MAY 2023

From Bench to Practice:
Exploring Real World Evidence of COVID-19 Vaccines

VDMP-XXX-MONTH-2023

Introductions

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Special thanks to Jordan Overcash, Ni Zheng, and Alina Bogdanov for helping to conduct the underlying analyses presented here.

Session Overview

- Background
- The Beginning
- Vaccines!
- Variants
- Flattening the Next Curve
- The Future
- Questions

Veradigm's Pandemic Priorities

Healthcare Practices

Throughout the pandemic, Veradigm's first priority has been supporting our **practices and patients** in terms of infrastructure, research queries and general guidance

Public Health Initiatives

Veradigm is contributing to **public health efforts** around potential reinfection analysis, symptom profiles, testing patterns, and data availability for non-commercial purposes, including FDA Sentinel analyses and collaborations through Mitre Health

Focused RWD and RWE

Veradigm is developing **distinct data products** and **custom analytics projects** to support deeper COVID-19 analysis and help us move from bench to practice

Prepare for the Future

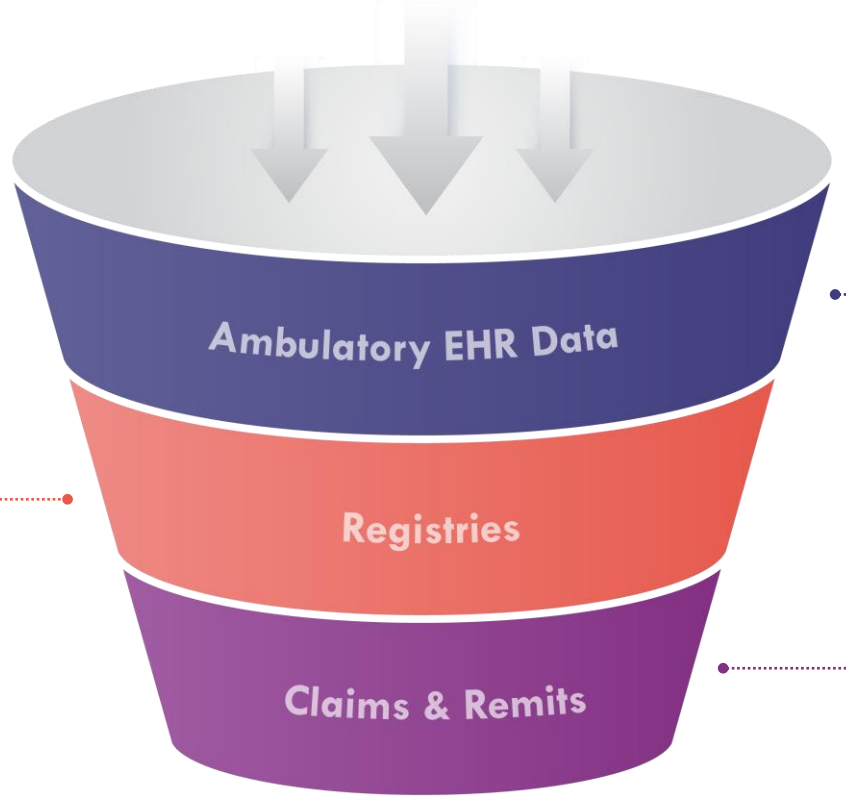
Veradigm is working with a number of collaborators to prepare for the future, both with chronic phase of COVID-19 and future pandemic preparedness

Background

Is our data pandemic fit-for-purpose?

Veradigm Real-World Data Defined

Veradigm
Real World Data



Registries
13M+ Patients*

Cardiology
11M+ Patients*

2.7M linked to closed claims

Metabolic
8M+ Patients*

2.5M linked to closed claims

Veradigm Network EHR (VNEHR) Data
174M+ Patients*

- Veradigm EHR (46M)
- Practice Fusion (42M)
- NextGen (86M)

69M linked to closed/open claims

Claims & Remits
207M/238M Claims**

*5 years of history: Q3 2017-Q2 2022
** Data is only stored at a rolling two-year period closed/open claims via third party vendor : Q3 2020 – Q2 2022

Veradigm Real World Data | Data Breadth and Scale

How can we leverage this for the pandemic?

Veradigm **Real World Data** is a comprehensive source for electronic health record (EHR), claims, and linked datasets

174M+
patients with clinical activity

135M+
patients with F2F/non-F2F visits

2.60B+
total visits

240k+
HCP activity

48M
Available for NLP extraction

~26%
patients linked to closed claims

~14%
patients linked to open claims

207M/238M*
MX payer/remit claims info via Payerpath

STRUCTURED AND UNSTRUCTURED DATA

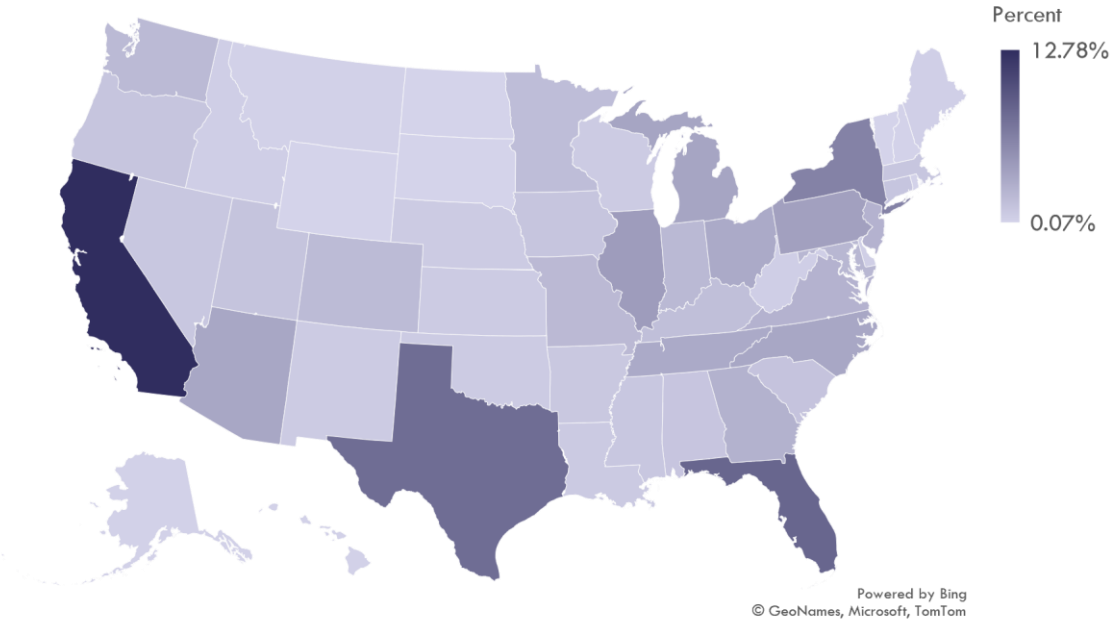
NLP extracts evidence not available In structured data

5 Year Time Period: Q3 2017 – Q2 2022
*Available in rolling two-year period. Closed/open claims via third party vendor: Q3 2020 – Q2 2022

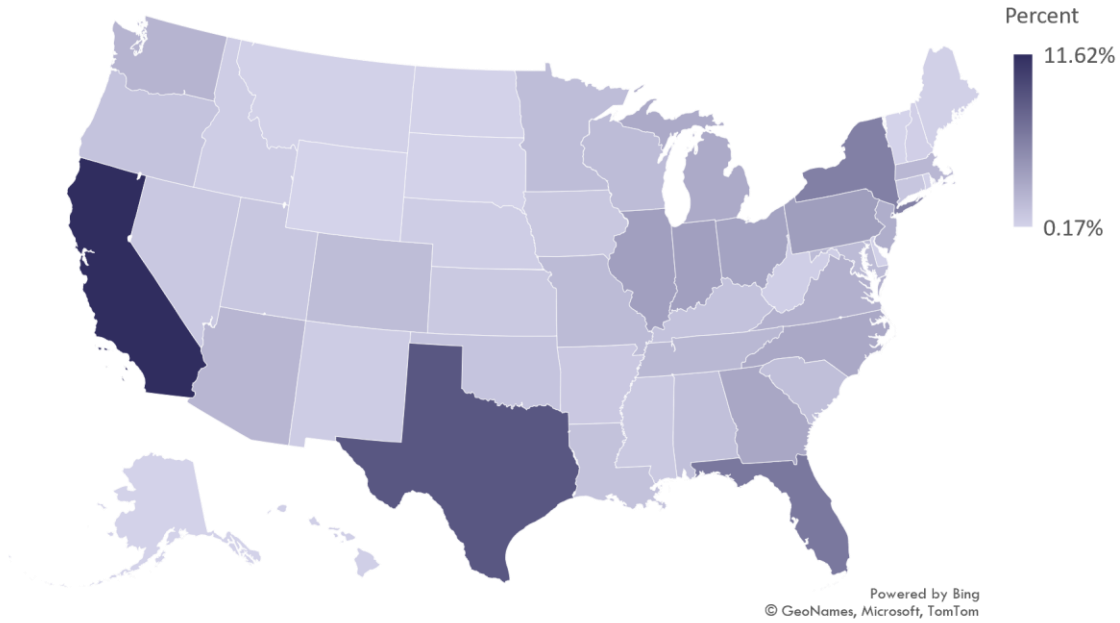
*Veradigm Roadmap 2022; however, currently available via HV marketplace
Bolded fields only available via Veradigm. Closed/open claims via third party vendor

Distribution of VNEHR data and US Population by State

VNEHR



US Census*



5 Year Time Period: Q3 2017 – Q2 2022
*Source: U.S. Census Bureau, Population Division, 2021

The Beginning (i.e., 2020)

The Beginning (i.e., 2020)

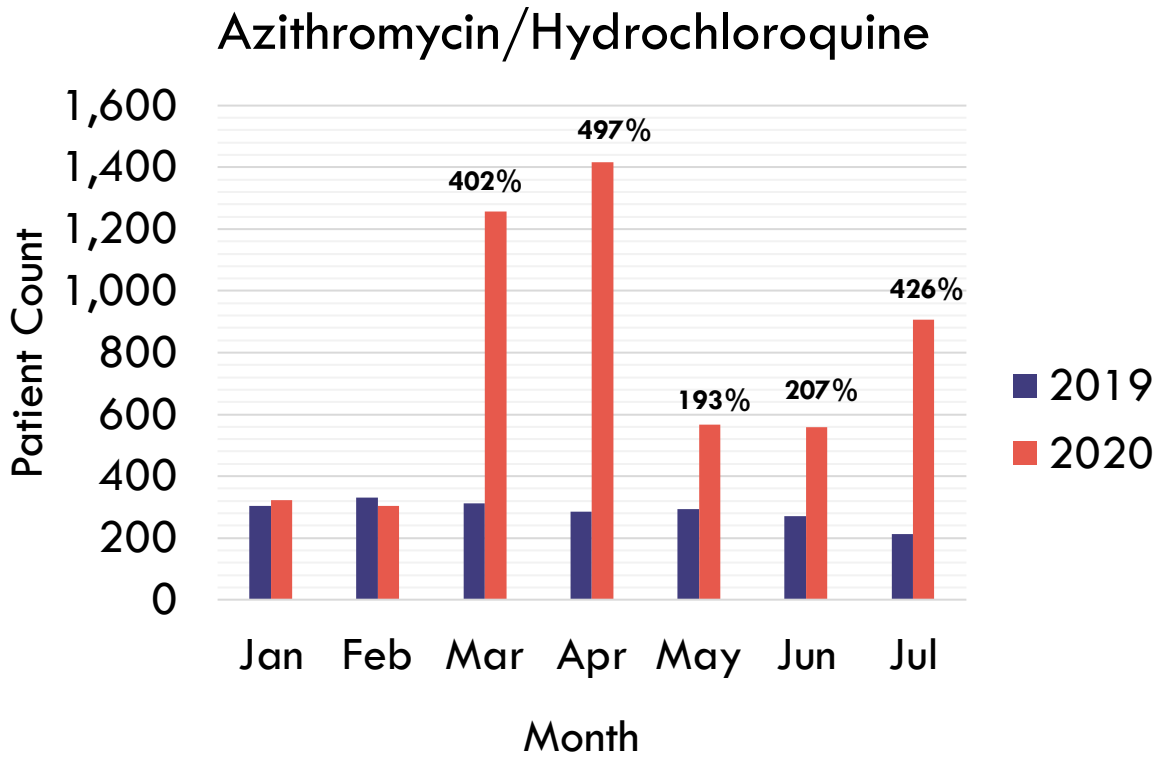
Medication Use Among COVID-19 Patients

- Veradigm created a dashboard tracking medication use among COVID patients defined using diagnosis and/or positive lab results.
- Informed analysis around potential benefit of existing therapies

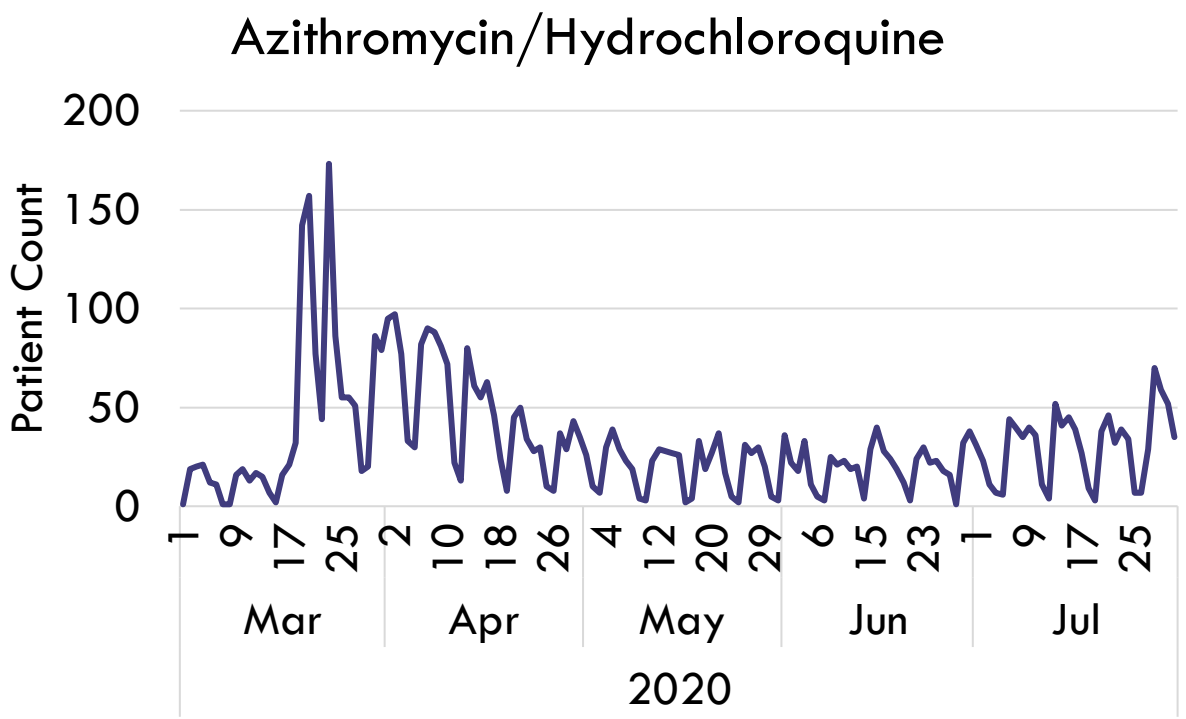
Medication	Positive Lab Result	COVID-19 Dx	Positive Lab Result or COVID-19 Dx	Negative Lab Result
All Patients	34,300	82,368	105,997	220,406
Zithromax Z-Pak	2,654	4,318	5,957	9,915
Azithromycin	2,585	4,154	5,664	8,952
Metformin HCl	1,359	2,453	3,350	7,807
Atorvastatin Calcium	1,204	2,375	3,175	9,809
Omeprazole	1,087	2,149	2,877	8,126
Prednisone	1,503	2,058	3,098	8,568
Benzonatate	1,309	1,932	2,728	4,356
Lisinopril	947	1,930	2,552	7,194
Ibuprofen	1,116	1,890	2,638	4,928
Losartan Potassium	978	1,697	2,360	7,079
Amoxicillin-Pot Clavulanate	1,080	1,627	2,331	6,651
Zithromax	708	1,423	1,830	2,386
Ventolin HFA	741	1,415	1,871	3,990
Albuterol Sulfate HFA	751	1,413	1,825	3,959
Amoxicillin	852	1,378	1,933	4,700
Fluticasone Propionate	770	1,377	1,868	4,988
Levothyroxine Sodium	688	1,348	1,829	6,524
hydrochlorothiazide	716	1,311	1,804	5,259
Gabapentin	514	1,212	1,560	4,770
Vitamin C	497	1,209	1,448	1,680
Albuterol Sulfate	639	1,132	1,538	3,135

The Beginning (i.e., 2020)

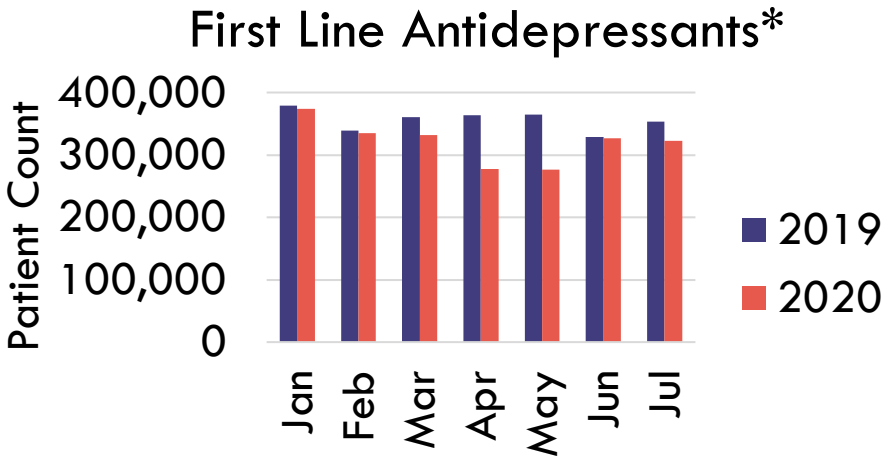
Year over Year



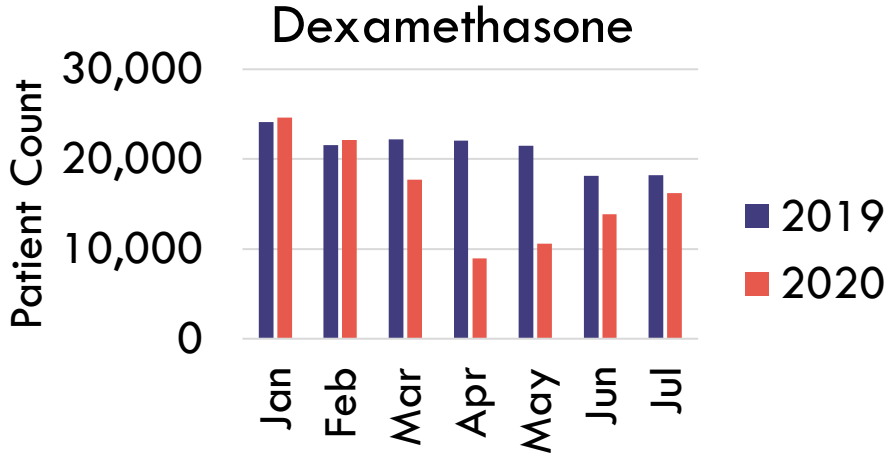
Daily Use - 2020

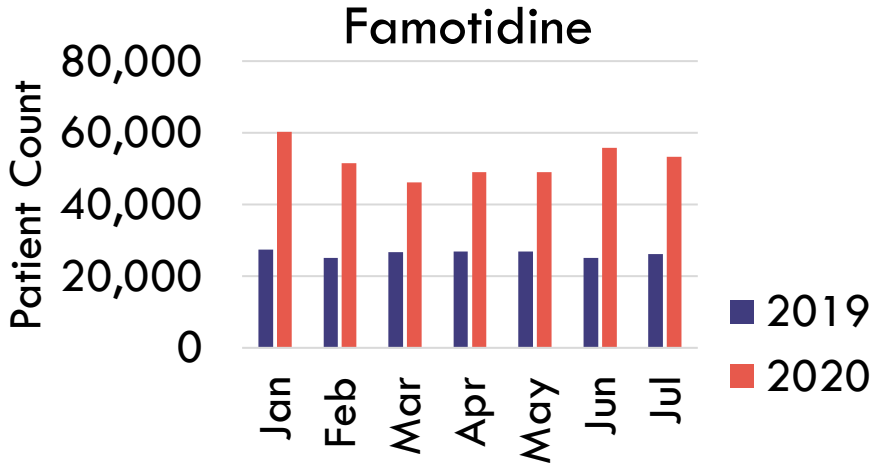


The Beginning (i.e., 2020)



* Citalopram, Desvenlafaxine, Duloxetine, Escitalopram, Fluoxetine, Fluvoxamine, Levomilnacipran, Paroxetine, Sertraline, Venlafaxine

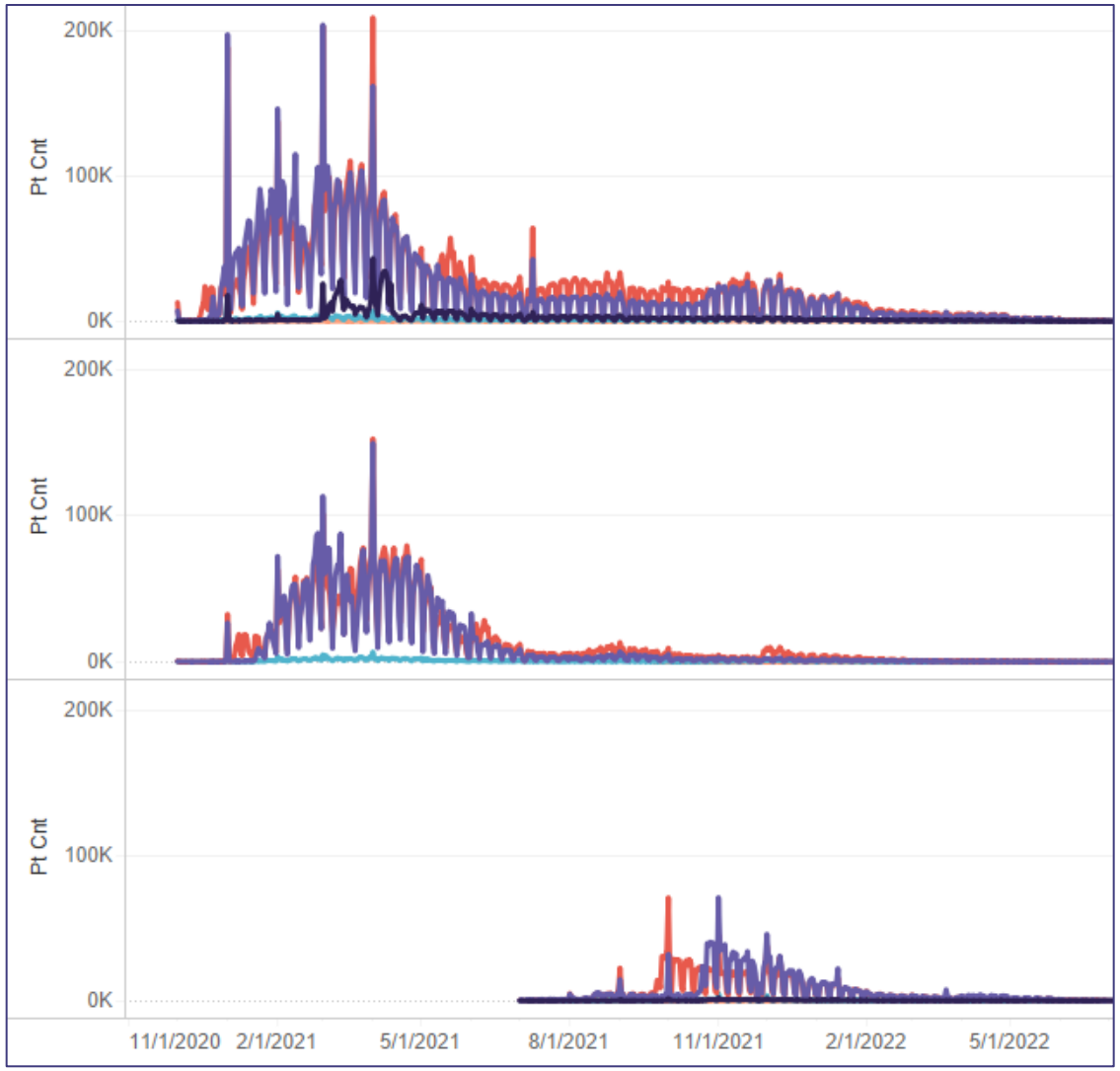




Vaccines!

Vaccination Uptake

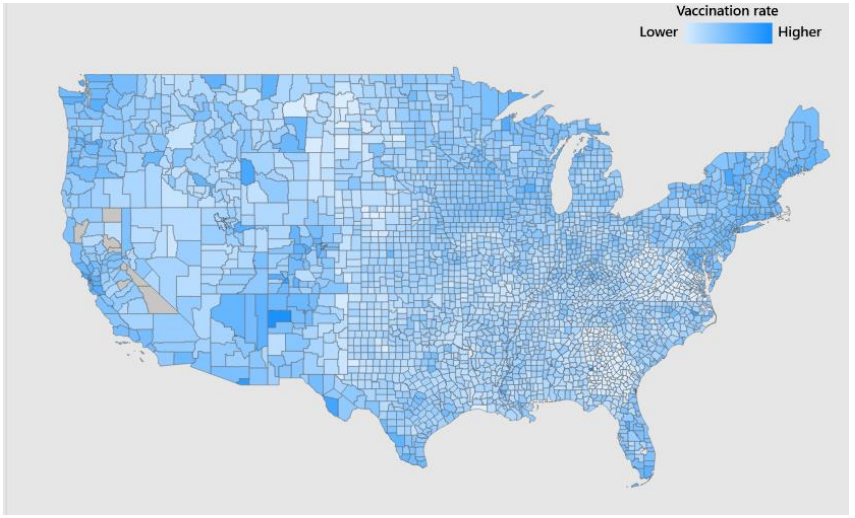
- Upon EUA, COVID-19 vaccinations started appearing in the EHR
  - EHRs include the opportunity to capture vaccines received outside of traditional HCP settings
- Trends could be compared to publicly available sources[1]
- Uptake was not universal or equal
- Vaccine uptake could be evaluated alongside key patient characteristics

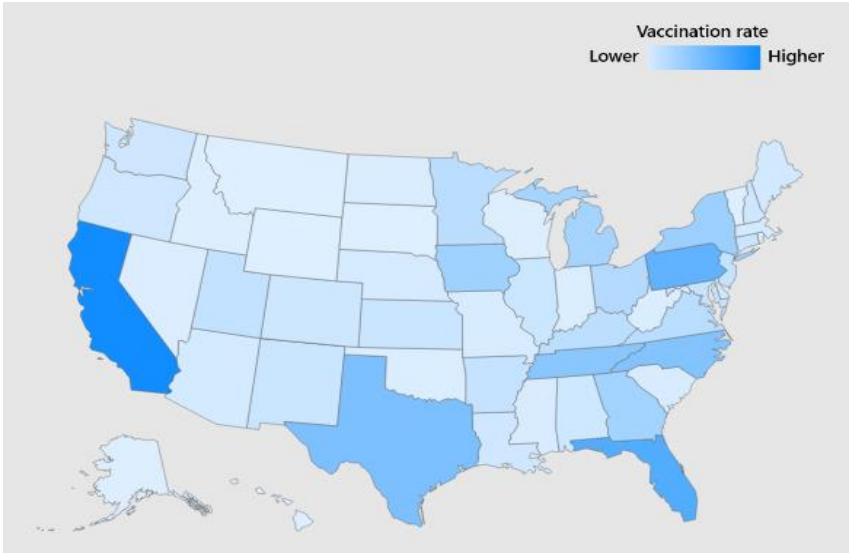


1. Centers for Disease Control and Prevention. COVID data tracker. Trends in number of COVID-19 vaccinations in the US,. Published April 17, 2023. Accessed April 17, 2023. https://covid.cdc.gov/covid-data-tracker/#vaccination-trends

Vaccination Gaps

- Rich patient data found in the EHR could be used to highlight vaccination gaps by patient profiled, in terms of:
  - Age
  - Gender
  - Race/ethnicity
  - Clinical profile
    - Immunocompromised
    - Presence of chronic conditions (e.g., diabetes, cardiovascular disease, respiratory disease, etc.)
- Geographic detail allowed helped focus public health outreach
- Fosters localized insights:
  - Within a zip code, what patient group is least likely to be fully vaccinated?
  - Can we use this to plan focused outreach and education?

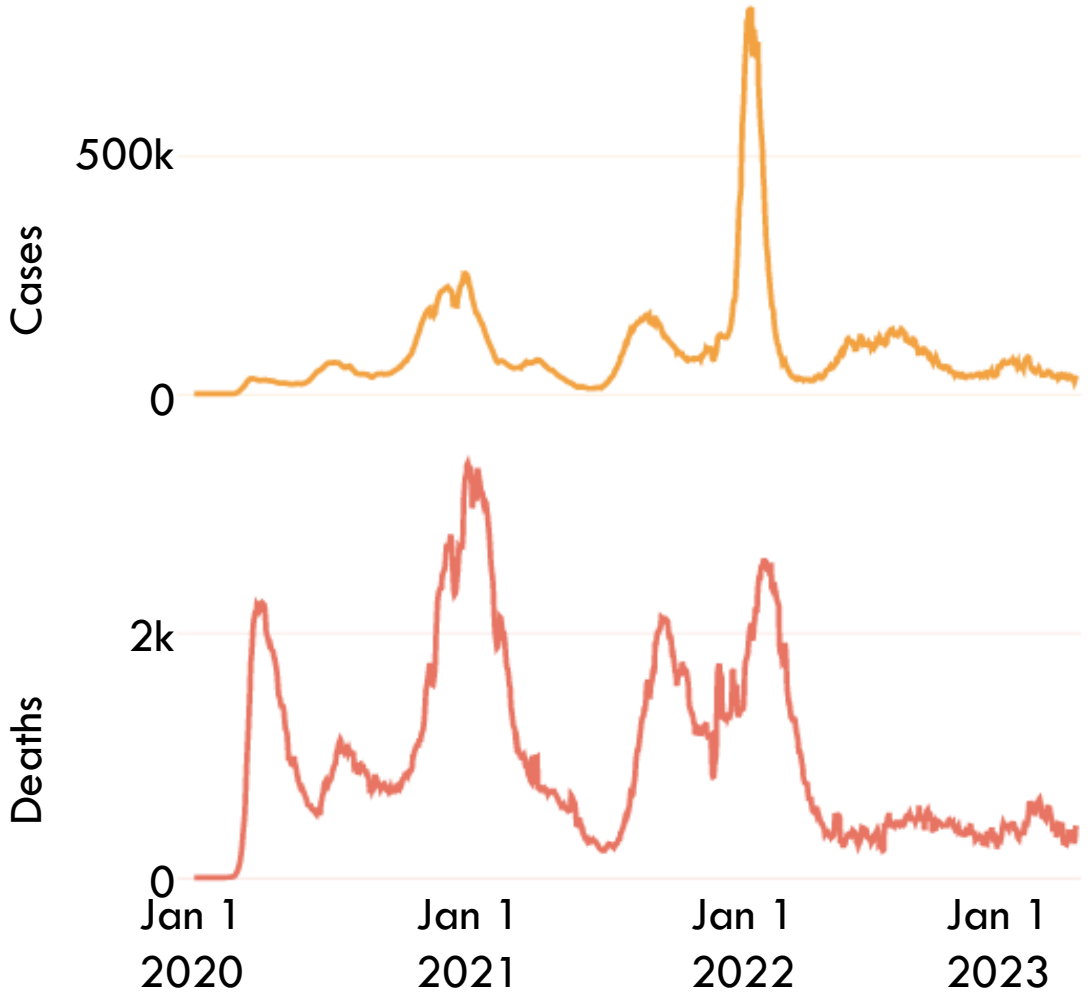




The Variants
(i.e., when COVID became COVIDs)

Incidence Over Time

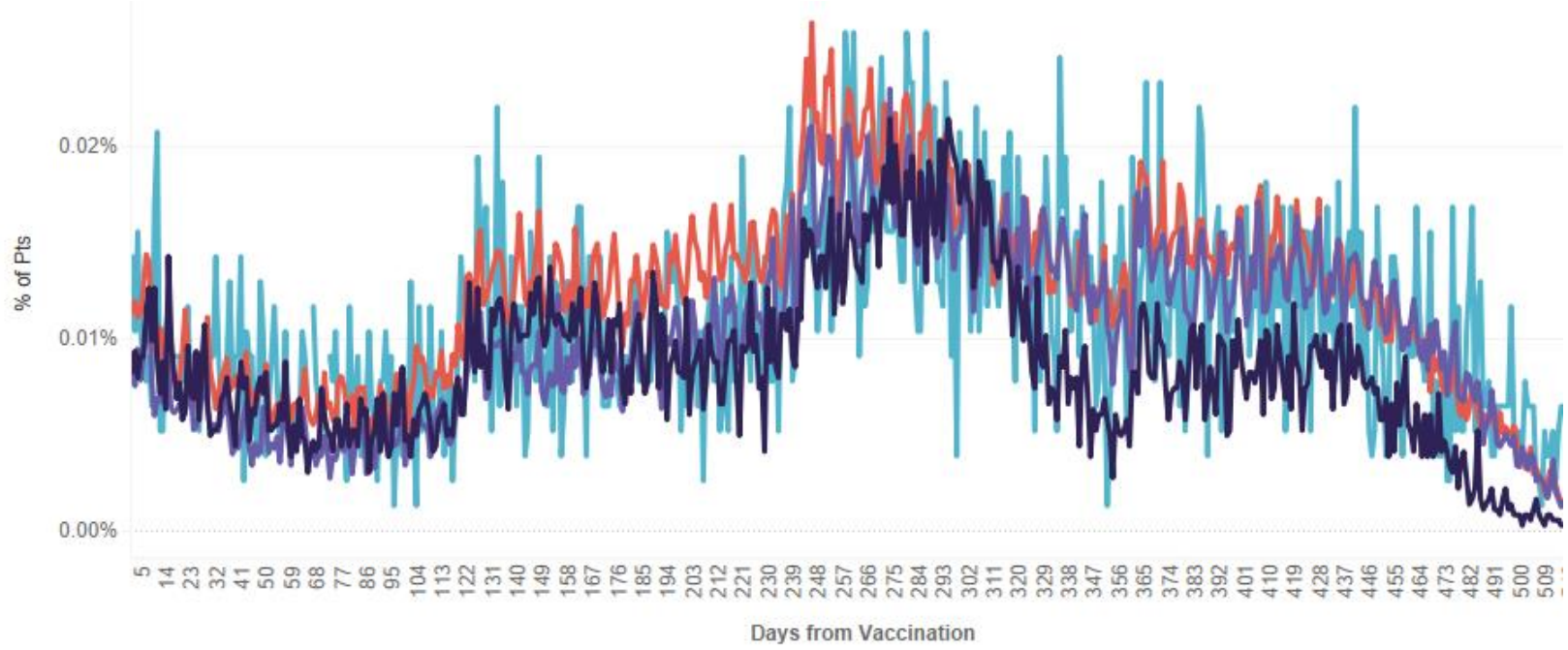
- COVID incidence as captured in the EHR corroborated publicly available reports[1]
  - EHR offered the ability to segment events rates by patient subsets, according to demographic or clinical characteristics
- Peaks and valleys correspond to vaccine and variant arrivals



1 Johns Hopkins University of Medicine. Coronavirus Resource Center: United States Overview [Website]. Accessed March 31, 2023. https://coronavirus.jhu.edu/region/united-states

When COVID became COVIDs

- Variants introduced the need to evaluate not only the rate of infections following vaccination but also:
  - Time since vaccination
  - Timing relative to dominant variant[1]



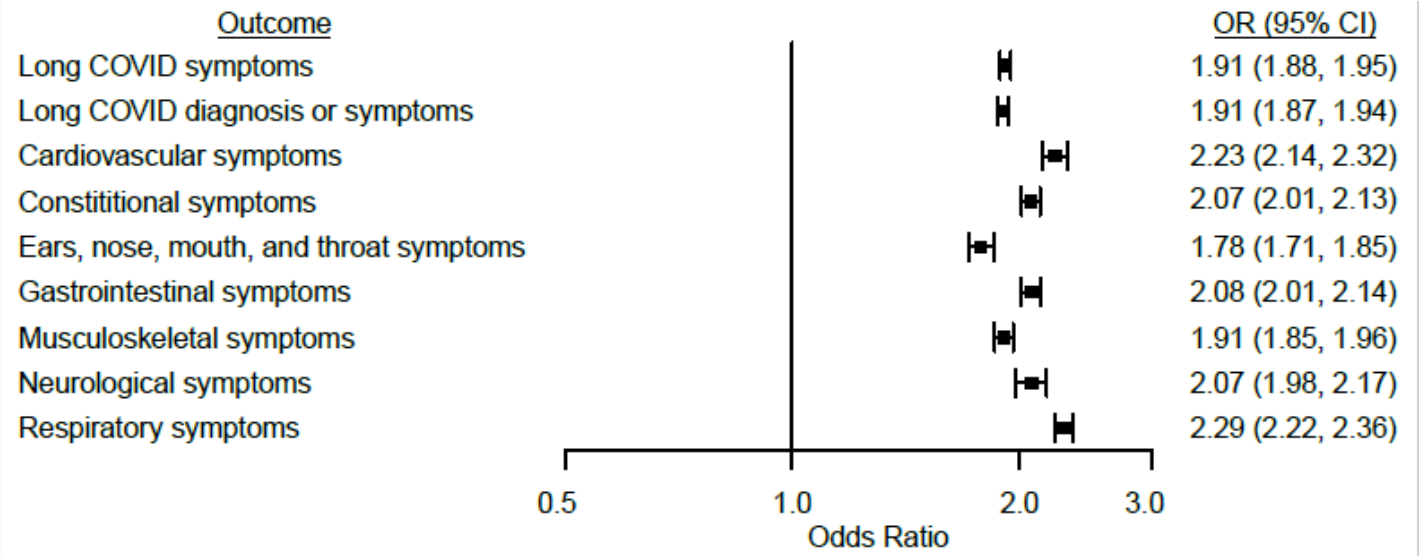
1 Pegu A, O'Connell SE, Schmidt SD, et al. Durability of mRNA-1273 vaccine-induced antibodies against SARS-CoV-2 variants. Science. 2021;373(6561):1372-1377.

Flattening the Next Curve

Flattening the Next Curve: Long COVID

- Estimates on the prevalence of long COVID vary widely, particularly those using symptom-based approaches
- Use of the designated code is low (<2%)
- Burden of long COVID is unknown but potentially large
- Approaches to flatten:
  - Preventing COVID also prevents long COVID
  - Preventing severe COVID reduces risk of long COVID

Compared to matched patients without COVID, patients with COVID were >5x more likely to have a potential COVID-related symptom 12+ weeks after COVID (14.8% vs. 2.9%)[1]



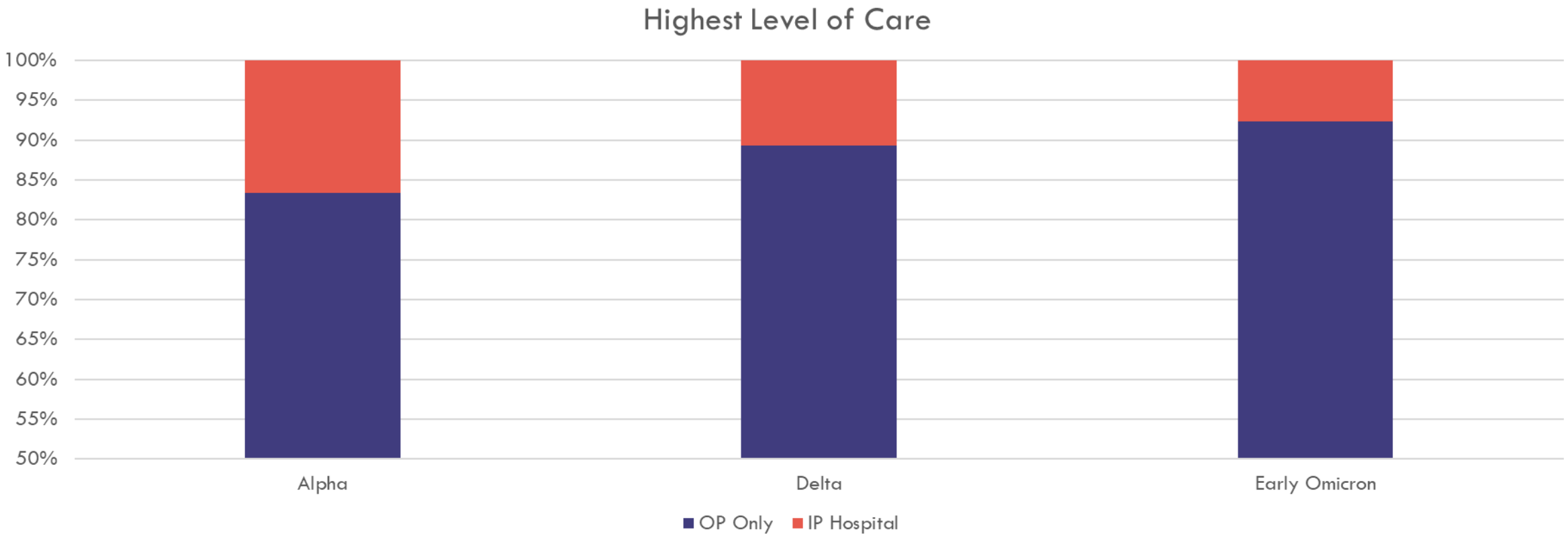
1 Sedgley R, Winer-Jones J, Bonafede M. Long COVID incidence in a large US ambulatory electronic health record system. Am J Epidemiology. doi:10.1093/aje/kwad095 [Online Ahead of Print]

The Changing Profile of COVID

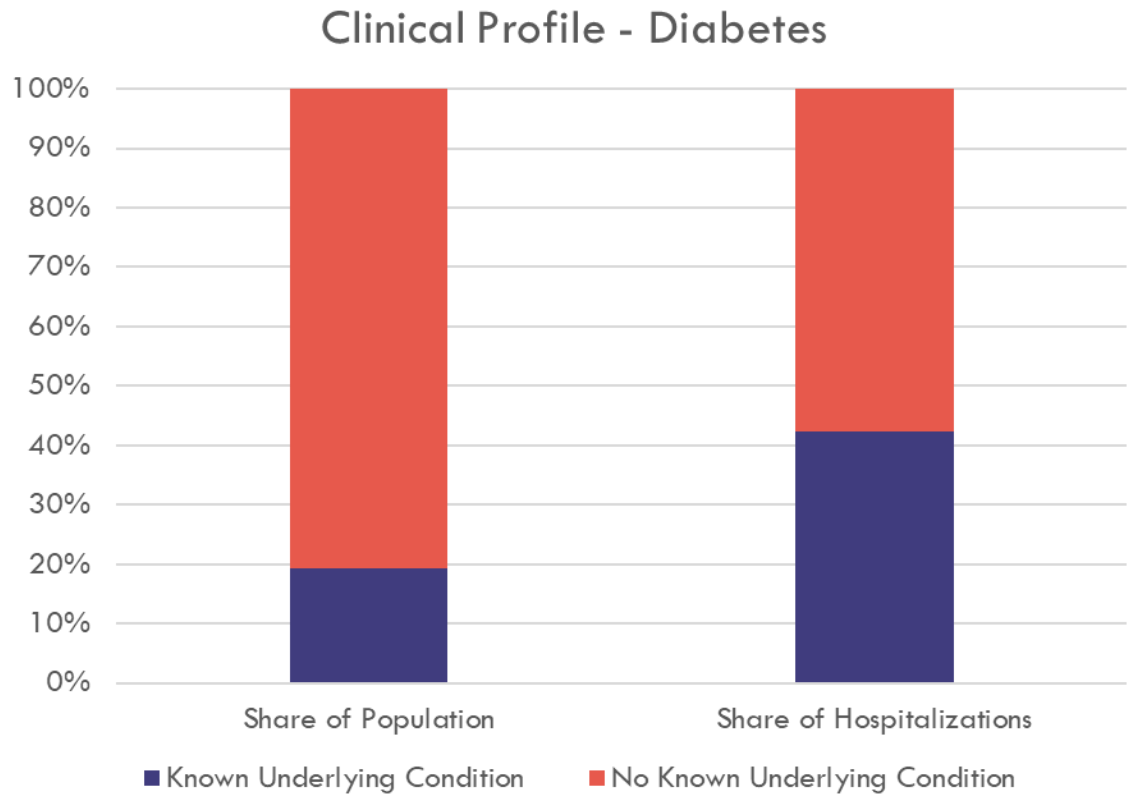
- COVID's profile has changed over the course of the pandemic, terms of:
  - What does a COVID case look like?
  - What does a severe COVID case look like?

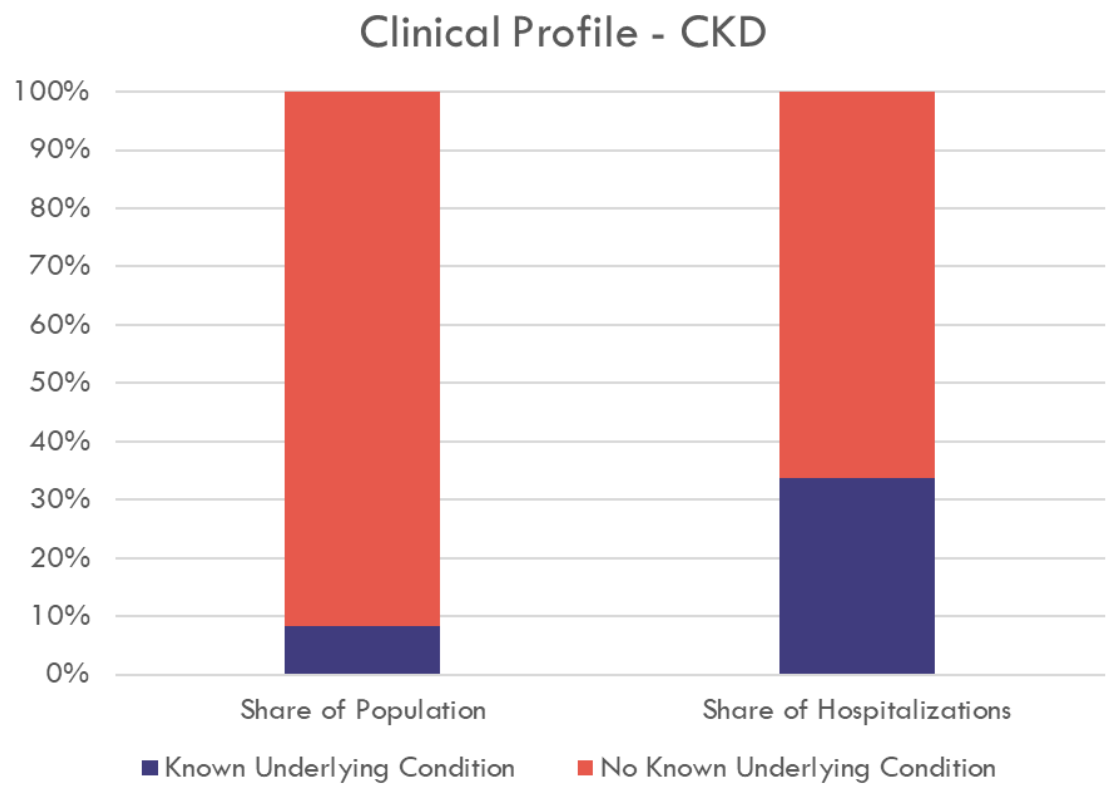
	2020						
	Mar	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**
First Positive PCR							
% with Fever	25.1%	21.6%	19.7%	18.1%	15.2%	14.3%	13.8%
% with Cough	28.3%	27.8%	25.2%	22.9%	19.9%	18.9%	18.4%
% with Additional Symptoms from CDC	22.9%	26.7%	26.6%	27.3%	27.4%	27.5%	27.3%

The Changing Profile of COVID Cases



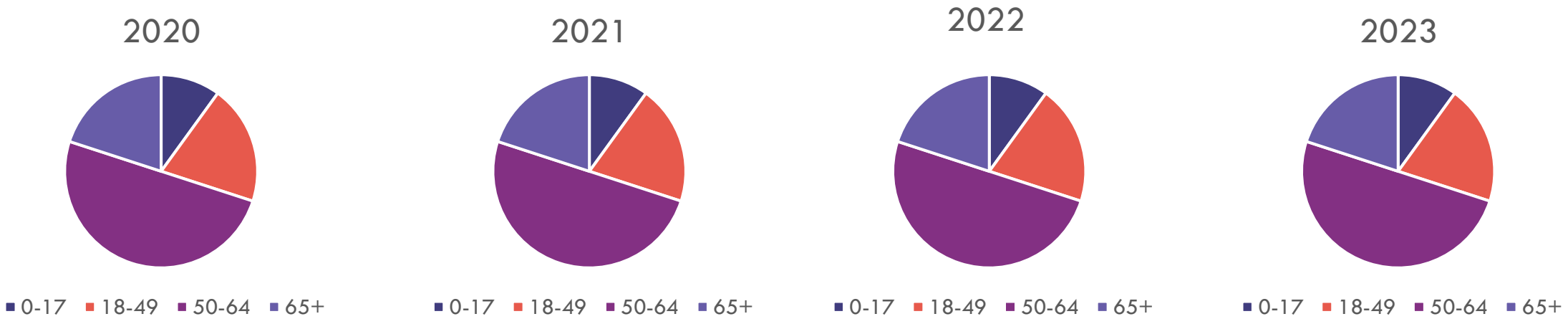
The Changing Profile of COVID Cases

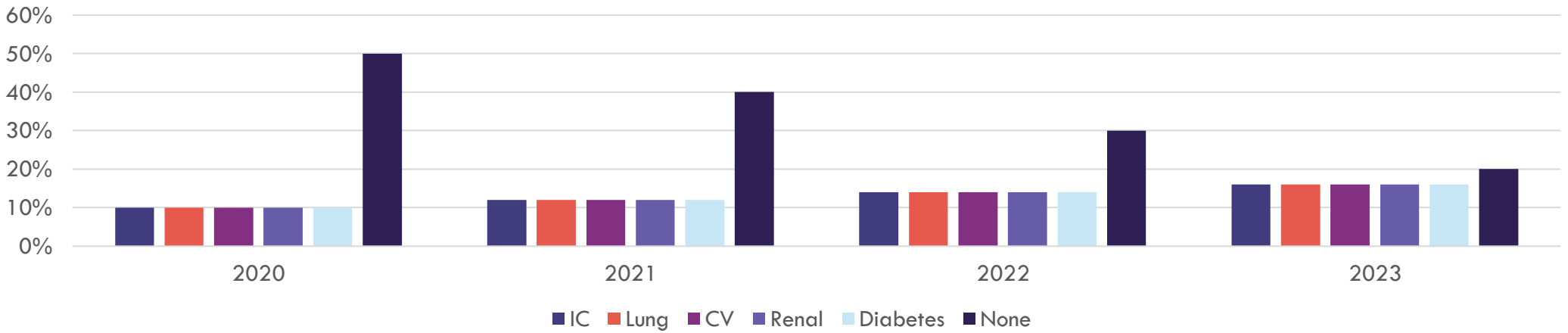




The Changing Profile of COVID Cases

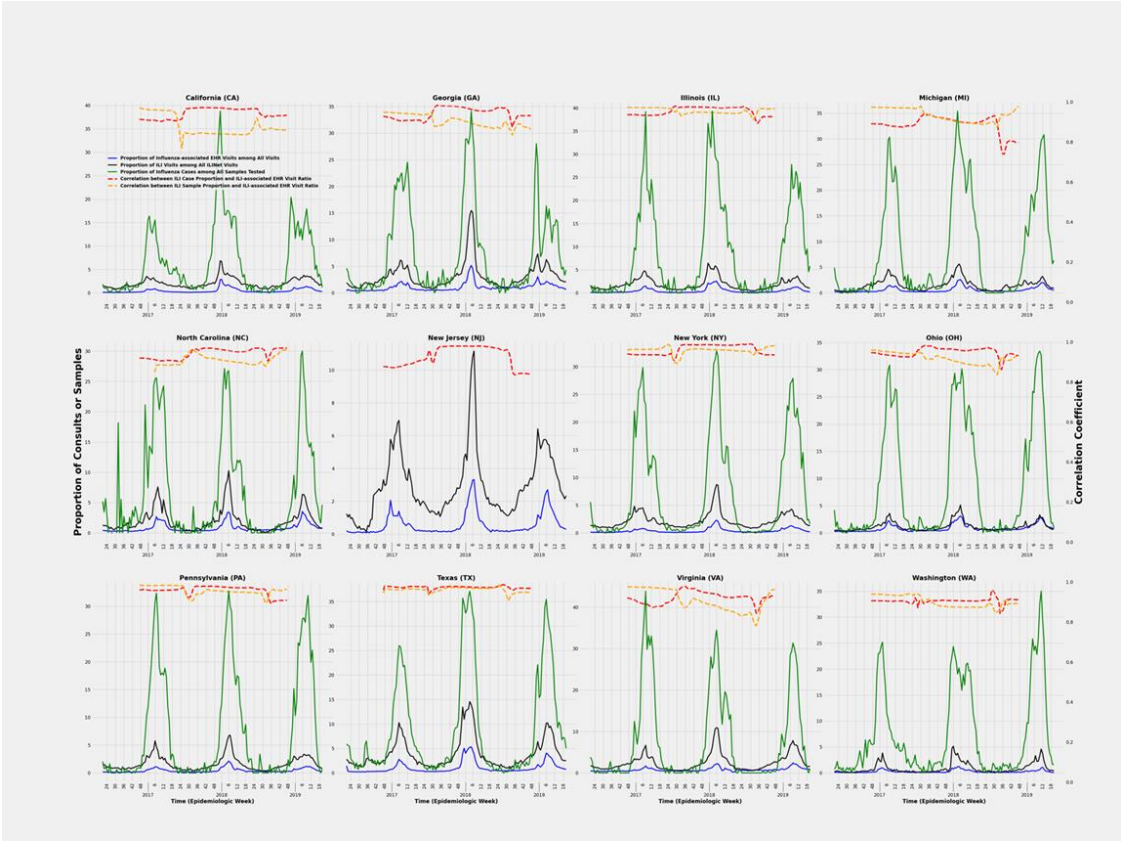
PLACEHOLDER
Data to be Updated





Supporting Surveillance Efforts

- In work with Mitre Health, we overlayed ILINet data with EHR data and found:
  - High but not perfect correlation between sources
    - Can EHR fill in gaps and complement existing data sources?
  - EHR included jurisdictions not found in ILINet
  - Can EHR fill in gaps in ILINet (or other similar sources)
- Leveraging EHR for new surveillance efforts



1 Palekar et al. Examining the Relationship Between Novel Data from Electronic Health Records (EHRs) and Traditional Public Health Surveillance Data for Influenza-like Illness among 12 U.S. Jurisdictions, 2016-2019, Intl J of Infectious Dis, Volume 116, Supp, 2022.

The Future

The Future

- Shortening the clinical and RWE development cycles
  - Maintaining the efficiencies gained
  - Strengthening the collaborations established
- Pressure-testing preparedness activities
  - What can we do now to be ready later?
  - How do we build off what we've done?
- Proactive focused outreach
  - Where are we doing well? Where can we do better?
    - Can we find the next pandemic sooner?
    - Can we test existing therapies faster?
    - Can we develop therapeutics faster?
- Hypothesis-driven RWE

Questions