions, prescribing physician, quantity, refills)
- Procedures (e.g., ICD-9/-10, CPT, HCPCS codes)
- Social History (e.g., tobacco, alcohol, and/or drug use)
- Vital Signs (e.g. height and weight, diastolic and systolic blood pressure)
- Linkage (e.g., unique identifier used to de-duplicate across data partners)
- *Future: Screens for behavioral health, social determinants*

Current data partners

Health Systems

- Children's Hospital Colorado
- Denver Health
- Kaiser Permanente Colorado

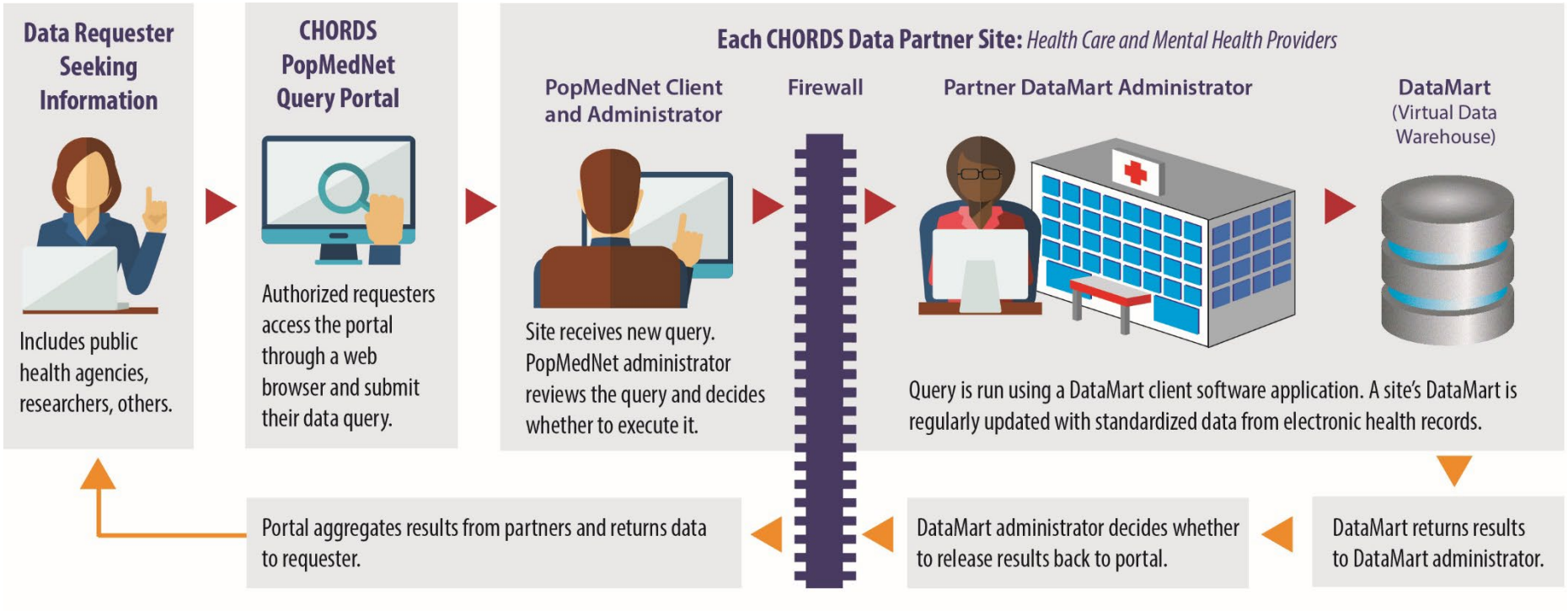
Mental Health Systems

- Mental Health Center of Denver
- Jefferson Center for Mental Health

Safety Net Providers

- Clinica Family Health
- Clinica Tepeyac
- Colorado Coalition for the Homeless
- High Plains Community Health Center
- North Colorado Health Alliance
- Salud Family Health Centers
- STRIDE Community Health Center

The Query Process



Patients in the CHORDS Network by County, 2011-2018

County	8-Year CHORDS Total*	5-Year ACS Estimate (2013-2017)
Adams	418,325	487,850
Arapahoe	400,664	626,612
Boulder	156,738	316,782
Broomfield	33,626	64,283
Denver	656,256	678, 467
Douglas	129,523	320,940
Jefferson	385,449	564,029
Larimer	85,320	330,976
Weld	99,344	285,729
Total	2,365,245	3,675,668

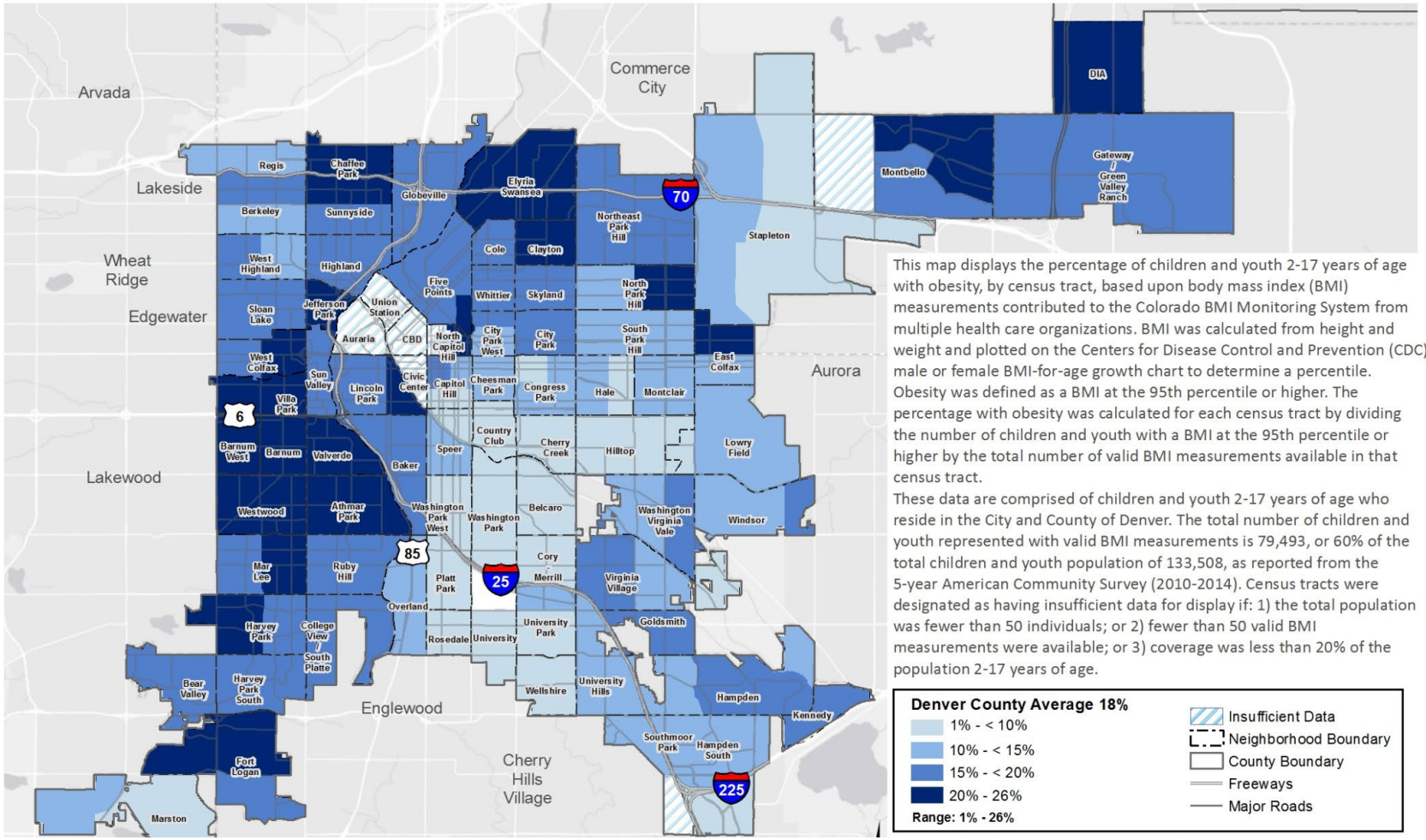
* Prior to Cross-Site Deduplication

CHORDS for Surveillance

- Survey advantages
  - Highly customized
  - Assess behaviors, attitudes
  - Unduplicated sample
  - Established baselines
  - Items designed for data user, validation well understood
  - Access to persons not receiving care
  - Easier to assess and manage missing data
- CHORDS advantages
  - Low cost per query
  - Assess diagnoses, phenotypes, care
  - Deduplication pending
  - Queries of any length
    - Avoids fatigue, response, recall bias
  - Longitudinal
  - Small confidence intervals
  - Granular populations
  - Rapid & changeable

Neighborhood Level Data – First Use Case

Estimated Prevalence of Children and Youth with Obesity (2012-2014): City and County of Denver



This map displays the percentage of children and youth 2-17 years of age with obesity, by census tract, based upon body mass index (BMI) measurements contributed to the Colorado BMI Monitoring System from multiple health care organizations. BMI was calculated from height and weight and plotted on the Centers for Disease Control and Prevention (CDC) male or female BMI-for-age growth chart to determine a percentile. Obesity was defined as a BMI at the 95th percentile or higher. The percentage with obesity was calculated for each census tract by dividing the number of children and youth with a BMI at the 95th percentile or higher by the total number of valid BMI measurements available in that census tract.

These data are comprised of children and youth 2-17 years of age who reside in the City and County of Denver. The total number of children and youth represented with valid BMI measurements is 79,493, or 60% of the total children and youth population of 133,508, as reported from the 5-year American Community Survey (2010-2014). Census tracts were designated as having insufficient data for display if: 1) the total population was fewer than 50 individuals; or 2) fewer than 50 valid BMI measurements were available; or 3) coverage was less than 20% of the population 2-17 years of age.

Denver County Average 18%

- 1% - < 10%
- 10% - < 15%
- 15% - < 20%
- 20% - 26%

Range: 1% - 26%

- Insufficient Data
- Neighborhood Boundary
- County Boundary
- Freeways
- Major Roads

CHORDS Adapters & Requests*, Part 1

- BMI Adapter
  - Childhood BMI
  - Adult BMI
- Cardiovascular Disease Adapter
  - Diagnosed Hypertension
- Diabetes Adapter
  - Diagnosed Diabetes (Pre-Diabetes, Type 1, Type 2, All Diabetes)
  - Diabetes Control among Adults with Type 2 Diabetes
- Liver Health Adapter
  - Diagnosed Cirrhosis
  - Hepatitis C RNA Screening

*Ready to use, available through local health departments or CHORDS project mgrs.

CHORDS Adapters & Requests, Part 2

- Mental Health Adapter
  - Diagnosed Depression
  - Diagnosed Depression during Pregnancy
- Substance Use Adapter
  - Diagnosed Cannabis Abuse and Dependence
  - Diagnosed Cannabis Poisoning and Adverse Effects
  - Diagnosed Cannabis Use
  - Diagnosed Opioid Use Disorder
- Tobacco Use Adapter
  - Tobacco Use

Mental Health Data| CHORDS vs BRFSS

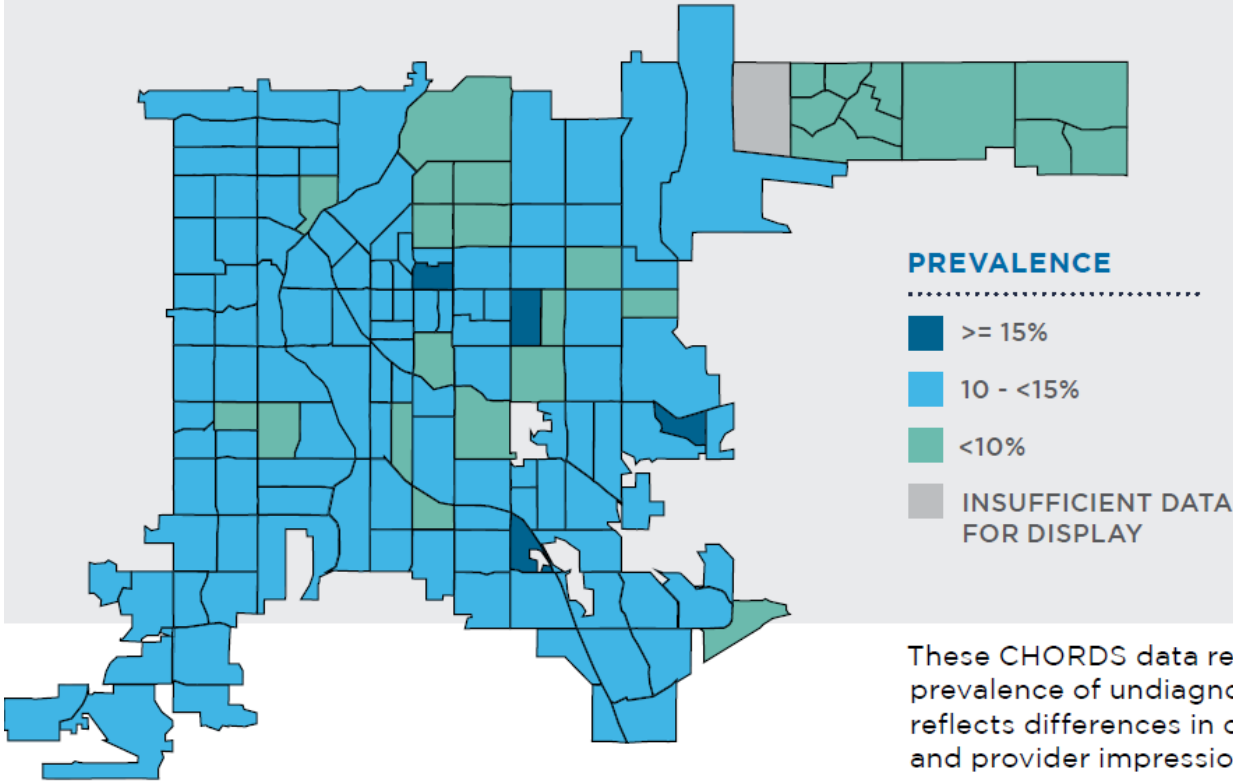
CHORDS: one year prevalence of depression dx
BRFSS: lifetime prevalence of depression dx

CHORDS 2016	**11.3%**
BRFSS	**20.1% [17.5, 22.6]**

- Different prevalence timeframe
- One-time self report & recall vs. recorded medical diagnosis
- CHORDS estimate includes duplicates

CHORDS provides significant data for small population comparisons

PREVALENCE OF DIAGNOSED DEPRESSION AMONG ADULTS 18 YEARS AND OLDER IN DENVER COUNTY BY CENSUS TRACT, 2016



Source: Colorado Health Observation Regional Data Service (CHORDS), 2016

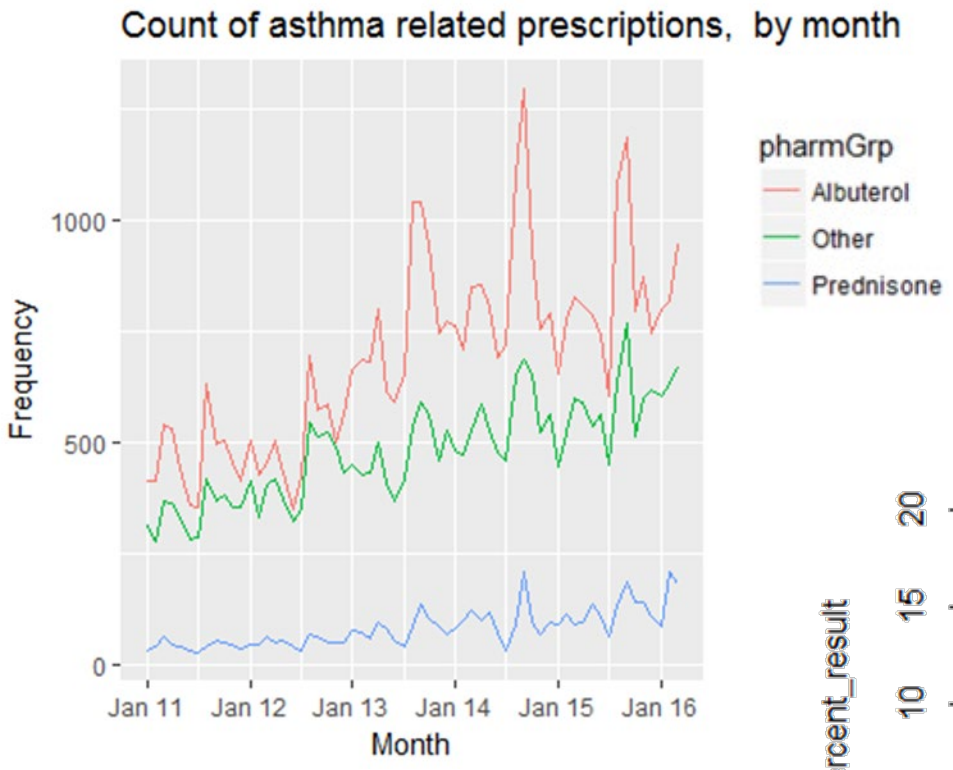
These CHORDS data reflect diagnoses, and not the prevalence of undiagnosed depression. Thus, it also reflects differences in care-seeking, access to care, and provider impression.

CHORDS for Research: Examples

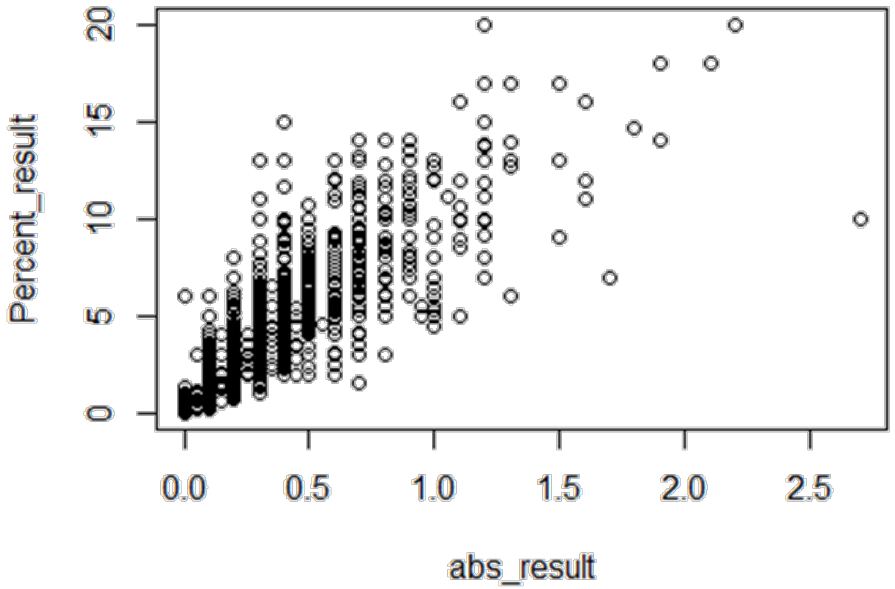
- Asthma Exacerbation Index
- LARCs and Adolescent Pregnancy
- Spinal Fusion Procedures and Opioids

- Record-level granular data available (e.g. lat/long, all labs over time, etc.) with specific data sharing agreements

Research Use Case: Asthma



Absolute Eos. vs. % Eos.



Weighting CHORDS Data

- Patients in EHRs may not be representative of the population
- Results are produced as aggregate counts
- Each CHORDS data request creates a new dataset to weight
- CHORDS doesn't have the resources to weight data for every request – this is something the data user must do
- R & SAS raking programs developed for age, gender and geographic units
- Race/ethnicity requires record level imputation
  - Adding providers, linking records and Fed rules will reduce missing demographic data in near future

Work performed by Liza Reifler (Kaiser) and Emily Bacon (DPH)

Example: Diabetes rates of adults in Denver, 2015 Weighted by age and gender

	Adjusted Rates (%)	Crude Rates (%)	Absolute Difference (%)
Total Population	9.98	10.91	0.93
Females	9.62	10.58	0.96
Males	10.34	11.32	0.98
Adults 18-19	0.75	0.76	0.01
Adults 20-24	0.97	0.96	0.01
Adults 25-29	1.16	1.17	0.01
Adults 30-34	2.04	2.06	0.02

Patients in the CHORDS Network by Race, 2011-2018

Race	8-Year CHORDS Total*
White	1,570,884
Unknown	468,233
Black or African American	181,492
Asian	84,525
Multiple Race	34,387
American Indian or Alaska Native	19,475
Hawaiian or Pacific Islander	6,249

* Prior to Cross-Site Deduplication

Coming Soon! Record Linkage Across Providers for De-duplicated, Longitudinal Data

- Two approaches
  - Using Health Information Exchange (CORHIO) to create a unique Network-wide ID using PHI
    - In testing & QA; available 2019
  - Creating unique Network-wide ID using hashed patient demographic data (Privacy-Preserving Record Linkage, PPRL)
    - Design in process, expected 2020
- Linked records can also improve demographic data (real values rather than imputation)

www.chordsnetwork.org

Key Issues

Key Issues / Community Health / Colorado Health Observation Regio

Colorado Health Observation Regional Data Service

September 3, 2016

CHORDS

The Colorado Health Observation Regional Data Service (CHORDS) is a seven-county regional
Denver metro area that uses electronic health record data to support public health evaluation an
efforts. It began in 2011. Currently, 11 health care provider organizations contribute data.

CHORDS provides timely, location-based information on population health measures to help ans
highest rate of tobacco use, or of depression? Each health care organization retains full control
back to individual patients.

In 2016, the Colorado Health Foundation awarded a two-year, $1.9 million grant to the Colorado Health Institute (CHI) with the goals of expanding the number of public health agencies using CHORDS from one to six and bringing on additional health care and mental health providers to contribute data. These include local public health agencies representing Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas and Jefferson counties, as well as the University of Colorado Denver Adult and Child Consortium for Outcomes Research and Delivery Science (ACCORDS), Denver Health and CORHIO, Colorado's largest health information exchange network.

CHORDS data contributors are: Children's Hospital Colorado, Clinica Family Health, Clinica Tepeyac, the Colorado Alliance for Health Equity and Practice (CAHEP), Denver Health and Hospital Authority, High Plains Community Health Center, Inner City Health Center, Kaiser Permanente Colorado, Metro Community Providers Network, Salud Family Health Centers and the Stout Street Clinic operated by Colorado Coalition for the Homeless.

How Can I Learn More?

The project is always looking for new partnerships with both data contributors and interested users. If you are interested in participating or would like more information about CHORDS, please contact Sara Schmitt, Director of Community Health Policy at CHI, at 720.382.7081 or schmitts@coloradohealthinstitute.org.

CHORDS

Harmonizing Information for a Healthier Colorado

Information for Data Partners

The Colorado Health Observation Regional Data Service (CHORDS) collects, analyzes and presents data from participating partners' electronic health records (EHRs) to monitor population health, target areas for intervention and conduct research. All data are securely exchanged by removing personally identifiable patient information.

Five metro Denver local public health agencies are working together on this groundbreaking project to use data from 11 health care partners to better address obesity, diabetes, cardiovascular disease and mental health issues at the community level. CHORDS can help answer questions like *Which Aurora neighborhood has the highest rate of depression? Which Denver neighborhood has the highest levels of hypertension and lowest levels of hypertension control?* New community-based and clinic-based interventions, outreach programs and preventive services may be more successful because granular EHR data can identify specific communities or populations, measure factors affecting health and target interventions.

Your participation is the next step in achieving these goals.

How Does CHORDS Work?

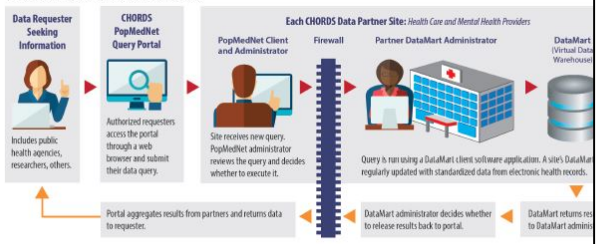
PopMedNet™ powers the data sharing in CHORDS, powered by a secure software application that req and receives data from partner sites, including fro mental health partners. Partners organize EHR dat into a common data model (a "virtual data wareho or VDW) and establish a connection to the CHORD network using PopMedNet.

In this distributed network, data partners retain fu control over their data; decide which data are avai for querying; which queries are approved and exe whether results are returned to requestors; and wh permitted to submit queries. CHORDS adheres to HIPAA and 42 CFR regulations, and exchanges dat accordance with established governance policies procedures.

Why Become a Data Partner?

Electronic health records are a critical source of population health data. Sharing and using these d will improve our collective understanding of obes hypertension and other health issues. These data a more comprehensive picture of health in commu

CHORDS Federated Query Overview



CHORDS

Frequently Asked Questions about Colorado Health Observation Regional Data Service (CHORDS)

Contents

Overview

1. What is CHORDS?

Colorado Health Observation Regional Data Service (CHORDS) is a regional collaborative partnership between Colorado health providers, public health departments, and the University of Colorado Denver to share health data. CHORDS collects, analyzes and presents data from participating partner electronic health records (EHRs) into one registry that can be used to monitor population health and conduct research. All data is securely exchanged by removing personally identifiable information.

CHORDS refers to both the technology platform and a virtual organization of partners. The partners agree to share patient health data which provides insight on local health needs and issues. CHORDS is funded by several federal and state grants/contracts and non-profit foundations.

2. What is the purpose of CHORDS?

CHORDS facilitates access to local health data for communities throughout Colorado to monitor population health trends, study populations or diseases, and evaluate interventions. EHR data provide a level of accuracy, statistical power, and geographic detail unavailable through established health surveys, the traditional local public health information source. New community- and clinic-based interventions, outreach programs, and preventive services, informed by local EHR data, may be more successful because granular data can identify specific communities or populations, measure factors affecting health, and target interventions. EHR data can answer many health questions that surveys or claims data typically cannot (e.g., which neighborhood has the highest level of hypertension and lowest level of hypertension control?).

CHORDS is broadening its scope and reach to provide

CHORDS

Harmonizing Information for a Healthier Colorado

CHORDS Maps page URL coming soon!

CHORDS
Harmonizing Information for a Healthier Colorado

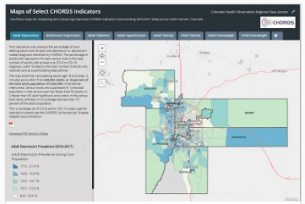
About CHORDS | About the Data | Visit Chordsnetwork.org

CHORDS Maps and Data Visualization Hub

The Colorado Health Observation Regional Data Service (CHORDS) is a regional network in Colorado that uses electronic health record data to improve population health neighborhood by neighborhood.

CHORDS generates community-level prevalence estimates for select conditions in Metropolitan Denver, Larimer and Weld counties. This website contains maps of the most recent estimates based on data collected from participating health care and mental health organizations.

Web Maps



CHORDS Web Maps

Visualize maps of select CHORDS indicators by census tract to compare differences across the metro area.

View Web Maps

PDF Maps

- CHORDS Coverage Maps
- Diagnosed Depression Prevalence — Adolescent, Adult
- Diagnosed Diabetes Prevalence — Adult
- Diagnosed Hypertension Prevalence — Adult
- Obesity Prevalence — Adult, Child
- Overweight Prevalence — Adult, Child
- Tobacco Use Prevalence — Adult

Contact Us

Other data partners are welcome. Please contact us at contactCHORDS@gmail.com to learn more about getting involved.

Can't find what you are looking for? For questions or more information regarding CHORDS, please contact CHORDS Project Manager for Public Health Monitoring, Greg Budney, via email at gregory.budney@dhha.org.

The Colorado Department of Public Health and Environment provides cartographic and web-based mapping services for CHORDS.

Funders

The Colorado Health Foundation

Adult and Child Consortium for Health Outcomes Research and Delivery Science

University of Colorado Anschutz Medical Campus

In-kind contributions from data partners and data users

Maps of Select CHORDS Indicators

Use these maps for visualizing and comparing important CHORDS indicators (representing 2016-2017 data) across metro Denver, Colorado

Colorado Health Observation Regional Data Service

CHORDS

Adult Depression | Adolescent Depression | Adult Diabetes | Adult Hypertension | Adult Obesity | Child Obesity | Adult Overweight | Child Overweight | Adult Tobacco Use

This interactive map displays the percentage of care-seeking adults with at least one depression or depression-related diagnosis identified by CHORDS. The percentage of adults with depression for each census tract is the total number of adults with at least one ICD-9 or ICD-10 diagnosis code* divided by the total number of adults who received care at a participating data partner.

The map examines care-seeking adults age 18 and older. It includes encounters from **883,080 adults, or 31 percent of the total adult population of 2,822,518** in the nine-county area (including Metropolitan Denver, Larimer, and Weld counties).

Census tracts are designated as having insufficient data if: 1) the total population in the census tract has fewer than 50 adults; or 2) fewer than 50 valid care encounters in the census tract were collected; or 3) coverage was less than 10 percent of the adult population.

Download PDF Version of Map

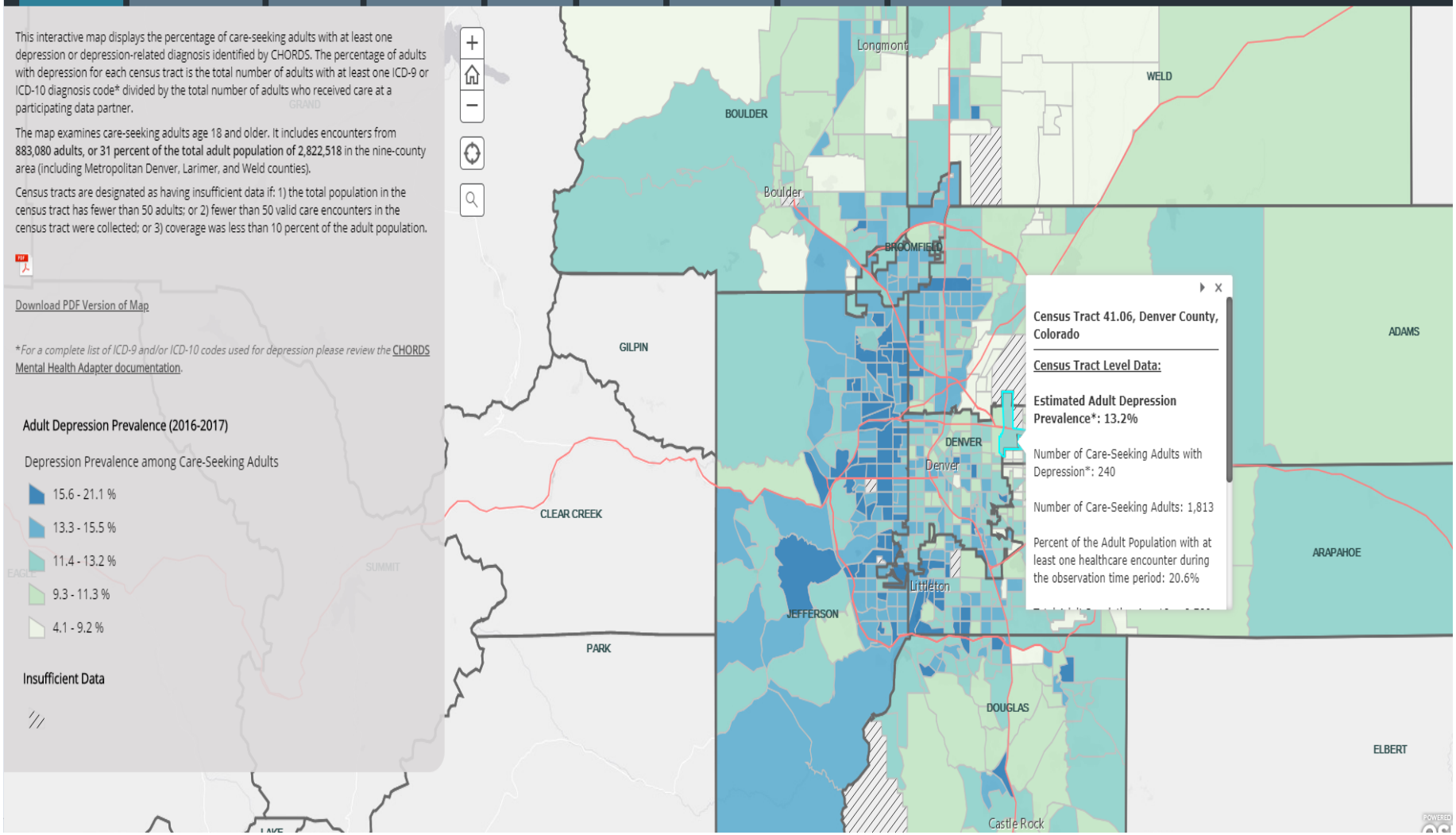
*For a complete list of ICD-9 and/or ICD-10 codes used for depression please review the CHORDS Mental Health Adapter documentation.

Adult Depression Prevalence (2016-2017)

Depression Prevalence among Care-Seeking Adults

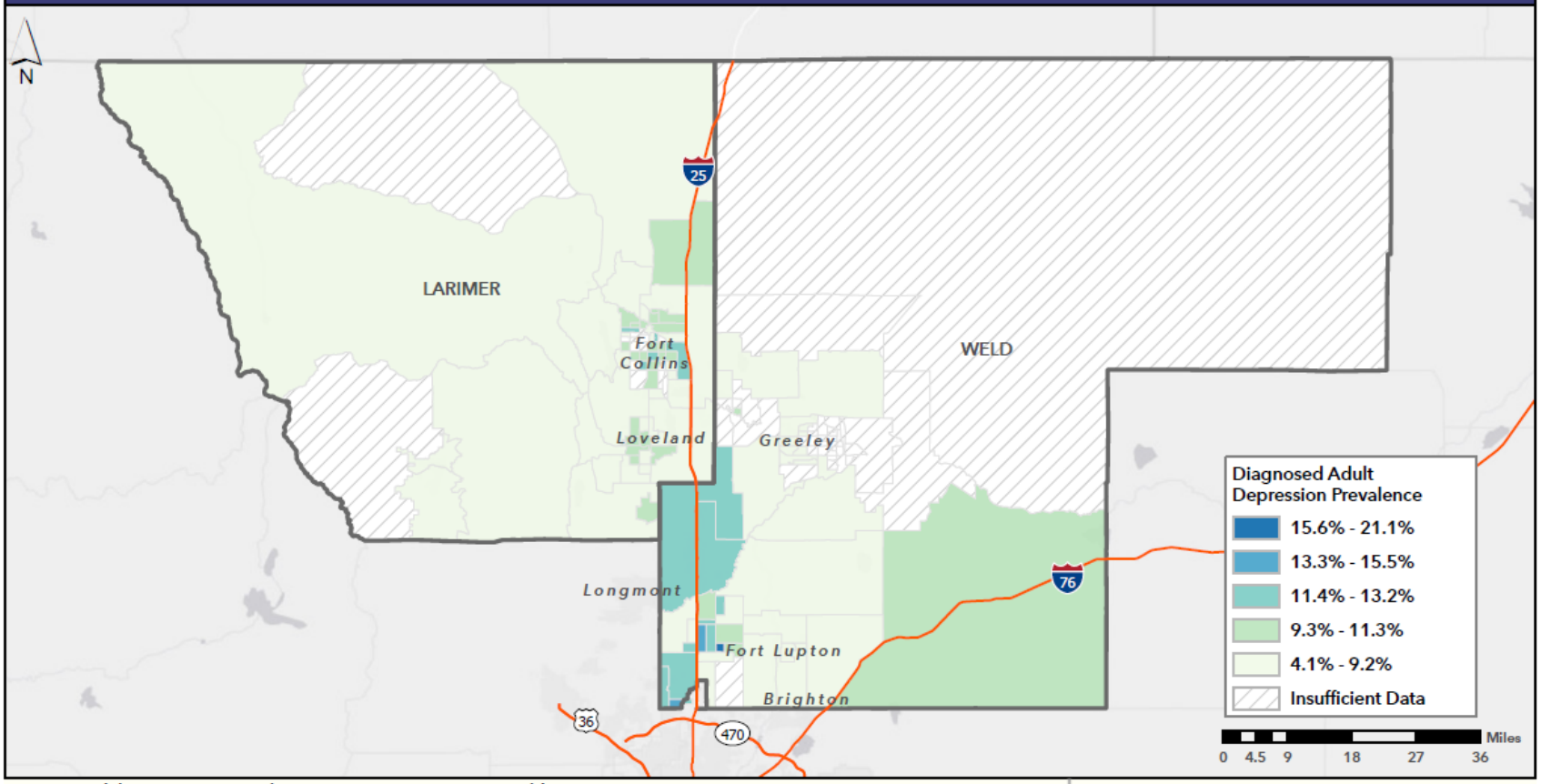
- 15.6 - 21.1 %
- 13.3 - 15.5 %
- 11.4 - 13.2 %
- 9.3 - 11.3 %
- 4.1 - 9.2 %

Insufficient Data



Percentage of Care-Seeking Adults Diagnosed with Depression (18 years and older) By Census Tract, Larimer and Weld Counties, Colorado, 2016-2017

CHORDS
Colorado Health Observation Regional Data Service



CHORDS Adult Depression Prevalence: Larimer County: 9.0%, Weld County: 9.2%

This map displays the percentage of care-seeking adults with at least one depression or depression-related diagnosis identified by CHORDS. The percentage of care-seeking adults with depression was calculated by dividing the number of adults with at least one ICD-9 or ICD-10 diagnosis code* residing in a census tract by the total number of adults who received care at a participating data partner.

These data are comprised of care-seeking adults age 18 and older. The total number of adults represented with at least one care encounter during the observation time period is 72,003, or 15% of the total adult population of 473,009, as reported by the latest 5-year American Community Survey. Census tracts are designated as having insufficient data if: 1) the total population in the census tract has fewer than 50 adults; or 2) fewer than 50 valid care encounters in the census tract were collected; or 3) coverage was less than 10% of the adult population.

*For a complete list of ICD-9 and/or ICD-10 codes used for depression please see the CHORDS Mental Health Adapter documentation.

Map Created March 2019. To request additional maps and/or aggregated data tables, please contact Greg Budney, CHORDS Project Manager for Public Health, at gregory.budney@dhha.org.

A list of participating CHORDS Data Partners can be found at www.chordsnetwork.org.

The Colorado Department of Public Health and Environment provides cartographic and web-based mapping services for CHORDS. This project is funded by The Colorado Health Foundation and the Adults and Child Consortium for Health Outcomes Research and Delivery Science.

Need help getting started?

Greg Budney, MPH

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CHORDS Project Manager for Public Health Monitoring

Rachel Zucker, MPH

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CHORDS Project Manager for Research

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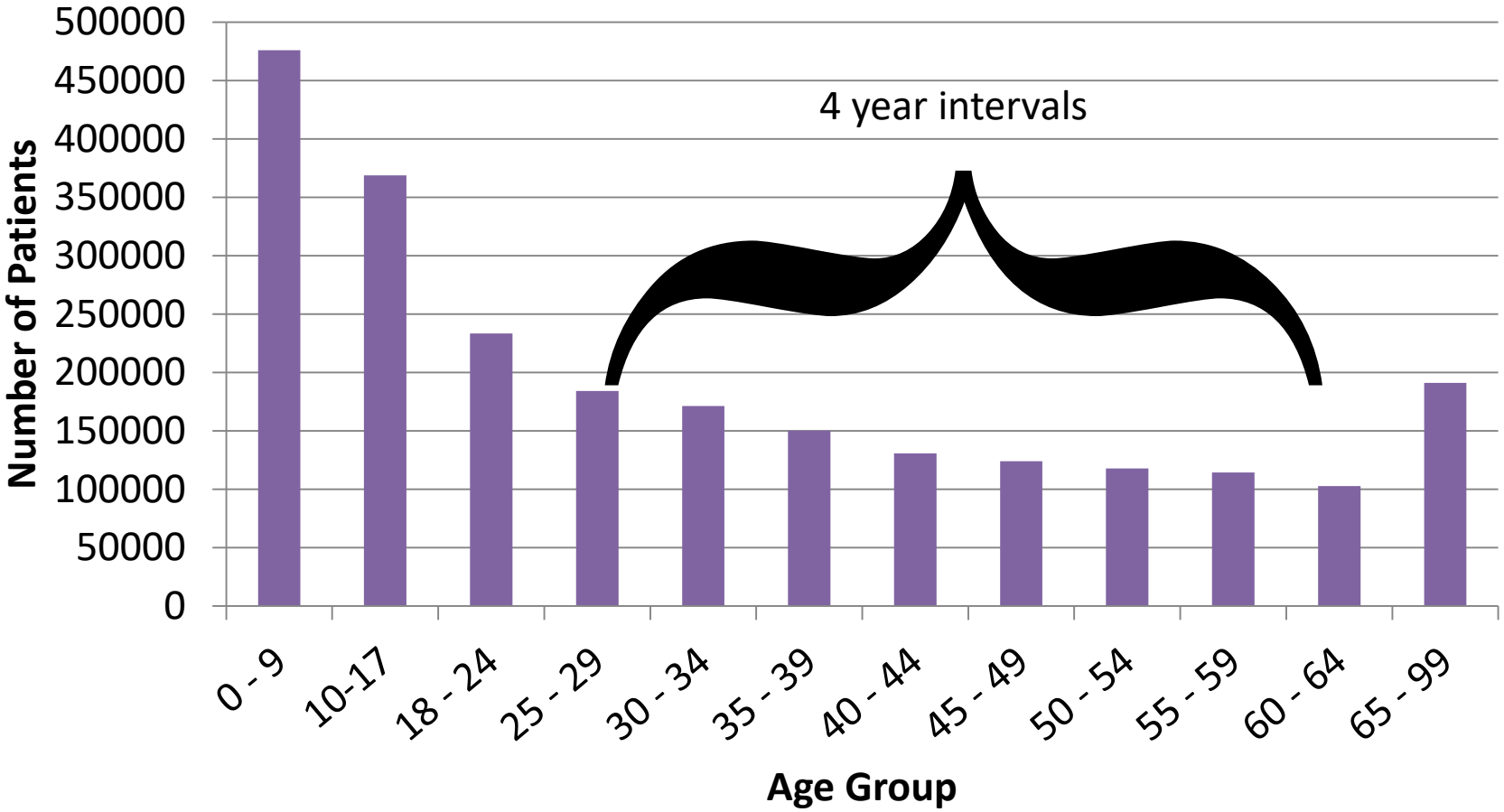
- Greg Budney
- Ken Scott
- Tessa Crume
- Emily McCormick-Kraus
- Emily Bacon
- Sara Schmidtt
- Art Davidson

END, INTRO TESSA CRUME

Patients in the CHORDS Network by Age Group, 2011-2018



* Prior to Cross-Site Deduplication