The Colorado Health Observation Regional Data Service (CHORDS):
Creating a Shared Distributed Data Network for Local Public Health and Research Needs

Presenters

- Rachel Zucker, Adult and Child Consortium for Health Outcomes Research and Delivery Science (ACCORDS)

BACKGROUND: CHORDS

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

CHORDS: A Primer

- **Data Partners:**
  Twelve health provider organizations in Colorado

- **Data Users:**
  Public health agencies serving the seven-county Denver Metro region and three public health agencies serving northern Colorado counties and local researchers from a variety of fields

- **Goal:**
  Expanded use of EHR data to achieve public health and research goals through reliable and location-specific information

- **Funding:**
  Primary support is provided by the Colorado Health Foundation (CHF); two-year renewal of grant began May 2018

CHORDS Data Partners

Health Systems

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

Mental Health Centers

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

Safety Net Providers

- Clinica Family Health
- Colorado Alliance for Health Equity and Practice
- Colorado Coalition for the Homeless
- High Plains Community Health Center
- Metro Community Providers Network
- Salud Family Health Centers
- Clinica Tepeyac

CHORDS Data

- Approximately 3 million patients' EHR data
- Limited dataset
- Geocoded home addresses

CHORDS: A Primer

- **Data Partners:**
  Twelve health provider organizations in Colorado

- **Data Users:**
  Public health agencies serving the seven-county Denver Metro region and three public health agencies serving northern Colorado counties and local researchers from a variety of fields

- **Goal:**
  Expanded use of EHR data to achieve public health and research goals through reliable and location-specific information

- **Funding:**
  Primary support is provided by the Colorado Health Foundation (CHF); two-year renewal of grant began May 2018
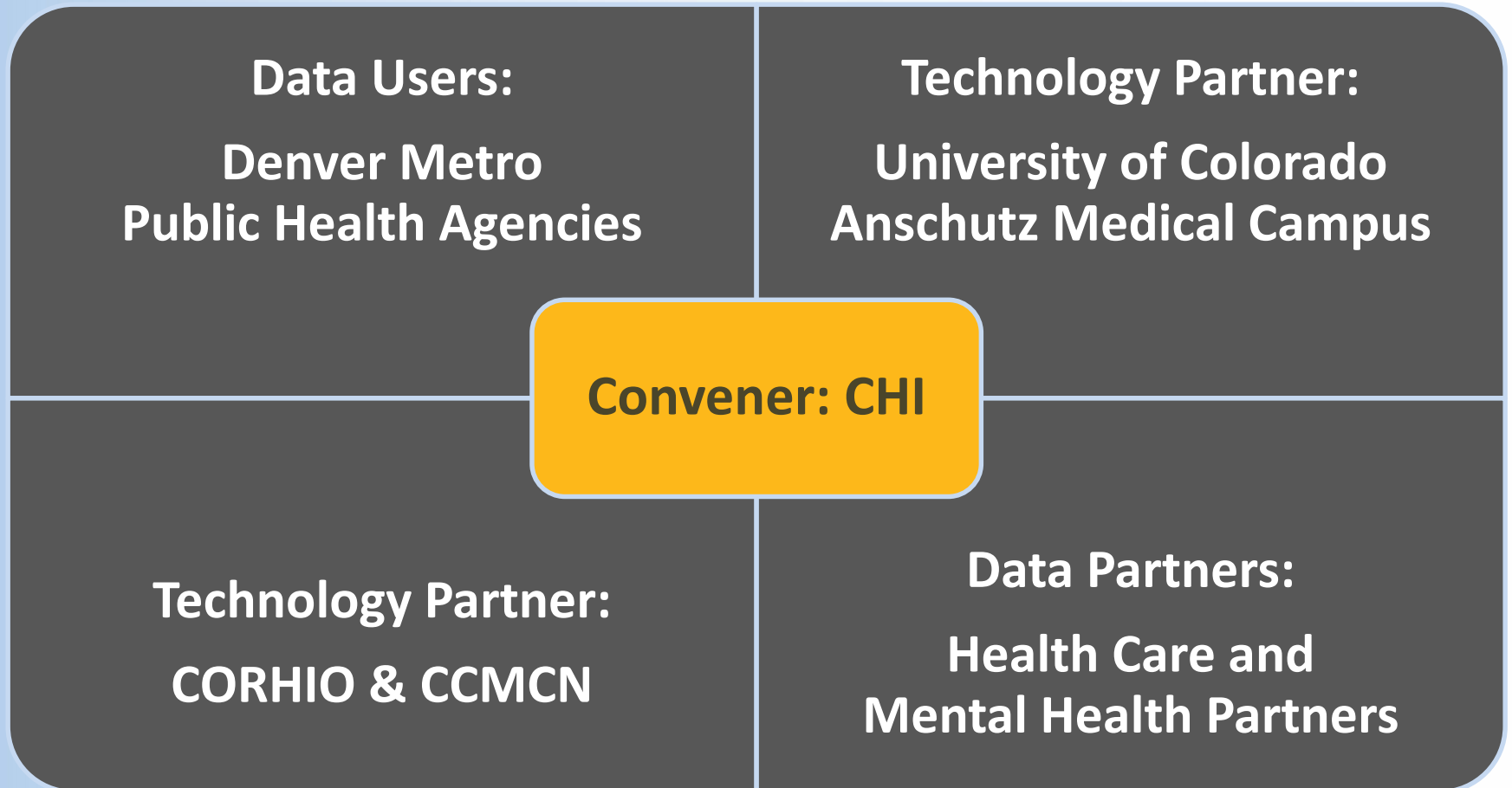
CHORDS Catchment in Colorado
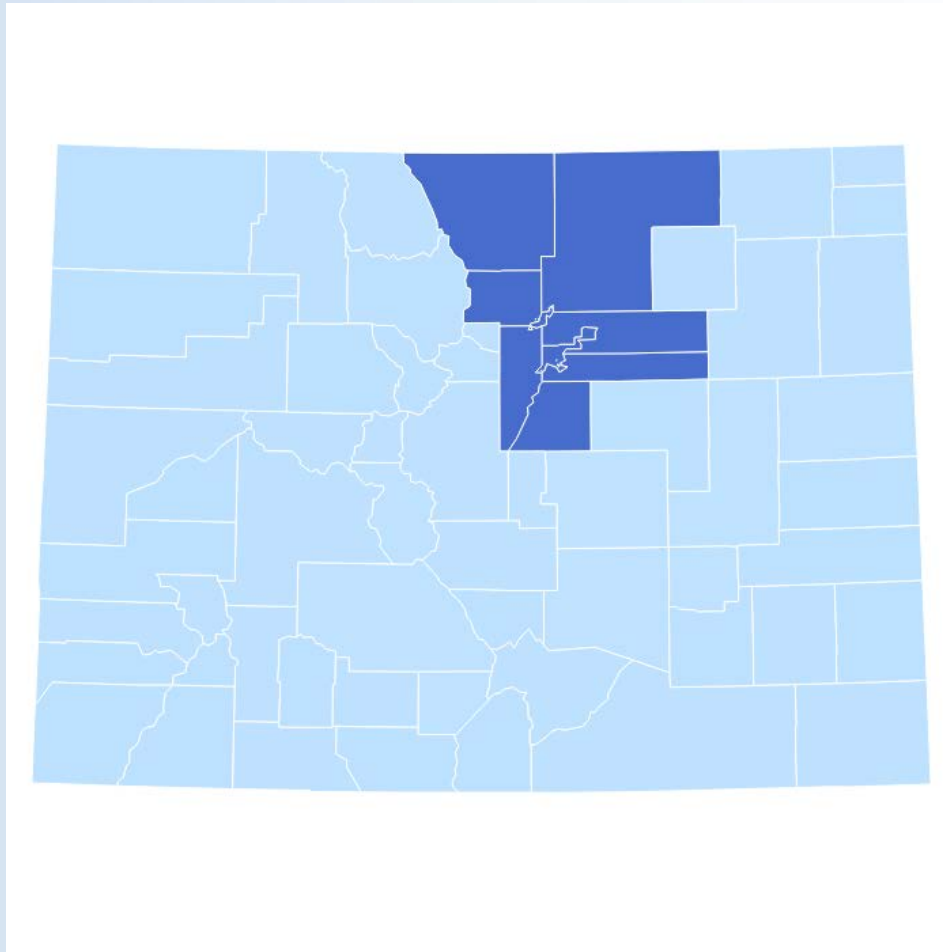
CHORDS Coverage

Colorado County	Coverage (CHORDS Patient Population ÷ ACS 2011-2015 Population estimates)
Adams	32%
Arapahoe	21%
Boulder	19%
Broomfield	20%
Denver	36%
Douglas	12%
Jefferson	21%
Larimer	7%
Weld	11%

CHORDS: A Primer

- **Data Partners:**
  Twelve health provider organizations in Colorado

- **Data Users:**
  Public health agencies serving the seven-county Denver Metro region and three public health agencies serving northern Colorado counties and local researchers from a variety of fields

- **Goal:**
  Expanded use of EHR data to achieve public health and research goals through reliable and location-specific information

- **Funding:**
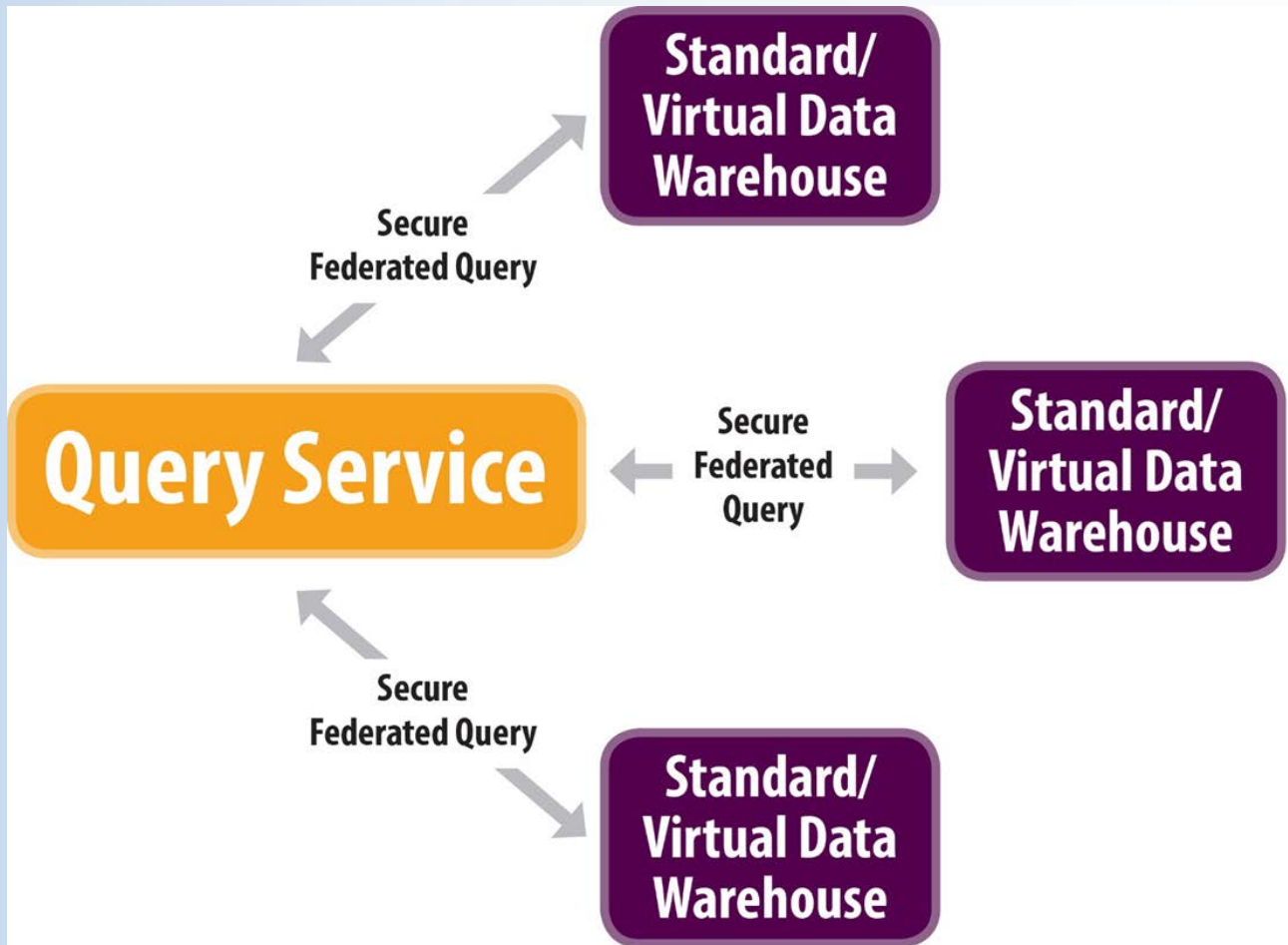 Primary support is provided by the Colorado Health Foundation (CHF); two-year renewal of grant began May 2018

The CHORDS Network

Data Users:

**Denver Metro
Public Health Agencies**

Technology Partner:

**University of Colorado
Anschutz Medical Campus**

Convener: CHI

Technology Partner:

CORHIO & CCMCN

Data Partners:

**Health Care and
Mental Health Partners**

BACKGROUND: POPMEDNET

Federated Model for Secure Data Sharing

PopMedNet

- Open-source application to facilitate data sharing among multi-site health data networks

- HIPAA-compliant distributed infrastructure

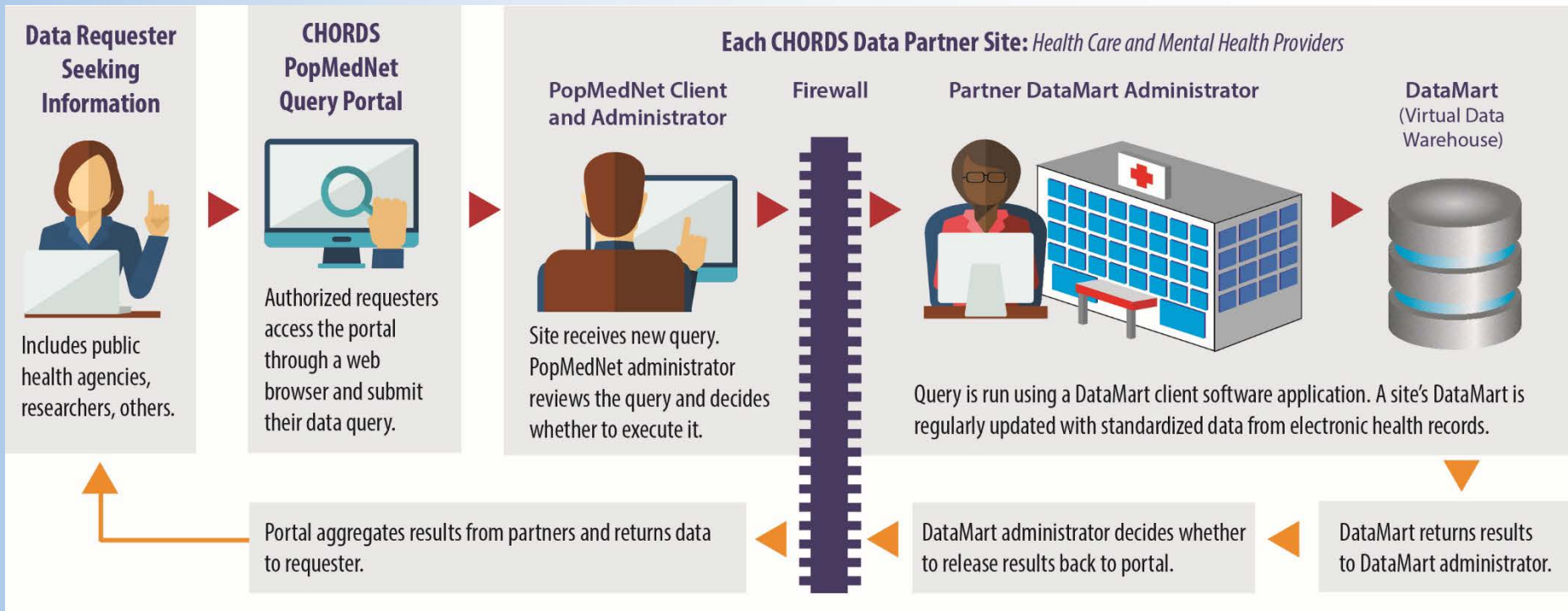| PopMedNet Portal	DataMart Client	Web Service API
• Web-based app for query distribution	• Windows application for query execution and response installed at each site	• Implements application logic to process requests against network(s)

PopMedNet

- Scalable; used by several regional and national networks:

The Query Process

Data Requester Seeking Information

Includes public health agencies, researchers, others.

CHORDS PopMedNet Query Portal

Authorized requesters access the portal through a web browser and submit their data query.

Each CHORDS Data Partner Site: *Health Care and Mental Health Providers*

PopMedNet Client and Administrator

Site receives new query. PopMedNet administrator reviews the query and decides whether to execute it.

Firewall

Partner DataMart Administrator

Query is run using a DataMart client software application. A site's DataMart is regularly updated with standardized data from electronic health records.

DataMart (Virtual Data Warehouse)

Portal aggregates results from partners and returns data to requester.

DataMart administrator decides whether to release results back to portal.

DataMart returns results to DataMart administrator.

BACKGROUND: CHORDS VIRTUAL DATA WAREHOUSE

The CHORDS Data Model

Colorado Health Observation Regional Data Service
Virtual Data Warehouse V3.1 Data Model
Version Issued: Summer 2017

REQUIRED FIELD

DEMOGRAPHICS

PERSON_ID
MRN
BIRTH_DATE
GENDER
PRIMARY_LANGUAGE
NEEDS_INTERPRETER
RACE1-5
HISPANIC
SEXUAL_ORIENTATION
GENDER_IDENTITY

CENSUS_LOCATION

PERSON_ID
LOC_START
LOC_END
GEOCODE

DIAGNOSES

DIAGNOSIS_ID
PERSON_ID
ENC_ID
PROVIDER
DIAGPROVIDER
DX

VITAL_SIGNS

VITAL_SIGN_ID
PERSON_ID
MEASURE_DATE
HT
WT
DIASTOLIC
SYSTOLIC

LAB_RESULTS

LAB_RESULTS_ID
PERSON_ID
RESULT_DT
LAB_DT
TEST_TYPE
LOINC
RESULT_NUM
RESULT_C
RESULT_UNIT

PRESCRIBING (P2)

PRESCRIBINGID
PERSON_ID
RXMD
RX_ORDER_DATE
RX_START_DATE
RX_END_DATE
RX_QUANTITY
RX_REFILLS

PROCEDURES

PROCEDURES_ID
ENC_ID

PROVIDER_SPECIALTY

PROVIDER
....
SPECIALTY
PROVIDER_TYPE
PROVIDER_BIRTH_YEAR
PROVIDER_GENDER
PROVIDER_RACE
PROVIDER_HISPANIC
YEAR_GRADUATED

ENCOUNTERS

ENC_ID
PERSON_ID
PROVIDER
ADATE
DDATE

SOCIAL_HISTORY

SOCIAL_HISTORY_I
D
PERSON_ID
CONTACT_DATE
TOBACCO_USER
ALCOHOL_USER
ILL_DRUG_USER
CIGARETTES_YN
ALCOHOL_OZ_PER
_WK
FEMALE_PARTNER
_YN
MALE_PARTNER_Y
N

The CHORDS Common Data Model: VDW

- **Encounters**
- **Diagnoses** (ICD-9/-10 codes)
- **Procedures** (ICD-9/-10; CPT, HCPCS)
- **Social History** (e.g., tobacco, alcohol, and/or drug use)
- **Laboratory Results** (e.g., test type, date of test and result)
- **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; rxnorm; prescribing md, quantity, refills)
- **Vital Signs** (e.g. height and weight; diastolic and systolic blood pressure)
- **New for 2019: Benefits, Linkage**

Enhancing Data Reliability

- Many existing data sources rely on self-reported measures

- CHORDS uses EHR data, accessing measurements entered by providers

Maintaining Patient Privacy

- CHORDS provides aggregated data for use by public health agencies

- Information cannot be traced back to individual patients – limited data set

- Each data partner retains full control over their patients' data – opt out model

NETWORK USES

CHORDS Network Use

- **Public Health**
  - Retrospective surveillance
    - Disease prevalence across demographic, geographic strata
    - Adapters standardized for specific case definitions

- **Healthcare Research**
  - Infrastructure (governance, analytic support) for internal/external research using CHORDS data

Public Health and Research Requests

- **Public Health Topics**:
  - Depression
  - Mental Health and Pregnancy
  - Hypertension
  - Diabetes
  - Adult/Child BMI
  - Tobacco Use
  - Opioid Use Disorder
  - Marijuana

- **Research Topics**:
  - Asthma Exacerbation Index
  - Adolescent Pregnancy and LARCs
  - Spinal Fusion Procedures and Opioids

Underlying Data

bhic Group	Care_Population	ValidBMI_Population	Count_of_Underweight	Prev_Underweight	Count_of_Healthy	Prev_Healthy	Count_of_Overweight	Pr
	196454	153058	7641	4.99	100538	65.69	22044	
	23155	18853	1582	8.39	13724	72.79	1951	
	49096	39495	2391	6.05	28268	71.57	4594	
	47004	36073	1646	4.56	22708	62.95	5507	
	48954	38011	1359	3.58	23032	60.59	6516	
	28245	20626	663	3.21	12806	62.09	3476	
	97755	76211	3588	4.71	50804	66.66	11567	
	98698	76847	4053	5.27	49734	64.72	10477	
	<=10	0	0	-	0	-	0	
	82279	67803	4107	6.06	48704	71.83	8242	
	30894	14419	877	6.08	9647	66.9	1986	
	83281	70836	2657	3.75	42187	59.56	11816	
	5330	4438	371	8.36	3255	73.34	472	
	16377	13145	765	5.82	8686	66.08	1890	
	2646	1864	190	10.19	1252	67.17	239	
	1390	1120	40	3.57	694	61.96	165	
	1496	1266	36	2.84	731	57.74	219	
	43310	27303	1193	4.37	16925	61.99	4309	
	125905	103922	5046	4.86	68995	66.39	14750	

CHORDS Testing | BMI: Percent Obese by Census Tract (Metro Denver Region, 2015)

Tri-County Region, Colorado

DO NOT SHARE DO NOT SHARE DO NOT SHARE

Legend

CHORDS BMI 2015 — County Boundaries
Percent Obese — Local Roads

Roads
- 0 - 22.2%
- 22.2% - 29.8% — Freeway or Other Major Road
- 29.8% - 37.2% — Major Road Less Important than a Freeway
- 37.2% - 47.0%

Notes: Classification is based on natural breaks (Jenks).
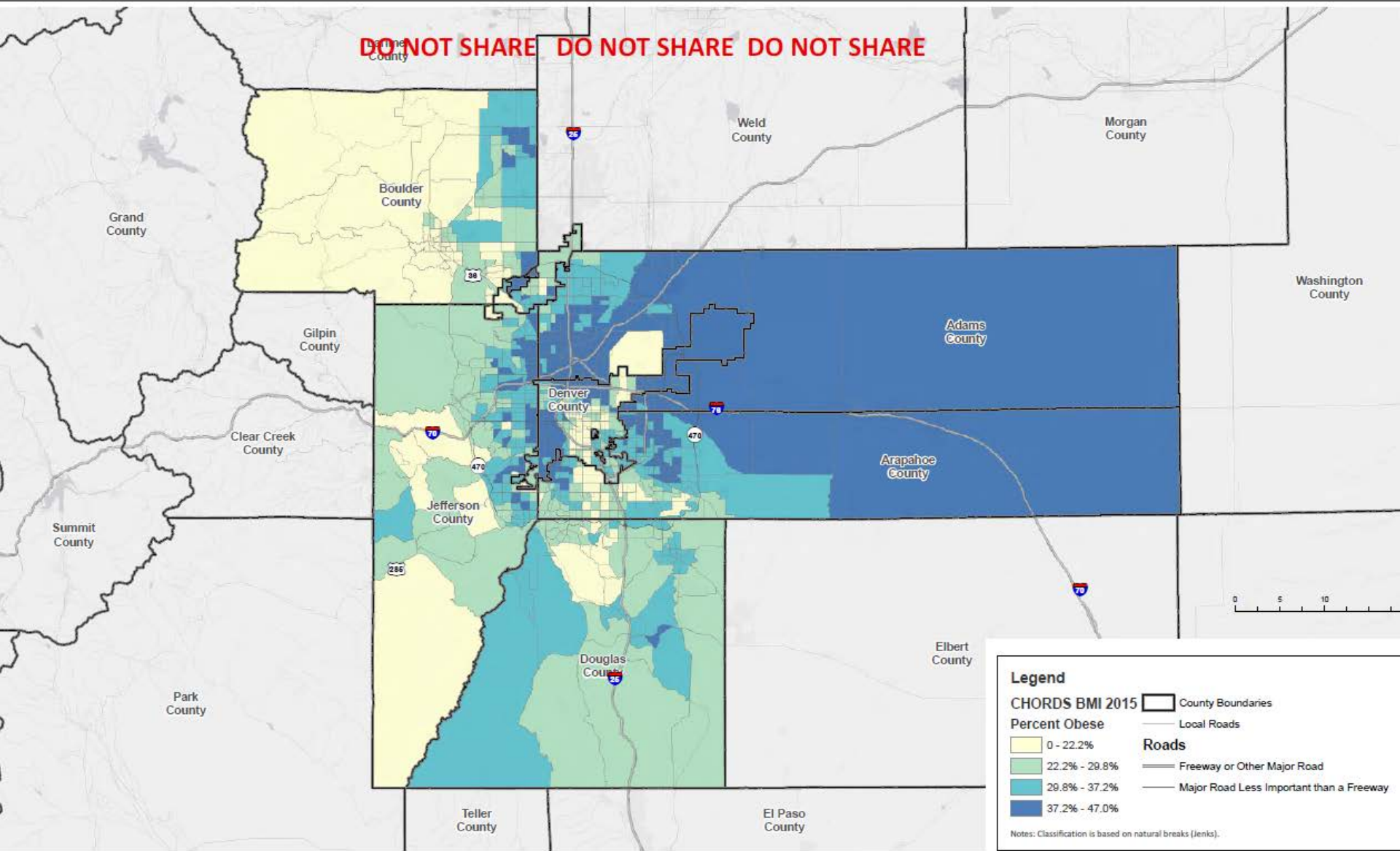
Source: CHORDS, 2015

Date Created: August 24, 2017

Public Health Use Case:
Depression Among the Latino Age Wave

Research Use Case: Asthma

Count of asthma related prescriptions, by month
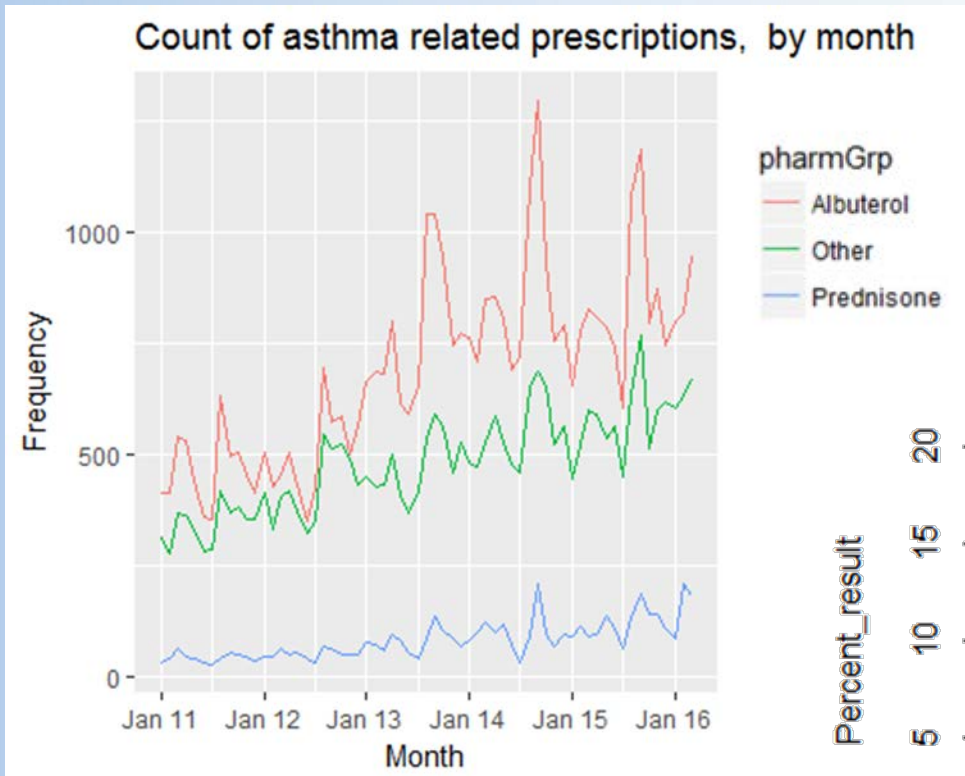
Absolute Eos. vs. % Eos.
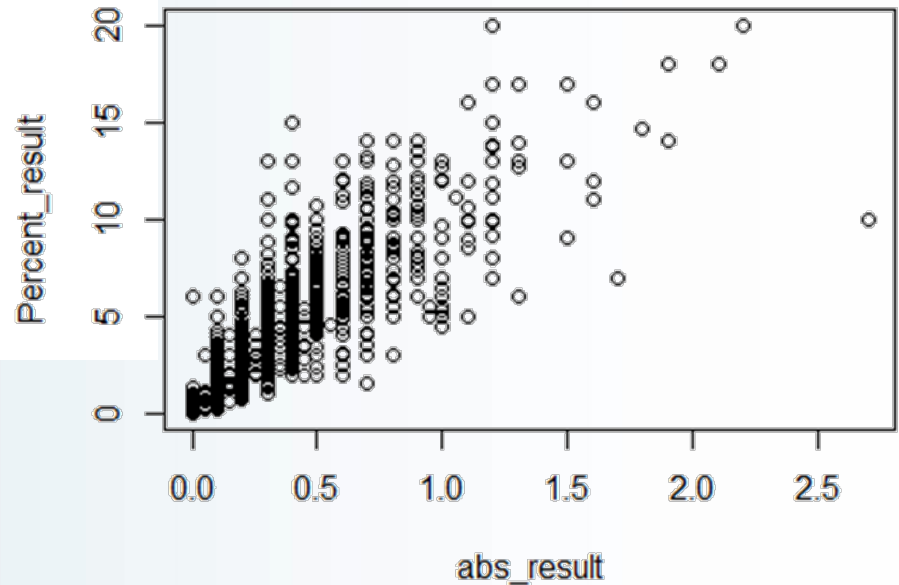
INNOVATION: CUSTOMIZING CHORDS

Structured public health requests

- Menu-driven user interface
- Small cell size suppression
- Tailored reports
- Enhancements for large numbers of records
- Coverage

Parameters ?

Observation Date Range

Start Date: 06/21/2017   **End Date:** 06/21/2018

Gender ?

Select All Genders   Clear Selections

- ☐ Male
- ☐ Female
- ☐ Unknown
- ☐ Other

Race ?

Select All Races   Clear Selections

- ☐ Native Hawaiian or Other Pacific Islander
- ☐ American Indian/Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ White
- ☐ More than one race, particular races unknown or not reported
- ☐ Unknown or Not Reported

Ethnicity ?

Hispanic:

Select All Ethnicities   Clear Selections

- ☐ Yes
- ☐ No
- ☐ Unknown

Age of Individuals ?

○ Age by Fixed Increments ● Age by Custom Ranges

Age of Individuals ?

○ Age by Fixed Increments ● Age by Custom Ranges

[Add New Date Range +]

Range Start [   ] **Range End** [   ]

Encounter ?

Types:

[Select All Encounters] Clear Selections

☐ Ambulatory Visit   ☐ Telephone   ☐ Other Encounters (not overnight)
☐ Acute Inpatient Hospital Stay   ☐ E-mail   ☐ Lab Only
☐ Emergency Department   ☐ Non-Acute Institutional Stays   ☐ Radiology Only

Location ?

Colorado Counties

[Select Denver Metro Area Only] [Select All Counties] Clear Selections

☐ Adams	☐ Chaffee	☐ Denver	☐ Gilpin	☐ Kit Carson	☐ Mineral	☐ Phillips	☐ San Juan
☐ Alamosa	☐ Cheyenne	☐ Dolores	☐ Grand	☐ Lake	☐ Moffat	☐ Pitkin	☐ San Miguel
☐ Arapahoe	☐ Clear Creek	☐ Douglas	☐ Gunnison	☐ La Plata	☐ Montezuma	☐ Prowers	☐ Sedgwick
☐ Archuleta	☐ Conejos	☐ Eagle	☐ Hinsdale	☐ Larimer	☐ Montrose	☐ Pueblo	☐ Summit
☐ Baca	☐ Costilla	☐ Elbert	☐ Huerfano	☐ Las Animas	☐ Morgan	☐ Rio Blanco	☐ Teller
☐ Bent	☐ Crowley	☐ El Paso	☐ Jackson	☐ Lincoln	☐ Otero	☐ Rio Grande	☐ Washington
☐ Boulder	☐ Custer	☐ Fremont	☐ Jefferson	☐ Logan	☐ Ouray	☐ Routt	☐ Weld
☐ Broomfield	☐ Delta	☐ Garfield	☐ Kiowa	☐ Mesa	☐ Park	☐ Saguache	☐ Yuma

Structured public health requests

- Menu-driven user interface
- Small cell size suppression
- Tailored reports
- Enhancements for large numbers of records
- Coverage

Small cell size suppression

- Aligned with CMS Guidelines
  - Cell sizes ≤10 are replaced with ≤10
  - This masking can be turned off for QA checks

Structured public health requests

- Menu-driven user interface
- Small cell size suppression
- Tailored reports
- Enhancements for large numbers of records
- Coverage

County	Demographic Variable	Demographic Group	Care_Population	ValidBMI_Population	Count_of_Un...
All	All	All	196454	153058	
All	AGE GROUP	0 - 3	23155	18853	
All	AGE GROUP	4 - 7	49096	39495	
All	AGE GROUP	8 - 11	47004	36073	
All	AGE GROUP	12 - 15	48954	38011	
All	AGE GROUP	16 - 19	28245	20626	
All	GENDER	F	97755	76211	
All	GENDER	M	98698	76847	
All	GENDER	O	<=10	0	
All	HISPANIC	N	82279	67803	
All	HISPANIC	U	30894	14419	
All	HISPANIC	Y	83281	70836	
All	RACE	AS	5330	4438	
All	RACE	BA	16377	13145	
All	RACE	HP	2646	1864	
All	RACE	IN	1390	1120	
All	RACE	MU	1496	1266	
All	RACE	UN	43310	27303	
All	RACE	WH	125905	103922	

Structured public health requests

- Menu-driven user interface
- Small cell size suppression
- Tailored reports
- **Enhancements for large numbers of records**
- Coverage

Enhancements for large numbers of records

- Change in file size of transmissions from DMC to Portal to minimize SQL Server space requirements
- Limiting displayed rows in Portal

Structured public health requests

- Menu-driven user interface
- Small cell size suppression
- Tailored reports
- Enhancements for large numbers of records
- Coverage

Exploring CHORDS Data

The Colorado Health Observation Regional Data Service (CHORDS) is gathering and aggregating electronic medical record data from 11 health care and mental health providers in the seven-county Denver metro area. For the first time, researchers and public health agencies have access to clinical data to help monitor public health trends. CHORDS data can be used alone or in conjunction with survey data sources.

This dashboard compares the population covered by CHORDS — people who received care at one or more of the participating health providers — with the population included in the American Community Survey. Comparisons are based on 2015 data and are available by county, age, gender and race.

Use the demographic filters below to explore CHORDS coverage data

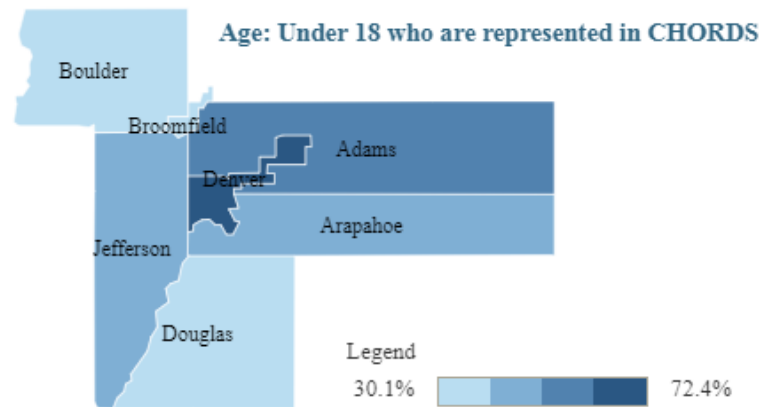**Demographic Filters**

Age
Under 18
18 and Over
65+

Gender
Females
Males

Total

Race
AIAN
Asian
Black
HPI
Hispanic
Multi
Race
White

Age: Under 18 who are represented in CHORDS

Boulder
Broomfield
Adams
Denver
Arapahoe
Jefferson
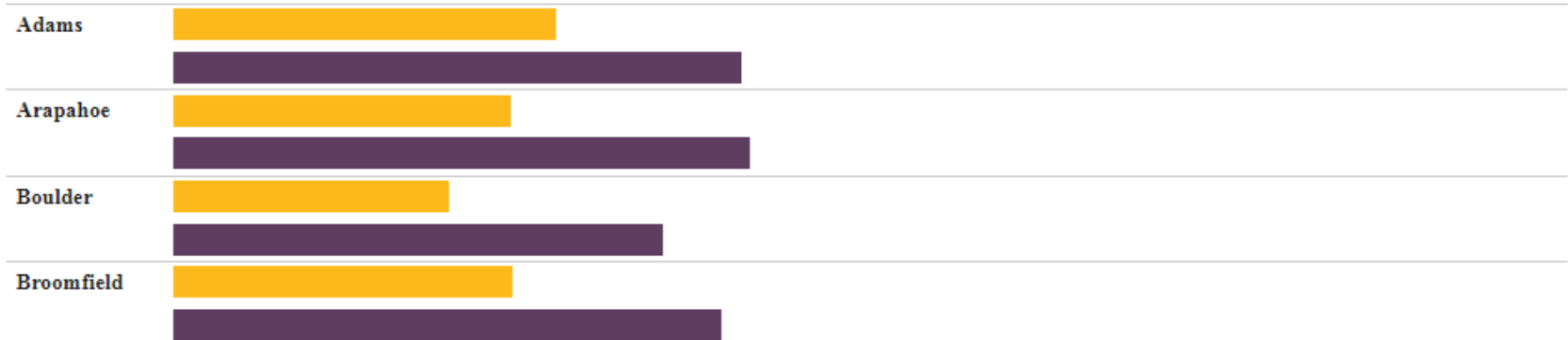Douglas

Legend
30.1%   72.4%

Select a Unit of Measure
◉ Percentage of Population Represented in CHORDS Compared with the ACS
◯ Number of People Represented in CHORDS Compared with the ACS

ACS   CHORDS

Adams

Arapahoe

Boulder

Broomfield

Customizing CHORDS

- Linking and de-duplicating records across data-contributing sites

CHALLENGES

Data Partners

- Legal/regulatory
- Different technical resources

Legal/Regulatory

- Unique processes at each site
- Agreements required to share data
  - Reciprocal DUA
- IRB approval: site by site considerations
- Research vs. public health

Data Partners

- Legal/regulatory

- Different technical resources

Different Technical Resources

- Full IT team vs. summer interns/part time assistance

- Software licensing considerations

- Previous experience in other data networks

Data Partners

- ETL (Extract, Transform and Load) challenges
- QA efforts

Data Partners: ETL

- Differing experience levels

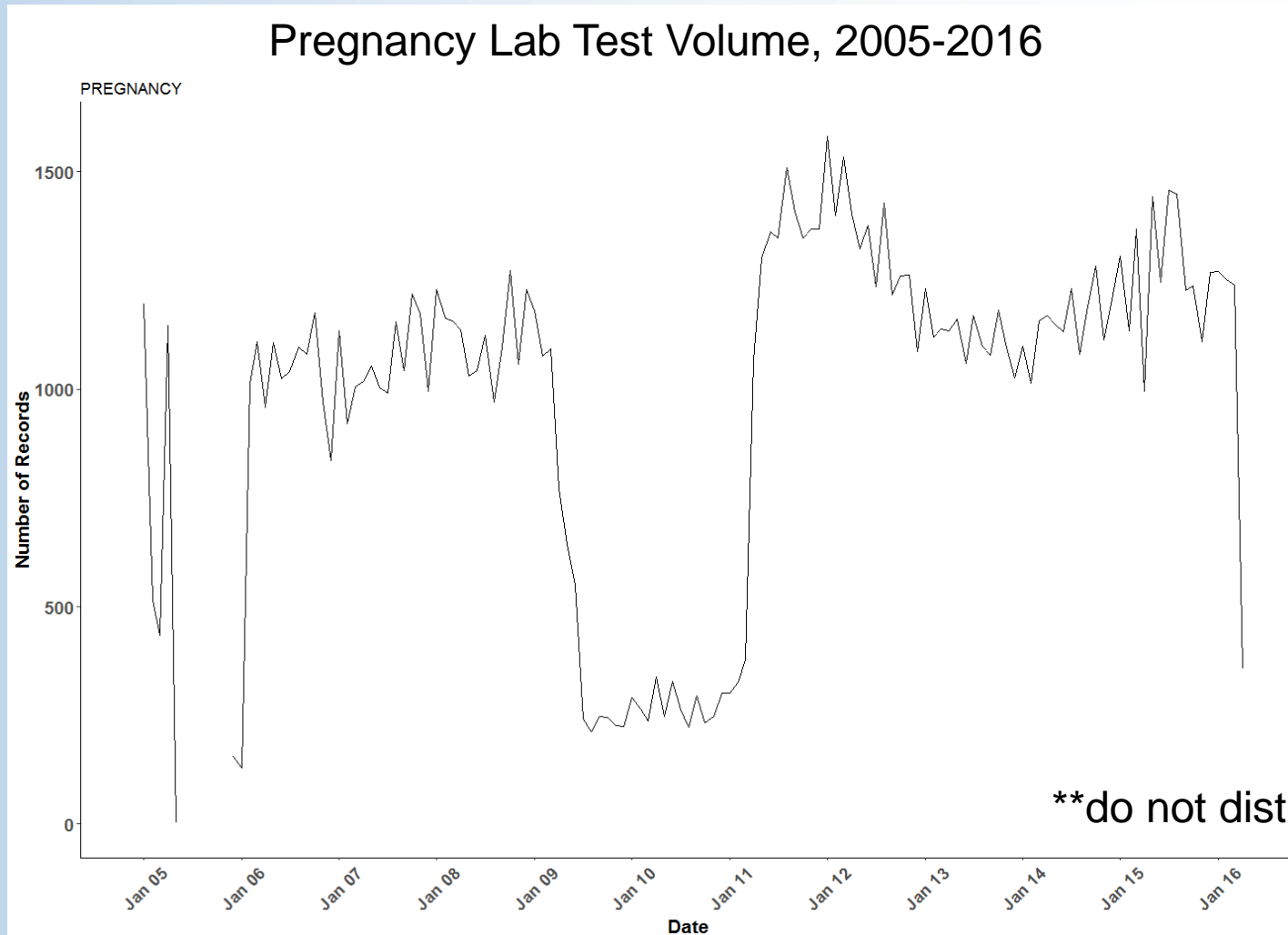- Site-specific decisions

- The mystery of the missing heights

Data Partners

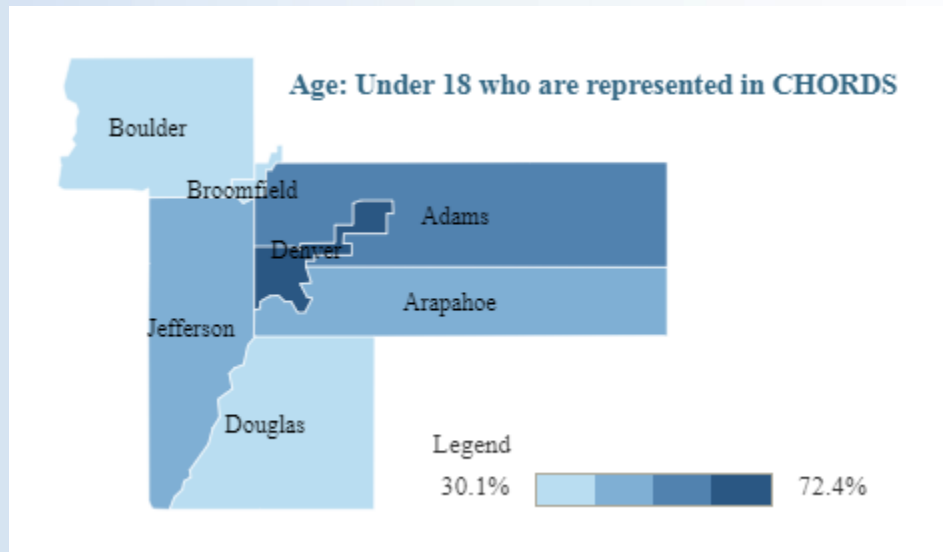- ETL challenges
- QA efforts

Data Partners: QA

Patient Volume Stratified by Age

**do not distribute.

Data Partners: QA

Pregnancy Lab Test Volume, 2005-2016

**do not distribute.
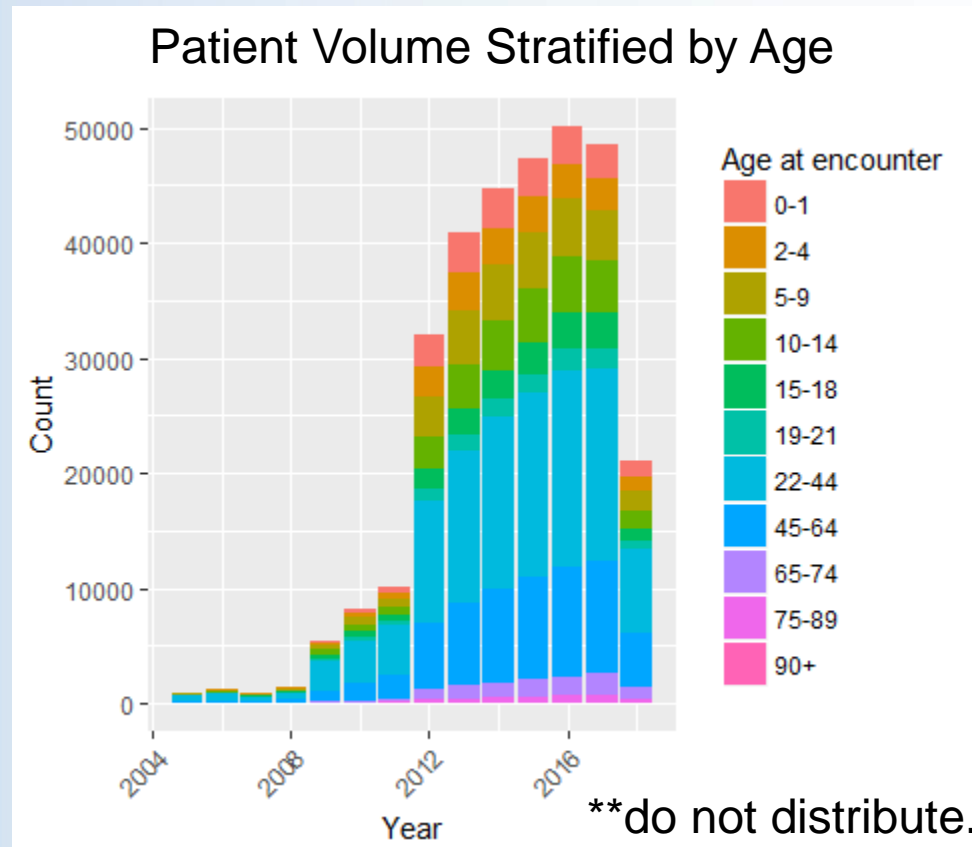
WHERE WE ARE NOW AND WHERE WE ARE GOING

Geographic Area

- NOW:
  - Metro Denver area

Age: Under 18 who are represented in CHORDS

Boulder

Broomfield

Denver

Adams

Arapahoe

Jefferson

Douglas

Legend
30.1%　72.4%

Geographic Area

- GOING TO:

  – Northern Colorado/Front Range

Data Partners

- NOW:
  - 12 data partners contributing data

Data Partners

- GOING TO:
  - Adding new data partners, including two of the largest state-wide systems.
  - Adding new behavioral health data partners
  - New outreach

VDW

- NOW
  - CHORDS VDW 3.1
  - Assessed data model concordance with:
    - HCSRN VDW CDM: 98%
    - PCORnet CDM: 47%

VDW

- GOING TO:
  - Balance of specialized tables/fields vs. staying in alignment: point of no return?
  - CHORDS VDW 3.2: BENEFITS and LINKAGE tables
  - Next up: Social Determinants, Screening?

Software

- Customization: pros and cons
- Keeping up with the Joneses (aka new releases)
- Help from the Harvard Pilgrim development team

Where Else?

- Linkage and de-duplication

- Expanded Research Agenda

Linkage and De-duplication

- We've got an eMPI... now what?
  - Distributed data network design
  - Which record "wins"

Where Else?

- Linkage and de-duplication

- Expanded Research Agenda

Expanded Research Agenda

- Deep dive into newer tables

- New fields, lab tests

- Revisiting regulatory/legal processes at each site

Questions?

Contacts

- Rachel Zucker (rachel.zucker@ucdenver.edu)

Additional Resources Online

www.coloradohealthinstitute.org/research/colorado-health-observation-regional-data-service