



# Precision Health Technologies from Medicine to Public Health Impact



Leslie A. Lenert MD, MS, FACP, FACMI  
Associate Vice President for Data Science and Informatics  
Medical University of South Carolina



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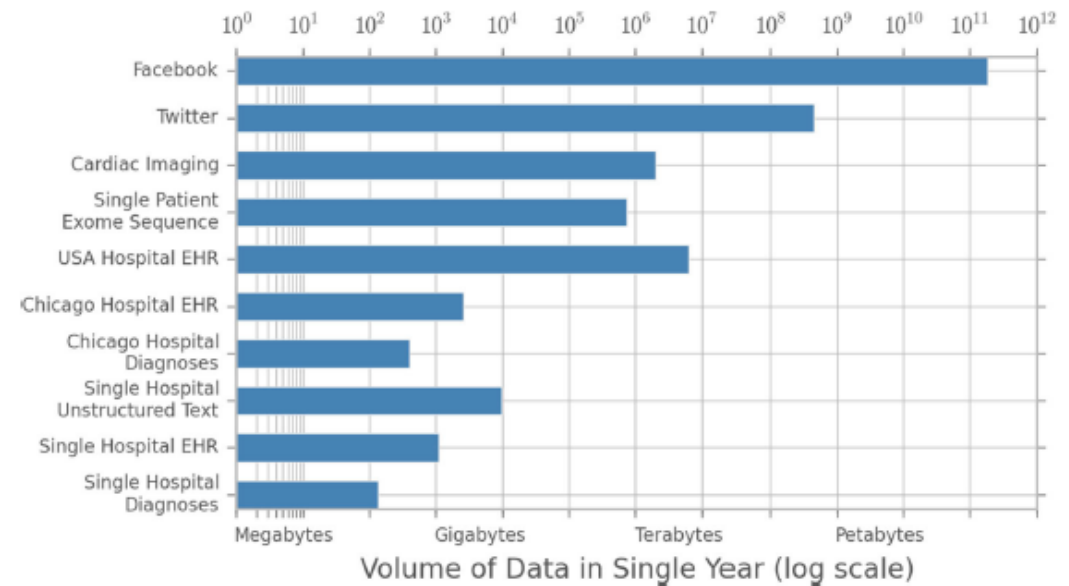
# From Medicine to Public Health Impact: Vision

What if public health had two things:

- *Access to the data* from the health system and analyze it.
- *The ability to influence the health system* to control disease and prevent outbreaks without massive effort?

The health system was 17.2% of the US economy in 2022

The Health System generates hundreds of *billions* terabytes of data a year, growing exponentially.





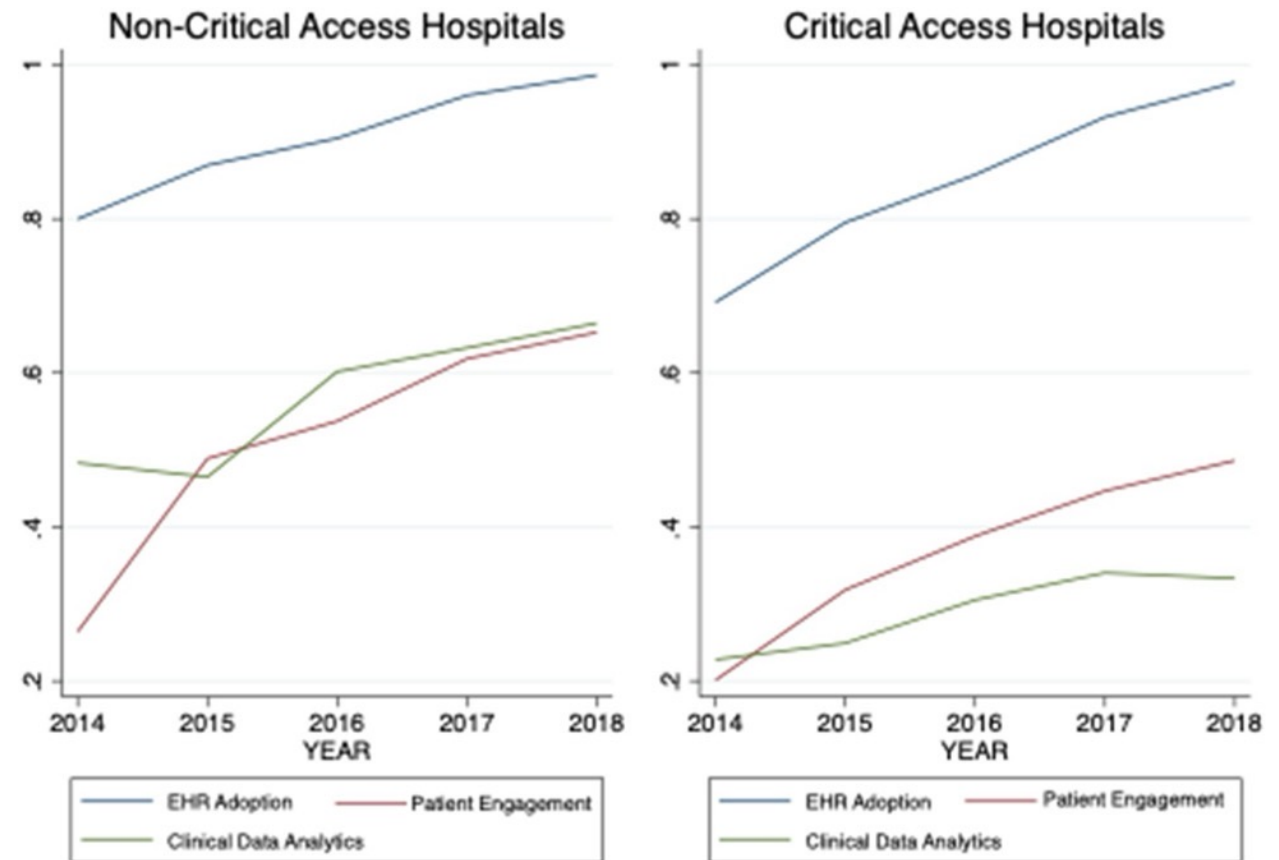
# Learning objectives

- Understand how health policy and interoperability standards have laid a foundation for using data from the health system and mobile devices for precision public health.
- Understand how next generation electronic health records systems (EHRs) will support precision population health surveillance and interventions through automated electronic case reporting (eCR) and advanced decision support systems.
- Understand how EHRs and public health data systems such as immunization registries will support precision population health interventions through bulk data queries.
- Understand how mobile technologies support engagement of consumers in precision public health surveillance and intervention.

*“The future is already here – it's just not evenly distributed.” William Gibson*

# Policy foundations for precision public health

- “Meaningful Use” of electronic medical records (2009)
  - Widespread adoption of EHRs achieved through an incentive program and penalties.
    - Certified technology
  - **Integrated decision support**
  - **Integrated health reporting\***
    - Public health laboratory reporting
    - Immunizations
    - “Syndromic” surveillance
      - (Admission discharge and transfer” feeds from Emergency Departments”



*J Am Med Inform Assoc*, Volume 28, Issue 9, September 2021, Pages 1947–1954, <https://doi.org/10.1093/jamia/ocab102>

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# Decision support in an EHR

The screenshot displays the NoteWriter interface for an Opioid Overdose Note. The left sidebar contains various patient information sections: Chief Complaint (None), ED Vitals (None), ED Notes, ED Triage Notes, ED Provider Notes, ED Current OP Medications (None), Home Medications (None), Allergies (no verify date) (Not on File), and Medical History (No past medical history documented, No pertinent negatives). The main content area is titled "Opioid Overdose Note" and includes a "Pre-Hospital Admission" section with the following fields:

- Was Naloxone given pre-hospital?  Yes  No
- Who administered Naloxone?  EMS  Family/Friend  Unknown  Other
- Route of administration:  Intranasal  Intravenous  Intramuscular
- What prompted pre-hospital Naloxone administration? (Multi-select):
  - Decreased respiratory rate/apnea
  - Pinpoint pupils
  - History of opioid use
  - Finding at scene - suggested of opioid use
  - Unresponsiveness
  - Other
- Response to pre-hospital Naloxone (Multi-select):
  - Increased level of consciousness
  - Increased respiratory rate
  - No response
  - Other
- Additional dose of Naloxone given?  Yes  No

The "Additional Notes" section is currently empty. A blue circle highlights the "What prompted pre-hospital Naloxone administration?" and "Response to pre-hospital Naloxone" sections, with arrows pointing to the "Opioid Pre-Hospital" tab and the "Opioid Overdose Note" title.

**Attestations**

Attestation  
.opiod

**Opioid Clinical Documentation**

**Pre-Hospital Notes**  
Was naloxone given? Yes, it was administered by EMS. The dose given was Intranasal at 4.0 mg. Naloxone given because of Decreased respiratory rate/apnea, Pinpoint pupils and History of opioid use. After administration patient exhibited Increased level of consciousness and Increased respiratory rate. Was an additional dose given? No

**Opioid ED Notes**  
The pt has a rx for opioids and endorses taking fentanyl IM. The pt states a daily use over the course of 3 months. Naloxone was NOT administered in the ED. The chance this event was an overdose is Definite (95% or greater) and it was Unintentional/accidental. Pupil size at arrival to ED was 5-6mm.

**Opioid Treatment Plan**  
A peer recovery specialist was contacted. The patient was referred to Charleston Center. Buprenorphine was given at a dose of 12 mg sublingual. Overdose prevention was discussed. An intranasal naloxone kit was ordered for the pt at discharge.

# Policy foundations II

- 21<sup>st</sup> Century Cures Act (2020, final rule)
  - Access to EHR data by consumers and other providers without special effort
  - Data available in Fast healthcare interoperability Resource standards
  - Penalties for “information blocking” (not supporting access)
  - USCDI standard for semantic content of queries

## Version 2



# What does this mean for public health?

- EHRs can
  - Respond to triggers in the medical record
  - Can communicate with outside systems to return the results of a query
    - In a standard format
    - With the same meaning across systems

## Epic EHR FHIR Resources available for query at a patient level

### Summary of Resources

<b>Account (Premium Billing)</b> Read, Search — R4	<b>Condition (Health Concern)</b> Read, Search — R4	<b>EpisodeOfCare</b> Read, Search — R4	<b>Observation (Newborn Delivery)</b> Read, Search — R4
<b>AdverseEvent</b> Read, Search — R4	<b>Condition (Infection)</b> Read, Search — R4	<b>ExplanationOfBenefit</b> Read, Search — R4	<b>Observation (Obstetric Details)</b> Read, Search — R4 Read, Search — STU3
<b>AllergyIntolerance</b> Read, Search, Create — R4 Read, Search, Create — STU3 Read, Search — DSTU2	<b>Condition (Medical History)</b> Read, Search — R4	<b>FamilyMemberHistory</b> Read, Search — R4 Search — DSTU2	<b>Observation (Obstetrics-Gynecology)</b> Read, Search — R4
<b>Appointment</b> Read, Search, \$book, \$find — STU3	<b>Condition (Problems)</b> Read, Search, Create — R4 Create — STU3 Read, Search — DSTU2 Create — CDS Hooks - R4	<b>Flag (Health Concern)</b> Read, Search — R4 Read, Search — STU3	<b>Observation (Periodontal)</b> Read, Search — R4
<b>Appointment (Appointments)</b> Read, Search — R4	<b>Condition (Reason for Visit)</b> Read, Search — R4	<b>Flag (Infection)</b> Read, Search — R4 Read, Search — STU3	<b>Observation (SmartData Elements)</b> Read, Search — R4
<b>Binary (CCDA Documents)</b> Read — DSTU2	<b>Consent (Code Status)</b> Read, Search — R4 Read, Search — STU3	<b>Flag (Isolation)</b> Read, Search — R4	<b>Observation (Social History)</b> Read, Search — R4 Read, Search, \$lastn — STU3 Read, Search — DSTU2
<b>Binary (Clinical Notes)</b> Read — R4 Read — STU3	<b>Consent (Document)</b> Read, Search — R4 Read, Search — STU3	<b>Flag (Patient FYI)</b> Read, Search — R4 Read, Search, Create, Operation — STU3	<b>Observation (Vitals)</b> Read, Search, Create — R4 Read, Search, Create, Operation — STU3 Read, Search — DSTU2
<b>Binary (Correspondences)</b> Read — R4 Read — STU3	<b>Coverage</b> Read, Search — R4 Read, Search — STU3	<b>Goal (Care Path)</b> Read, Search — R4	<b>Organization</b> Read, Search — R4 Read — STU3
<b>Binary (Document Information)</b> Read — R4	<b>COVID SMART Scheduling Links</b> \$bulk-publish — R4	<b>Goal (Care Plan)</b> Read, Search — R4 Read, Search — STU3	<b>Patient</b> Read, Search, Create, \$match — R4 Read, Search, Create — STU3 Read, Search — DSTU2
<b>Binary (External CDAs)</b> Read — R4	<b>Device</b>	<b>Goal (Pathway Step)</b> Read, Search — R4	



Patient is diagnosed with a reportable condition, such as COVID-19



Healthcare provider enters patient's information into the electronic health record (EHR)



Data in the EHR automatically triggers a case report that is validated and sent to the appropriate public health agencies if it meets reportability criteria



The public health agency receives the case report in real time and a response about reportability is sent back to the provider



State or local health department reaches out to patient for contact tracing, services, or other public health action



[cdc.gov/eCR](https://cdc.gov/eCR)

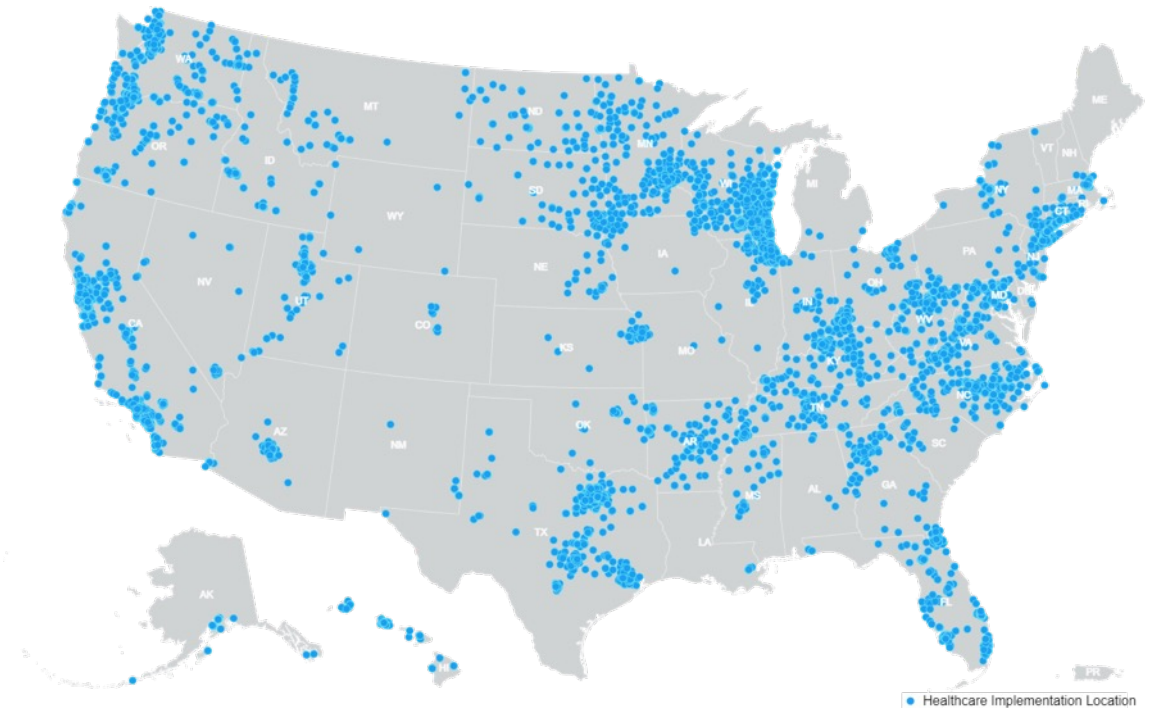




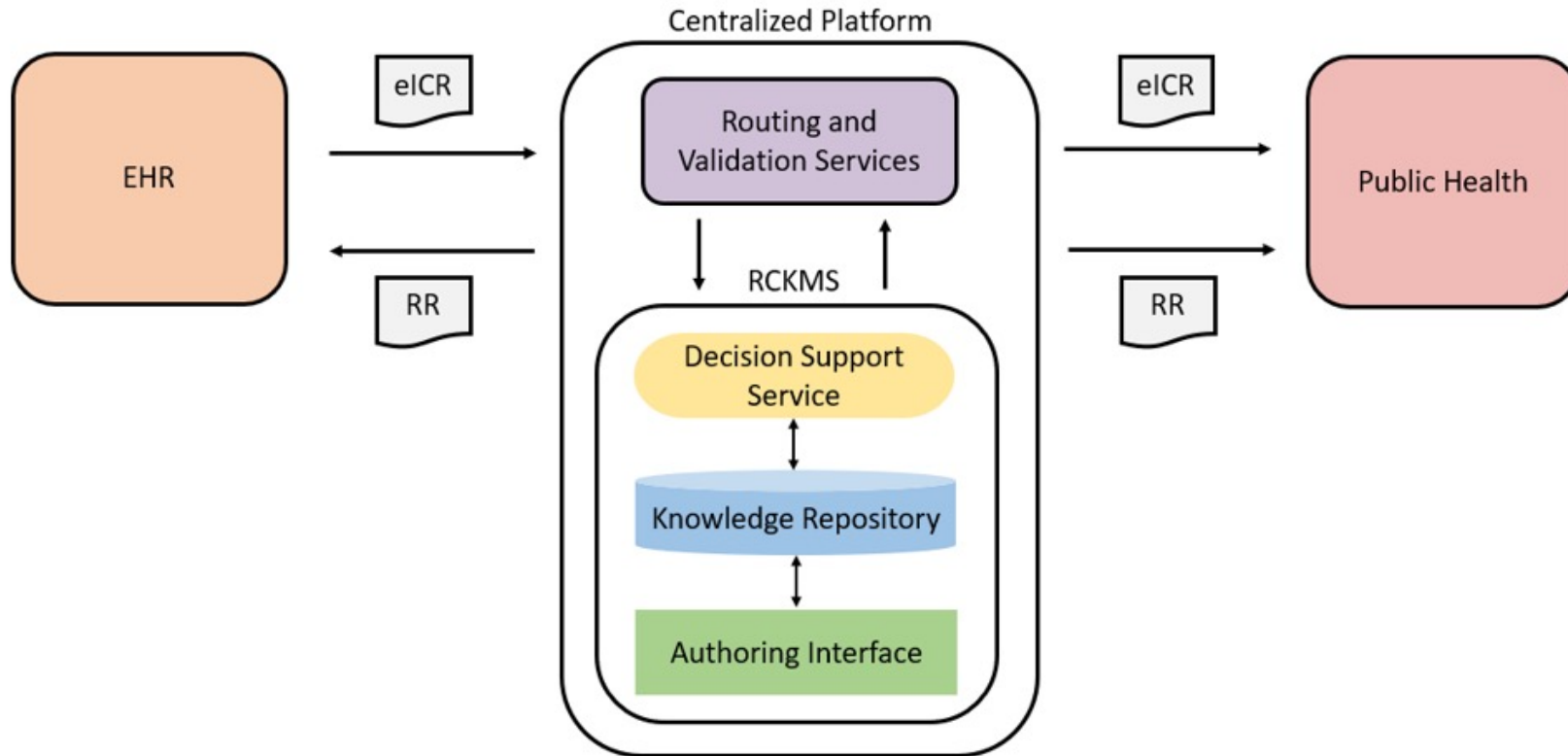
# What does this mean? Precision Public Health!

- A state or jurisdictional public health entity can define (based on reporting laws) a precise clinical event that triggers:
  - Automated collection of existing data from an EHR
  - Automated display of a form requesting additional data
  - Automated transmission of the data in the form to public health
  - In an interpretable standards-based way!

COVID-19 eCR reporting foundational systems



# To a near optimal one: eCR Now Architecture



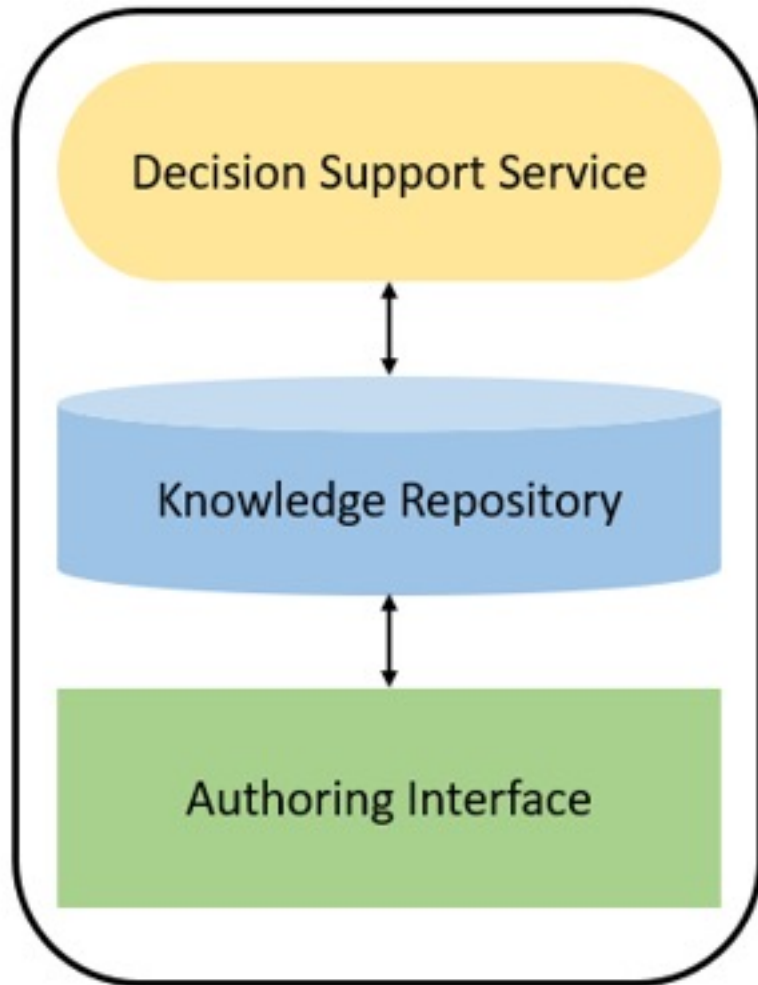
## Assumptions

National high performance cloud infrastructure for public health

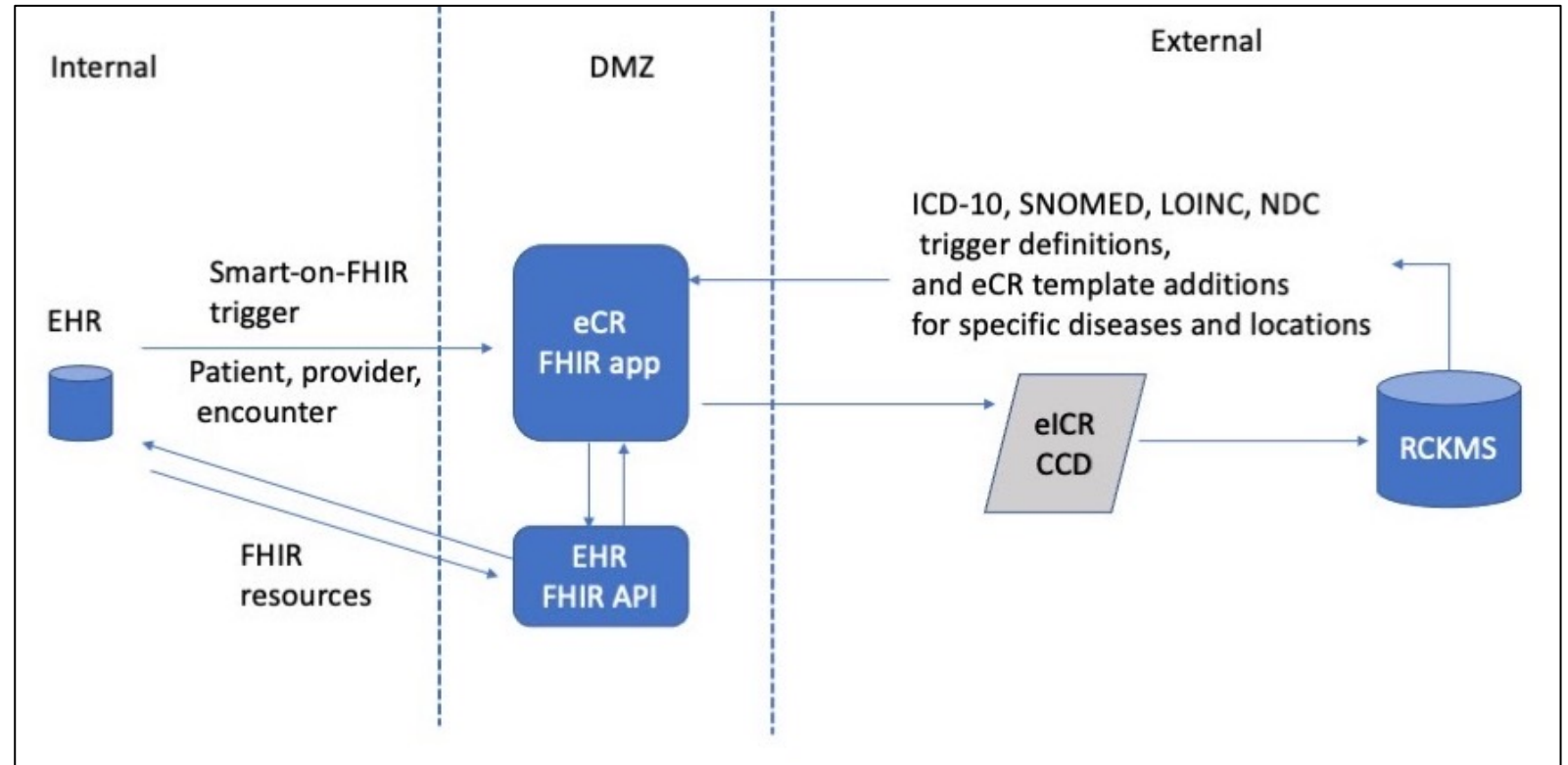
Central case adjudication  
Central case routing

## Rule authoring remotely

RCKMS

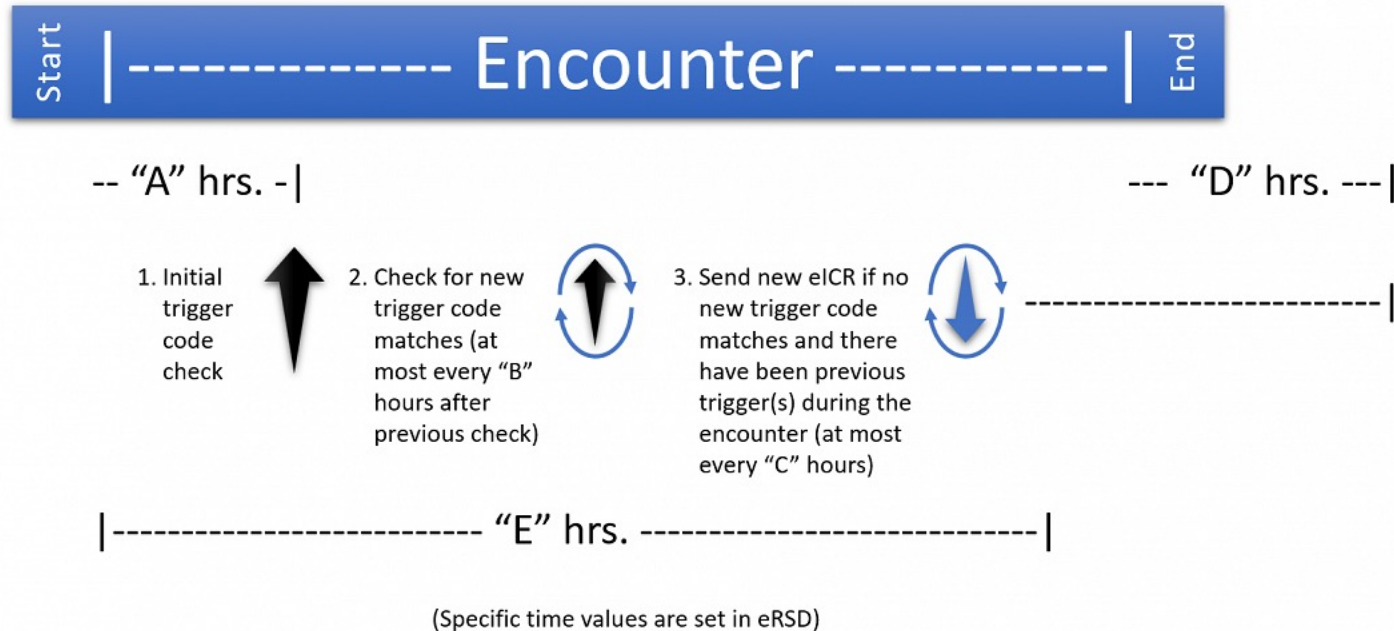


## Rule integration into an EHR



# Caveats and complexities: Single transmission of data doesn't match the evolution of cases in clinical care

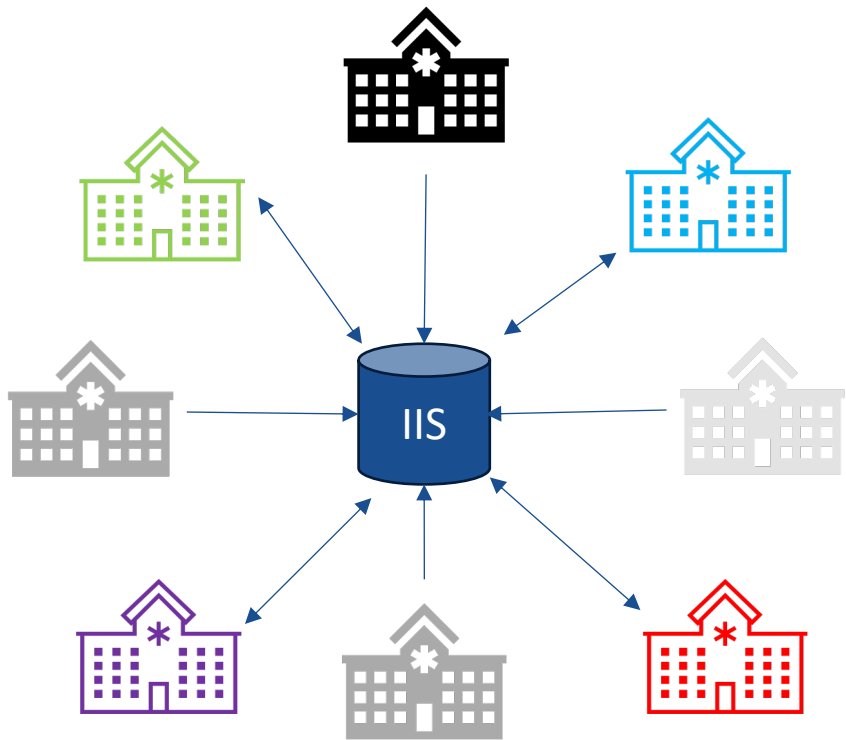
## eICR Triggering and Transmission Timing



Opinion: There are better approaches but this will work well enough if triggering is implemented "natively" in EHRs for performance.

For my view of a more optimal approach see: Mishara, Duke, Karki et al. J Med Internet Res. <https://pubmed.ncbi.nlm.nih.gov/34383669/>

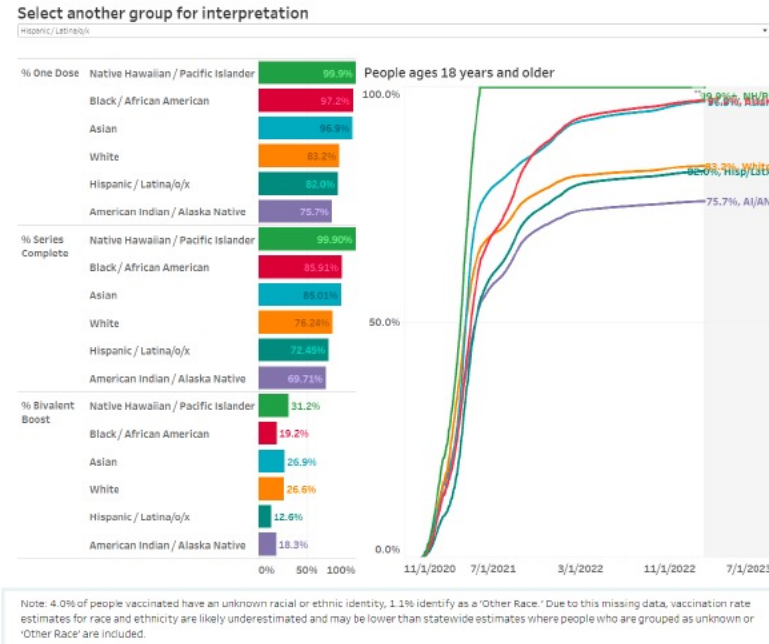
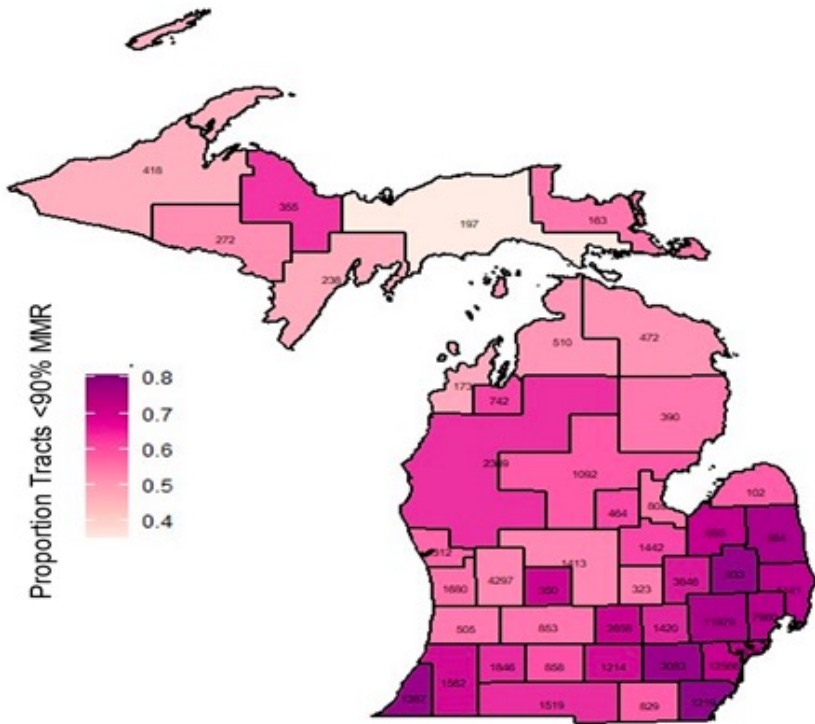
# Immunization Information System (IIS) access for precision population health



One way (reporting only) or two-way connections (patient-level data return)



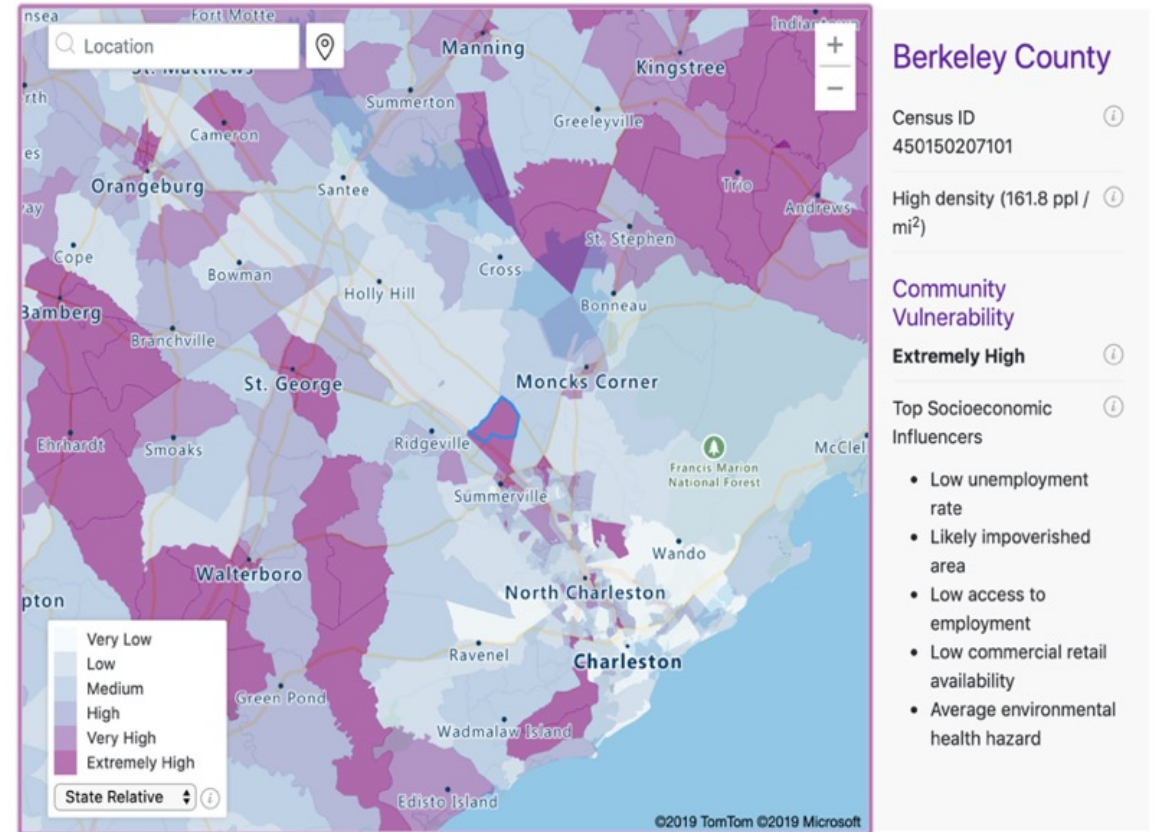
# High level of precision public health via IIS



“targeted identification of vaccination gaps”

# Precision population health outreach

- Define population membership
- Compute risks of members of population
  - Social determinants of health
    - **Geolinked** vs. questionnaires
  - Demographic factors
    - (Often available in IIS systems)
  - Clinical status
    - **EHR data**
- Prioritize
  - Rule of rescue? Health equity?
- Conduct outreach
- Measure outcomes
- Update population membership







To overcome efficiency issues, replicate data in a FHIR server and support asynchronous bulk queries

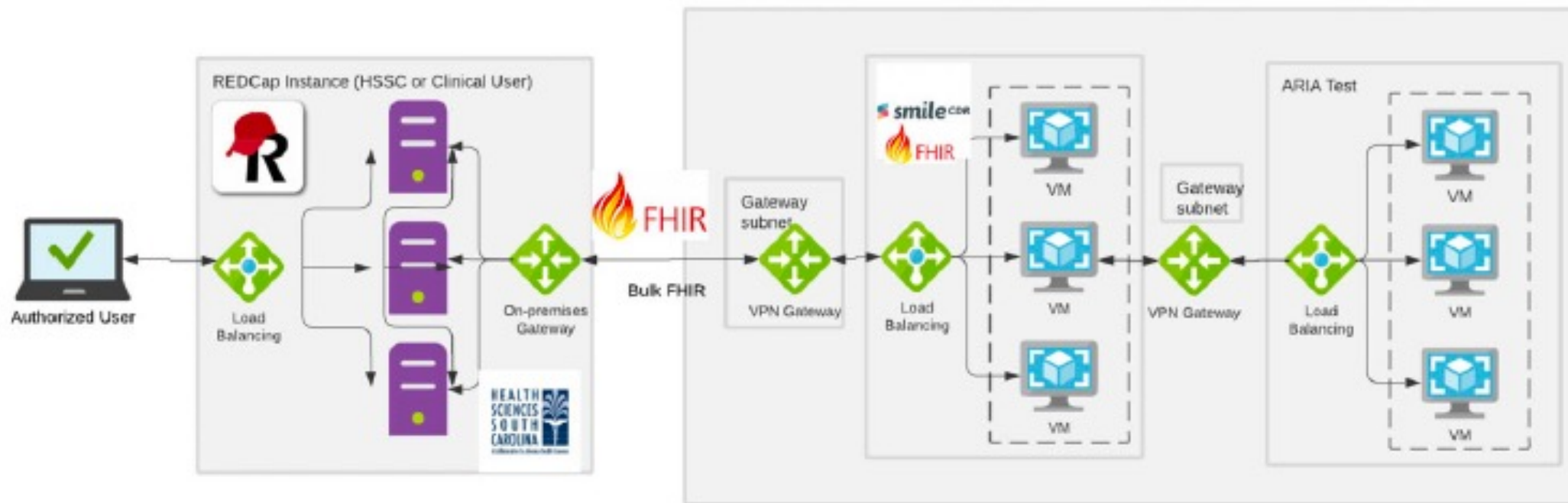


Figure 1. Architecture of VACtrac vaccination tracking tool that combined a FHIR server that replicates IIS vaccination data and a REDCap-based low-footprint population outreach tool.



# CDC initiative for vaccine registry data access using Bulk FHIR

Pages

## Helios FHIR Accelerator for Public Health Home

Created by Joshua Procius, last modified by Forrest White on Jan 06, 2023

### MISSION STATEMENT

The Accelerator is an alliance of Government, Private Sector, and Philanthropic partners that will help to ensure public health needs are at the forefront as the US Core FHIR profiles evolve and rollout nationwide. The Accelerator will focus on extending and adopting existing HL7 specifications in ways that are scalable, adaptable, sustainable, and suitable for public health. Participants in the Accelerator will help to provide the resources and technical support needed for public health practitioners to develop, test, and adopt more efficient, FHIR-based ways of accessing and exchanging data nationwide. Initial support is being provided by CDC and ONC, with ongoing investment from private industry, government, and philanthropic sources. Membership is open to state, tribal, local, territorial and Federal Public Health agencies, private sector partners and other groups interested in the equitable and effective use of data for the advancement of public health. Interested parties are encouraged to email us at [helios@hl7.org](mailto:helios@hl7.org).



Lessons learned from VACTRaC:

1. Expand queries using using master person index
2. Maintain lists of patients for optimal performance
3. Filter responses by vaccine?

## HELIOS PRIORITY AREAS FOR 2022

### Make Data in Public Health Systems Accessible in Bulk



**Ensure authorized users of immunization information systems can access vaccination data in bulk.**

This will help health providers and payers to proactively support their patient populations by addressing gaps in care and preventing redundancies while lowering burden on state public health agencies and on data requestors. Helios members will help create a uniform process for querying immunization data in IIS, leveraging BulkFHIR. Helios members will also assist in developing implementation guidance and open-source code samples, conducting pilots, and participating in Connectathons.



Horseshoe > Everyone > In Our DNA SC

**In Our DNA SC**

Clinical Documentation

Gene Guides

**Contact Us**

MUSC Project Leadership

## In Our DNA SC

### Employee Sign-Up

Enroll Now

MUSC employees are now eligible to participate in the In Our DNA SC community health research project! Please note that you will be taken to MyChart to review, consent, enroll, and schedule your sample collection.

## In Our DNA SC

Inherited: a big, beautiful smile & a tendency for high cholesterol

Sign Up Now Via MyChart

Link in to authenticate  
Via BMIC gateway

MUSC Health  
Medical University of South Carolina

MyChart Username  
lenert

Password

Sign in

Forgot username? Forgot password?

Sign Up Online

Pay as Guest

Guest Estimates

HTML link  
out via BMIC  
gateway

1:00 87%

bmic-consent-s.musc.edu

## In Our DNA SC Consent

Download FAQs Contact Us

### You will need approximately 20 minutes to complete this consent

Research Consent and Authorization  
Helix Research Network

Site Study Title: In Our DNA SC: A Helix Research Network study

Site Principal Investigator: Daniel Judge, MD

Member Site Consent Form

#### Consent and Authorization to Participate in a Research Study

##### Study Summary

We are asking you to consider taking part in a research study being done by Dr. Daniel Judge at The Medical University of South Carolina (MUSC). The first part of this consent form gives you a summary of this study. We will give you more details about the study later in this form. The study team will also explain the study to you and answer any questions you have.

Research studies include only people who choose to take part. It is your choice whether or not you want to take part in this study. Please take your time to make a decision about participating. You can discuss your decision with your family, friends, and health care team.

**Purpose of the study:** The researchers want to study DNA and its connection to your health. DNA is in your blood, your saliva, and other tissues in your body. DNA is the unique instructions you are born with that tell your body how to work. By looking at DNA, you can learn information about your health, certain traits, and even your ancestral roots. DNA is also called your genetic information. DNA is mostly the same from person to person, but there are slight differences. Some of these differences may be important. We are still learning how DNA impacts health. The study will look at the DNA of many different people from many different backgrounds and combine it with information from their health records. The study's primary goal is to understand how learning about DNA can help improve health care for individuals, families, and the communities.

This study is part of a research network. This means that information and samples collected as part of this study will be entered into a database and will be used by approved researchers to perform many studies over time.

**Study Procedures:** If you choose to be in this study, you will provide a sample for DNA sequencing. Sequencing is the process of reading the letters of your DNA. This study may sequence your whole genome. We provide more information about what "whole genome" means later in this consent form. Once you have given us your sample, your participation will not take a lot of your time. The research team will collect health information about you from your medical record and may ask you questions about your health using surveys or other data collection tools. Over time, you may be asked to provide additional samples for research. There is no planned end date for this study. If you choose to enroll, you will be part of this study until you withdraw or until the study ends.

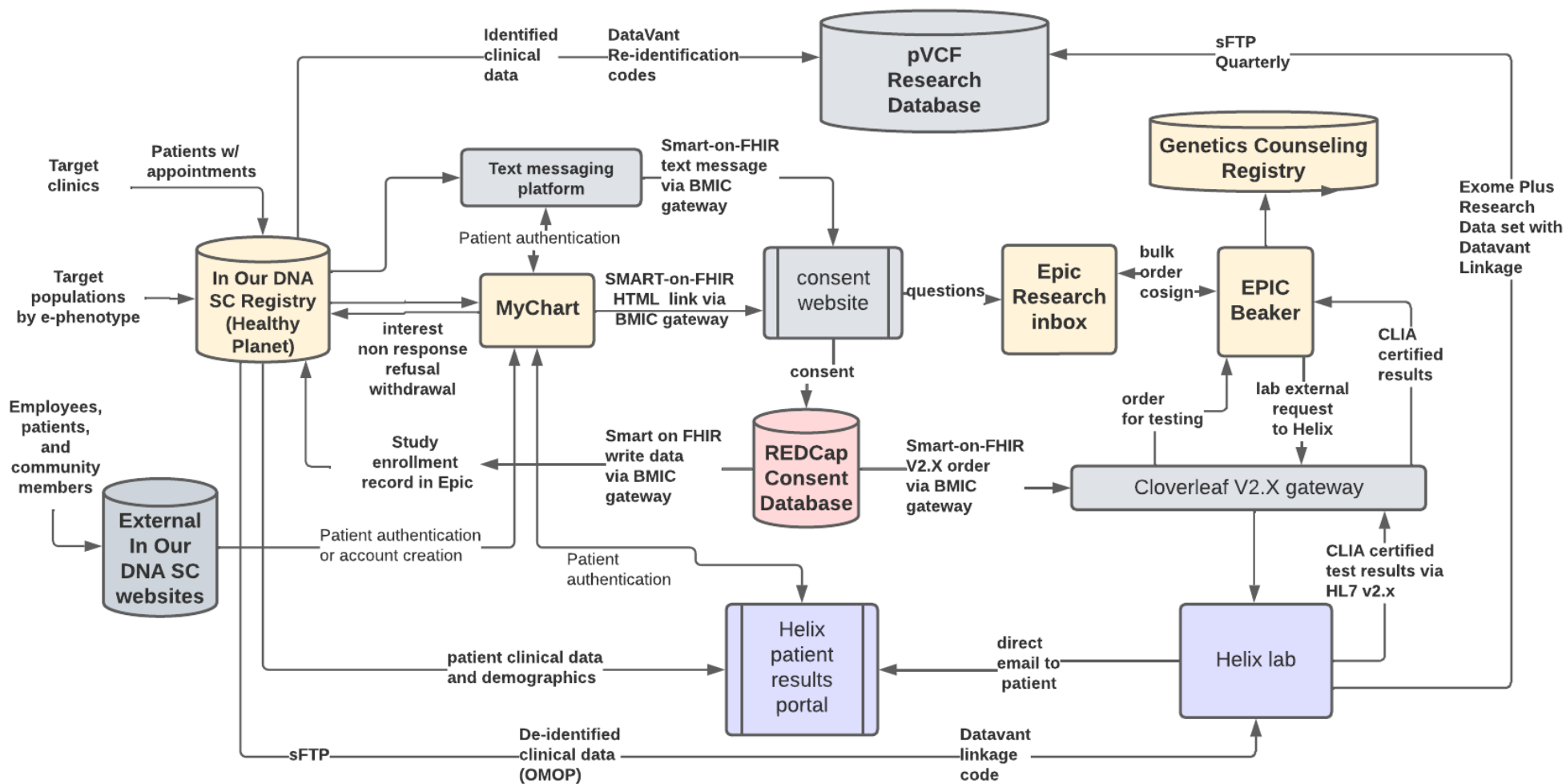
Version 3, 02/17/2022

E&I Review Services  
IRB Study #21143  
02/18/2022

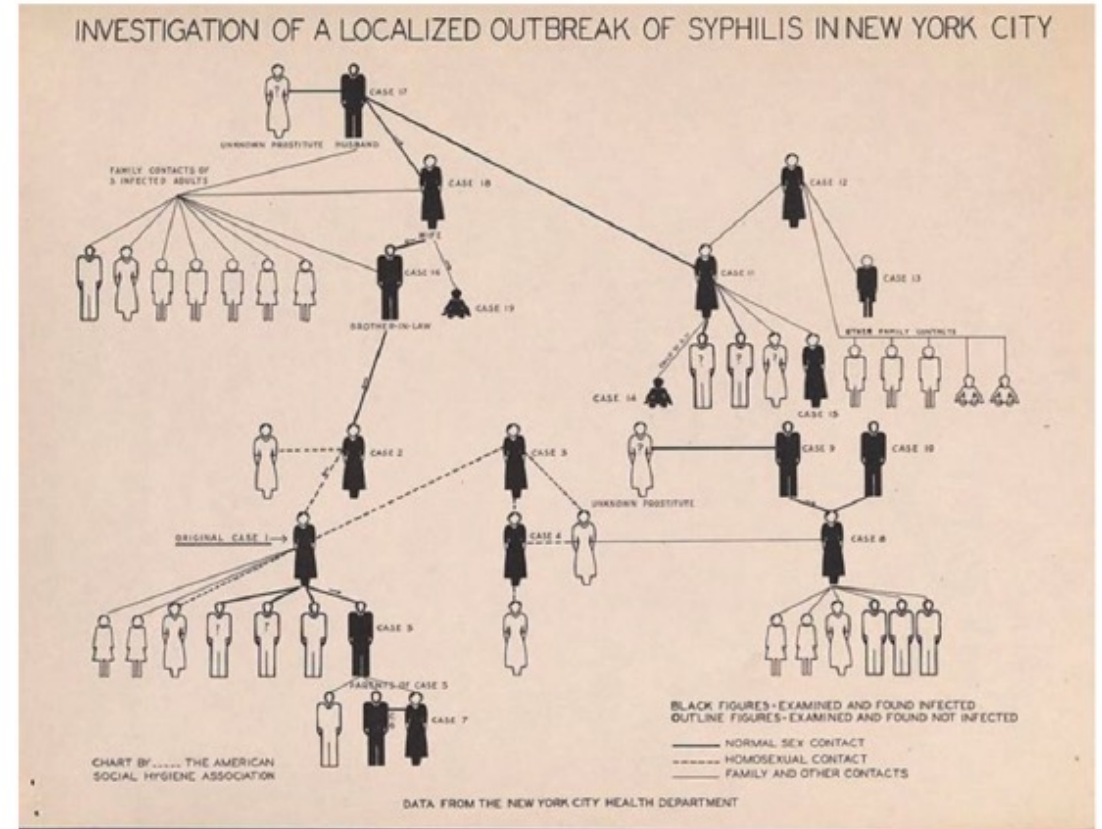
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Research Consent and Authorization  
Helix Research Network

# Flexible Architecture to Target Populations by Clinic, e-Phenotype, Race and Ethnicity: Integration with Notable




# Mobile technologies and precision public health: Electronic contact tracing/exposure notification

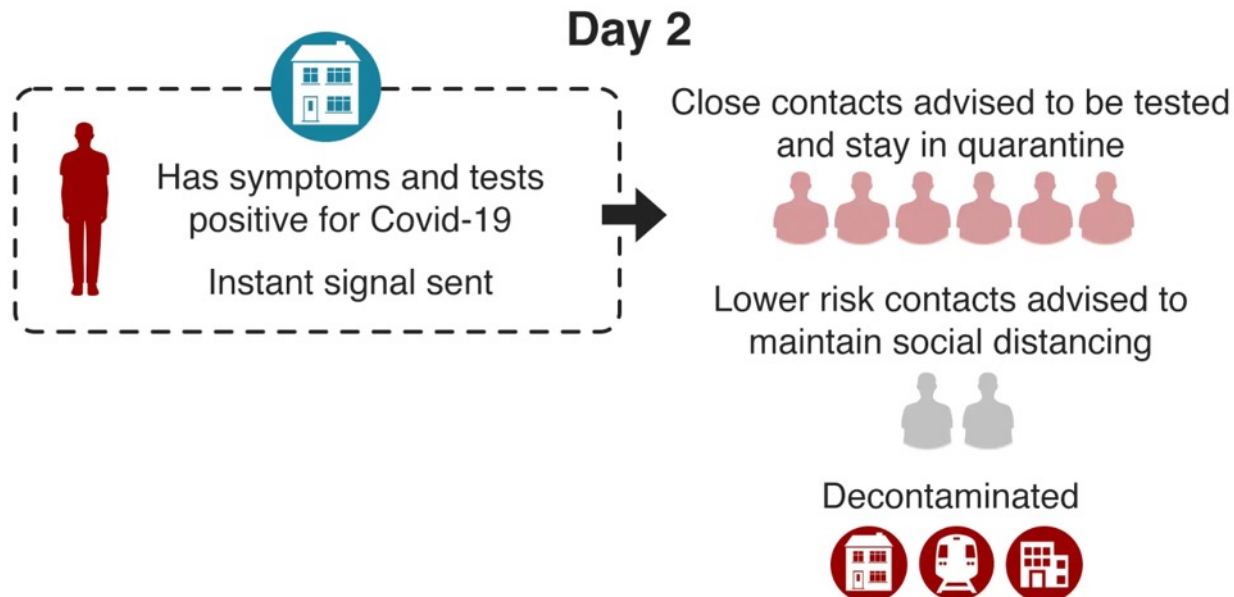
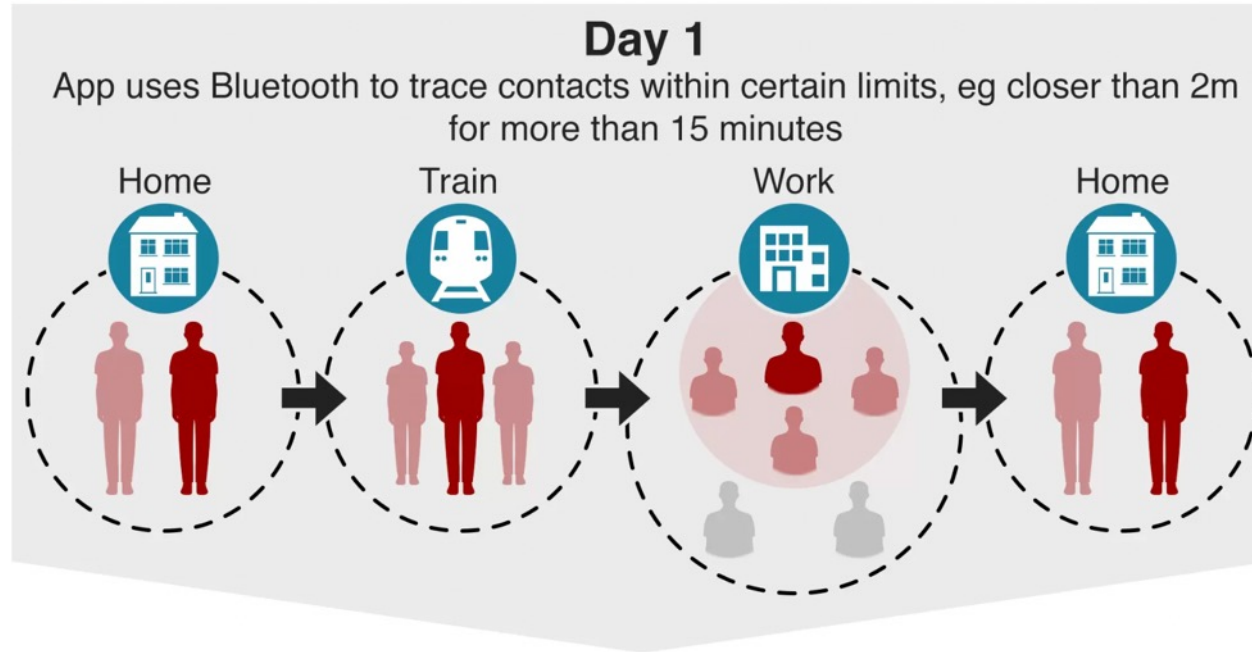




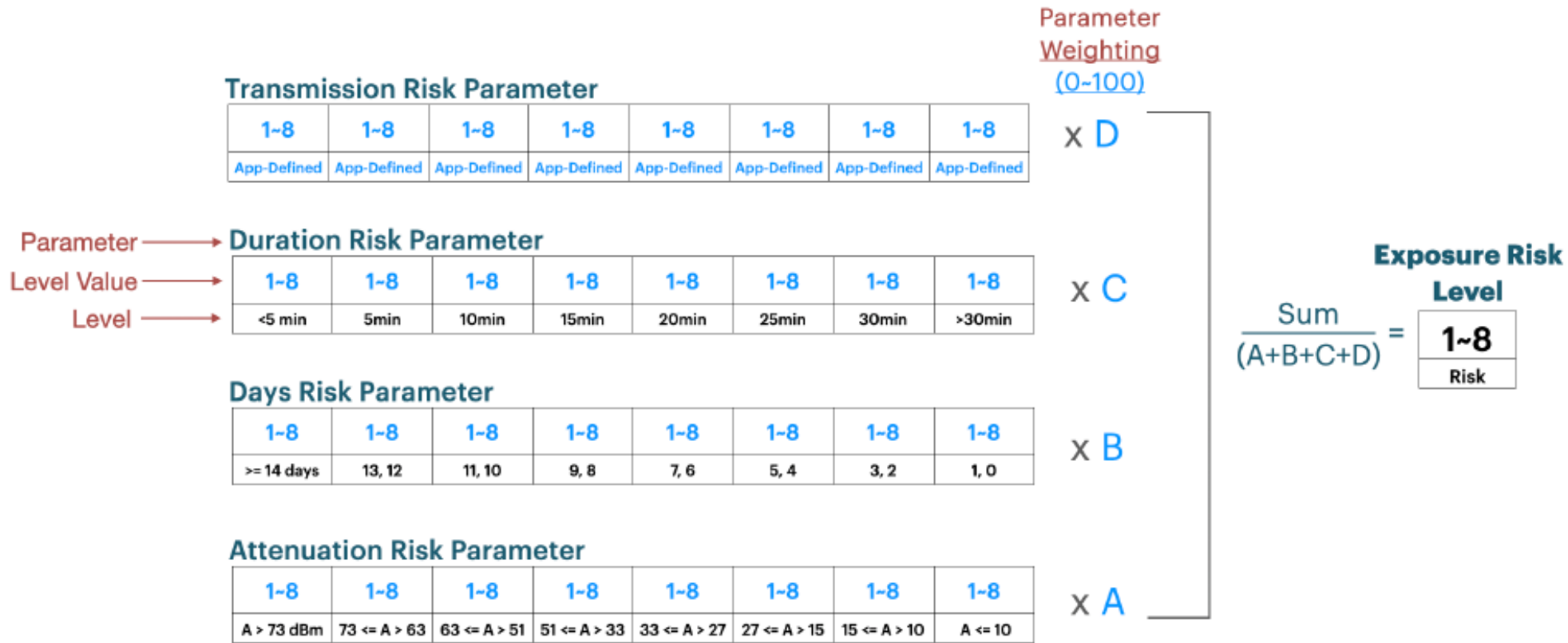
# Conceptual model of exposure notification

## How the app would track coronavirus contacts

 Has Covid-19, but is unaware as has no symptoms



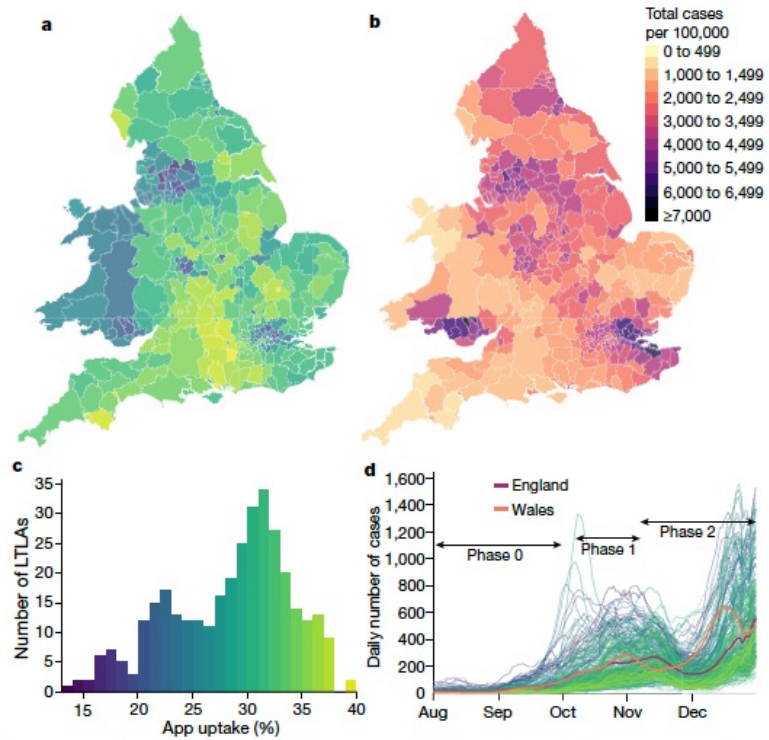
# Algorithm for *secure, anonymous*, risk assessment of COVID-19 exposure: lost opportunity?



Blue = app-defined value

# UK experience

- 34 million smartphones
- 21 million installations
- 16.5 million active users
- 72% consent to notification w/ positive test
- 4.2 notifications per positive test
- 284K cases avoided
- 4K deaths



**Fig. 1 | Geographical variability of app uptake and cases of COVID-19.** a, c, Map (a) and histogram (c) of app uptake by LTLA. Colours in a indicate app uptake as shown in c. b, Cumulative cases of COVID-19 per 100,000 population over analysis phases 1 and 2. d, Seven-day rolling mean of daily cases of COVID-19 per 100,000 population. Each line represents an LTLA, coloured by app uptake as shown in c. Values for England and Wales are also shown. Black horizontal arrows indicate our analysis phases. In b, d, case numbers are for the whole LTLA population, not just app users.

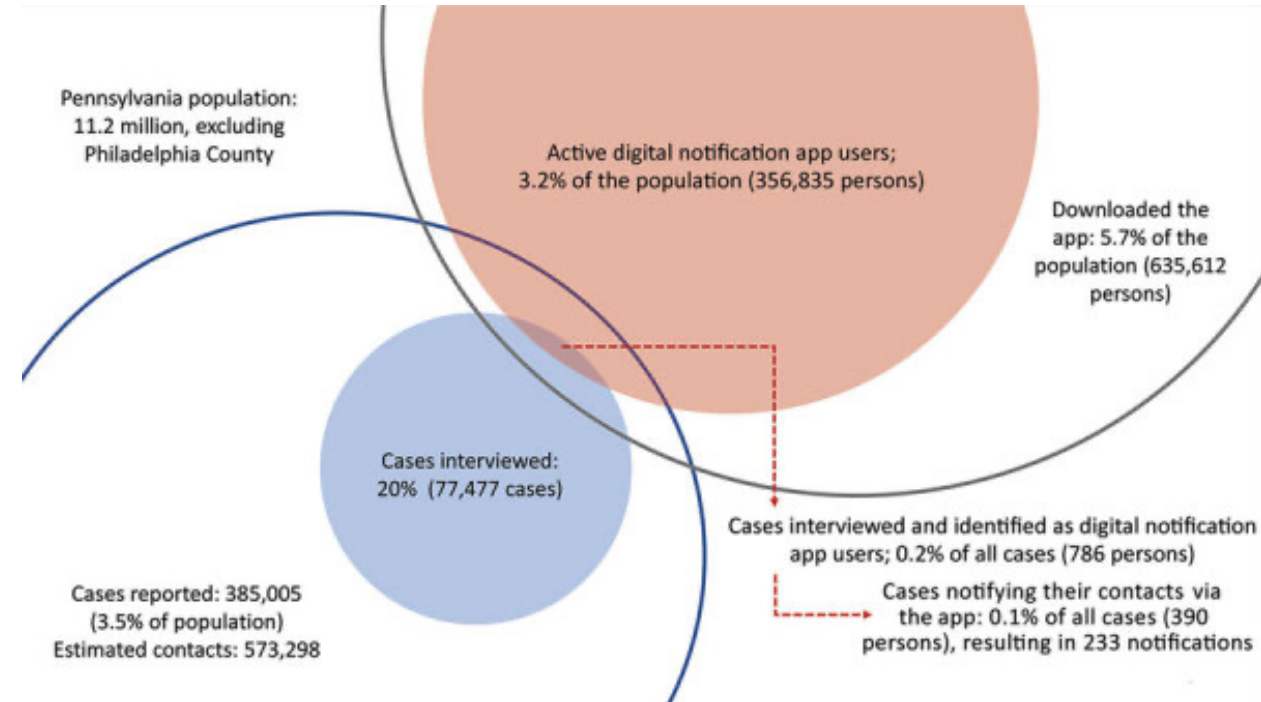
**Table 1 | The estimated effect of the NHS COVID-19 app**

SAR among individuals notified by the app	6%	
Cases and deaths averted in phases 1 and 2:	Cases	Deaths
From modelling of digital tracing	284,000 (108,000–450,000)	4,200 (1,600–6,600)
From matched-neighbours regression	594,000 (317,000–914,000)	8,700 (4,700–13,500)



# What limited success in the USA?

- Low rates of adoption due to politicization of COVID-19 and privacy concerns
- Bluetooth algorithm imprecision
- Google and Apple proprietary concerns and implementation controls
- Slow test result return
- Slow issuing of keys (independent from return of clinical results)
- Low rates of sharing positive results



# Reality check

- Limits due to
  - Policy: Unwillingness to set aside HIPAA privacy regulations for clinical data
    - Voluntary requirement for sharing exposures
  - Focus: no collaboration with the health system on population efforts
    - Delivery of results paired to GAEN use
  - Design:
    - Response to testing was not integrated into applications
    - Unable to modify what definition of exposure was or actions needed as pandemic evolved

## Perspective

### **Balancing health privacy, health information exchange, and research in the context of the COVID-19 pandemic**

**Leslie Lenert<sup>1</sup> and Brooke Yeager McSwain<sup>2</sup>**

<sup>1</sup>Center for Biomedical Informatics, Medical University of South Carolina, Charleston, South Carolina, USA and <sup>2</sup>South Carolina Childrens' Telehealth Collaborative, South Carolina, USA

Corresponding Author: Leslie Lenert, MD, MS, FACP, FACMI, Data Science and Informatics, Medical University of South Carolina, 135 Cannon Street, Suite 405J, Charleston, SC 29425, USA; lenert@musc.edu

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# Summary and conclusions

- Precision public health is possible
  - Requires a strong policy foundation (Meaningful use, 21<sup>st</sup> Century Cures Act, and maintenance of certification approaches)
  - Collaborative view that integrates existing health system infrastructure into public health operations
    - EHR technologies
    - Standards
    - Population health outreach efforts
    - Public health supports sometimes rather than leading
  - End-to-end design that includes the health system as a partner to achieve desired outcomes