Innovation and Partnership: COVID-19 Exposure Notifications in Washington State

Washington State Department of Health

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Executive Summary

During the COVID-19 pandemic, public health agencies had to rapidly develop and adapt systems and tools to slow the spread of disease and communicate updated guidance to the public. Washington state, in partnership with the University of Washington, Apple, Google, the Brotman Baty Institute, Microsoft and Microsoft Research, MITRE, Amazon Web Services, the Association of Public Health Laboratories, the Internet Security Research Group, the National Institutes of Health, and the Linux Foundation, collaborated to implement "WA Notify," a novel, opt-in, privacy-preserving exposure notification (EN) system using Bluetooth on smartphones to alert users of anonymous COVID-19 exposures. Washington state has led EN development and use. It was the second state to implement EN, has one of the highest rates of adoption among U.S. states, and has developed and shared innovative analytic infrastructure and modeling techniques. Washington state leads a multi-state community of practice and is committed to strengthening the public-private-academic partnerships that have made EN so successful. Continued adoption and use of WA Notify has resulted in increased timeliness of exposure notifications, expanded access to underserved populations, and new estimates of significant numbers of COVID-19 cases averted due to WA Notify. These demonstrate the program's effectiveness in slowing

the spread of COVID-19 and providing equitable and accessible health guidance to the public.

Define the Public Health Problem

To mitigate disease outbreaks, an essential service of public health, both infected individuals and their contacts need to be aware of their individual risk and counseled on appropriate actions. Traditionally this has been done through notifiable condition reporting, contact tracing, and case investigation. However, there are several important limitations to contact tracing, including the inability to handle surges in case volumes, the inability to identify unknown contacts, and an unwillingness to respond to public health outreach. As the scope and severity of the COVID-19 pandemic rapidly became evident, these issues became critical. EN technology offered a way to capitalize on the facts that the disease spread through proximity, smart phones are ubiquitous worldwide, and there were established methods in the security community on ensuring anonymity. Within months there were a handful of disparate efforts to create "digital contract tracing," which emerged as a new tool to support public health's pandemic response.

Exposure notification (EN) is an interoperable, anonymous, digital contact tracing tool, supported on both Apple and Google smartphones, created to complement traditional contract tracing processes. EN uses Bluetooth Low Energy technology to alert users of exposures based on detected proximity and duration to individuals who subsequently and anonymously share their COVID-19 infection status.

Washington state sees EN as an innovative and effective way to assist the Department Of Health's (DOH) efforts to limit the spread of COVID-19 by facilitating exposure notification distribution and public health recommendations for protective behaviors. The primary goals for EN in Washington state were to provide:
> 1) A supplemental or complementary pathway for public health to notify individuals of their possible exposure to someone who has tested positive for COVID-19 while simultaneously preserving the message recipient's privacy, data safety, and anonymity; and
> 2) Rapid, individualized, dissemination of public health guidance regarding protective behaviors, including instructions to self-isolate and get tested.

Throughout the pandemic, EN has proven to be an effective, non-pharmaceutical public health intervention and a new way for the public to engage with Public Health.

Washington state is one of 20 U.S. jurisdictions that currently operate an EN system for COVID-19, and are able to share ENs across borders, many using Google/Apple Exposure Notification technology (1). While the underlying technology is similar, each jurisdiction develops a unique approach to implementation, often using ideas shared through the community of practice.

Since launching WA Notify in November 2020, Washington state has continued to expand and make improvements to the system, using the available technology to implement it in an innovative way. System enhancements have focused on increasing adoption of the

tool, making WA Notify more accessible and user friendly, and integrating WA Notify with other reporting systems. DOH has collaborated with the University of Washington both on these technology enhancements, and on gathering and evaluating user feedback on many aspects of the tool, which guides improvements and future directions.

Design and Implementation Model Practices and Governance

Development costs for this project, for a system that has been activated 3.84M times in Washington State (as of 2/7/23, 2021 population 7.7M), are minimal due to public-private-academic collaboration. The current operational technology is supported on the phone by Apple and Google. Specific elements of a de-centralized, privacy-preserving infrastructure are managed nationally by the National Institutes of Health (NIH), the Association of Public Health Laboratories (APHL), four of the major technology companies, and the non-profit Internet Security Research Group. States bear the cost of implementation, marketing, and ongoing monitoring of population level data, taking advantage of informal sharing of learnings.

In the U.S., EN system development began early in the COVID-19 pandemic. In April 2020, University of Washington (UW) researchers and other collaborators released proposed protocols for how to best utilize mobile phones to supplement contact tracing while preserving privacy and minimizing risks, called Privacy Sensitive Protocols and Mechanisms for Mobile Contact Tracing (PACT) (2). These protocols influenced Google and Apple's exposure notification (GAEN) protocol, released in May 2020 (3,4).

In addition to its role as a technology and implementation leader, Washington state offers an important case study for other reasons. Washington was the first U.S. state to report a COVID-19 infection and was one of the earliest states to be hit hard by COVID-19. With a strong partnership between the Washington State Department of Health (DOH), UW, and Microsoft Research, Washington state developed and tested their own app based on the PACT protocols, before adopting the GAEN technology.

In June 2020, Governor Jay Inslee, DOH leadership, and UW's School of Public Health convened a COVID-19 Exposure Notification Advisory Committee to provide guidance, oversight, and recommendations for EN implementation in Washington state. This committee was the first of its kind in the country. The group consisted of community stakeholders and experts in mobile technology, public health, outbreak investigation, ethics, equity, and security.

In September 2020, Apple and Google developed EN Express (ENX), a streamlined version of the GAEN technology, and made it freely available to designated public health authorities.

In November 2020, Washington state became the second state to launch an EN app using the ENX framework, first with a pilot version across the UW campus, and later state-wide. After thorough review of the technology, equity, accessibility, privacy, security, and

ethical considerations, the Advisory Committee recommended the adoption of EN in Washington state. Implementation was approved by the DOH Attorney General's Office, DOH Privacy and Security, the Secretary of Health and the Governor. WA Notify was launched on November 30, 2020.

As an early leader in exposure notification implementation, DOH leadership contributed to a report published by the Public Health Informatics Institute outlining the steps for public health adoption of the GAEN technology (5). Another important contribution was a decision paper shared to help inform public health leadership decision-making on implementing EN in other jurisdictions (6).

Strong collaboration with partners, a diverse advisory committee, thoughtful planning, robust data collection, an emphasis on accessibility, campaign development, and pilot testing all helped contribute to the success and rapid adoption of EN in Washington state compared with other states.

Currently, DOH leads the ongoing enhancement and maintenance of WA Notify, in collaboration with many partners. DOH and UW have an interagency agreement to conduct ongoing evaluation of WA Notify, explore technical solutions for implementing user-generated recommendations and enhanced cross-digital EN interoperability, and provide ongoing technical assistance and functionality modifications that maintain and support expansion of WA Notify adoption, utilization, and value.

DOH continues to engage with national partners on the technical implementation and improvements to EN, including Google, Apple, MITRE, and APHL. Ongoing collaboration through a unique private-public-academic partnership has been a critical contributor to the success of EN in the U.S.

To increase adoption and accessibility of EN tools nationally, Washington state leads a weekly meeting series with 17 other states that have also implemented EN systems. These calls are a valuable forum for collaboration, problem solving, and advancement of the tool. DOH periodically invites national partners to these calls to facilitate conversation, including Apple, Google, the White House Office of Science and Technology Policy, CDC, NIH, APHL, MITRE, Microsoft Research, Amazon Web Services, and others.

Information and Technology Solutions and Workflow

WA Notify is integrated with DOH public health systems to facilitate verification code distribution to positive individuals, provide post-exposure guidance, and allow for system monitoring and evaluation. Notably, only aggregate, anonymous data is available through interactions with WA Notify due to the design of the privacy-preserving technology. Through an integration with the Washington State Disease Reporting System, individuals who test positive for COVID-19 at a laboratory or provider's office are issued verification codes for results submitted to DOH through Electronic Laboratory Reporting (ELR). WA Notify users who test positive with at-home tests interact with WA Notify to

request verification codes to anonymously alert other users of exposure. Exposure notifications include a link to an interactive DOH webpage with post-exposure guidance. The information generated from interactions with WA Notify cannot be integrated with traditional public health systems using individual-level data, thus data analysis and evaluation are performed on an aggregate, population health level.
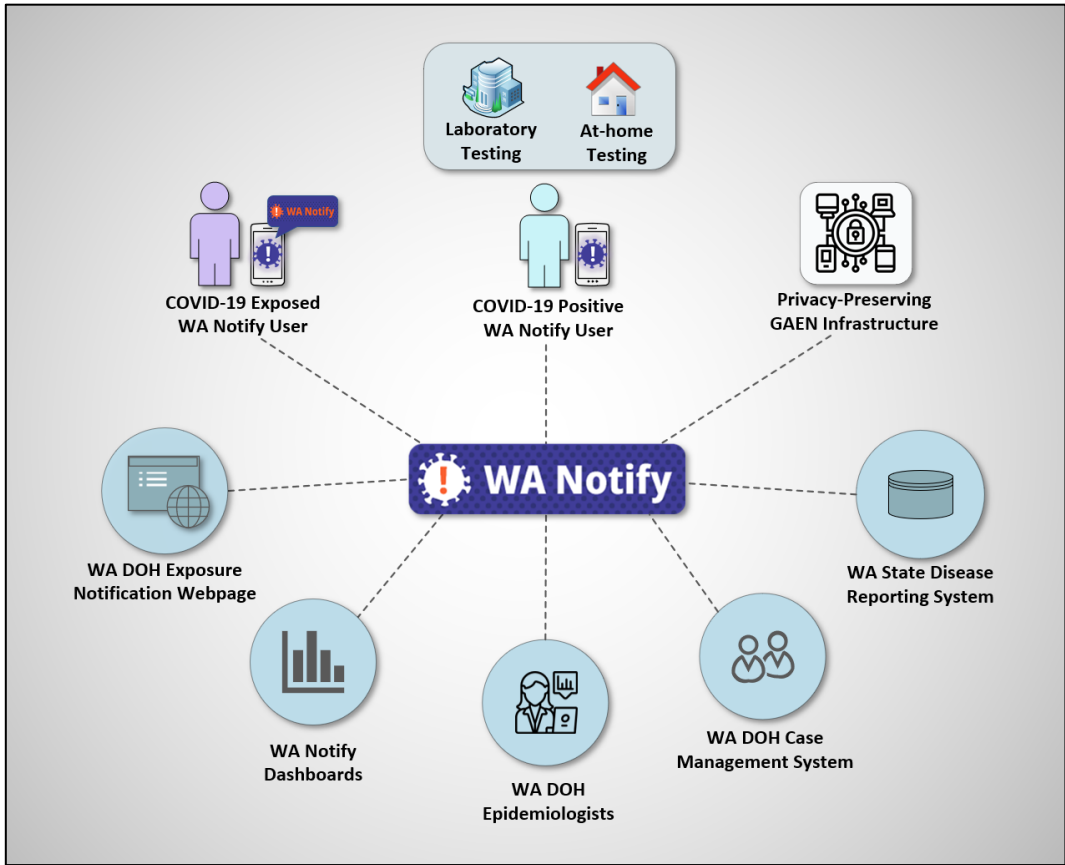

Figure 1. Privacy-preserving Framework: WA Notify User Interactions and Public Health Integrations

When two phones that are enabled with WA Notify are near each other, they exchange random IDs (keys) using Bluetooth Low Energy Technology. When a user tests positive for COVID-19, they may receive a verification code issued from DOH or request a code in WA Notify if they used an at-home test. The positive user is given the option to anonymously confirm their COVID-19 diagnosis in the app, which triggers the upload of their positive keys to the Key server. Phones with WA Notify enabled periodically check the Key server for matches with keys exchanged from other devices in the past 14 days. When a key match is identified and risk score criteria are met, exposure notifications are issued containing a link to a webpage with post-exposure guidance and access to a user experience survey—all without revealing the name or personal information of any user.
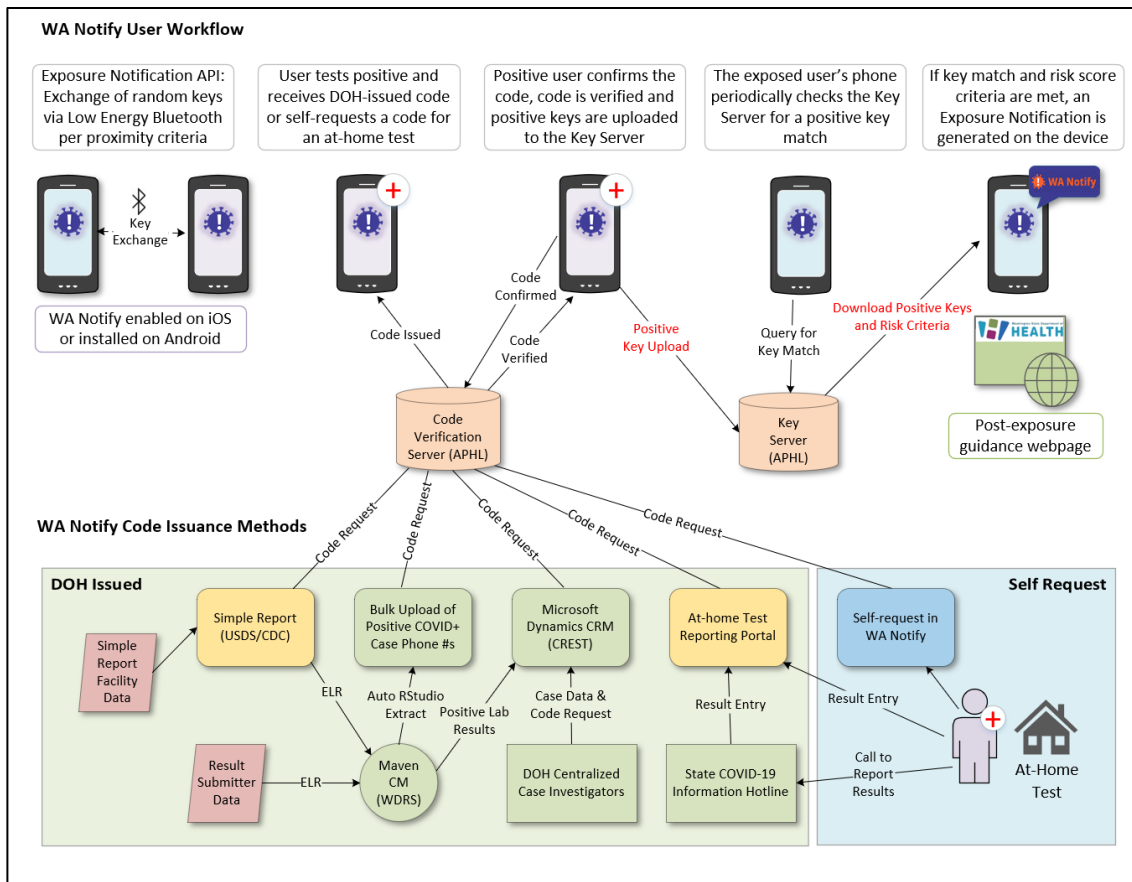
Figure 2. WA Notify User Workflow and Code Issuance Method Diagram

DOH issues verification codes via SMS to all phone numbers associated with a positive COVID-19 test result reported to DOH. The primary method of code issuance is performed through an automated process to upload an extract of positive results obtained from the Washington State Disease Reporting System (WDRS), run on the Maven disease surveillance platform, to the Exposure Notification Code Verification (ENCV) Server.

An API to the ENCV server was also integrated into the case management platform using a custom Microsoft Solution on Microsoft Dynamics called CREST (Case Risk and Exposure Surveillance Tool). This allows case investigators to issue verification codes during case and contact interviews directly in the CREST platform. DOH has also integrated automated code issuance APIs into Point of Care Test (SimpleReport) and at-home test reporting portals, reducing the time to issue codes to positive COVID-19 cases.

Critical data points in the workflow include data obtained from two key sources: the national ENCV server maintained by the Association of Public Health Laboratories (APHL), and the Exposure Notification Private Analytics (ENPA) system, hosted by MITRE. The ENCV Server is used to issue and verify codes confirmed by users. Once confirmed, positive user keys are uploaded to the national Key Server, also maintained by APHL. Data obtained from ENCV include data on verification code issuance and usage, keys uploaded, and

error metrics. Integration of multiple code issuance APIs allows for more granular monitoring of code issuance metrics by source.

Figure 3. Screenshot of Exposure Notification Code Verification server Interface

The ENPA system provides data on exposure notification interactions on a subset of users who opt-in to anonymously share this aggregate data with DOH. A key benefit of the ENX framework and the ENPA system is the availability of multiple notification types that allows for comparison of subgroups of users to further inform tuning of the tool to maximize efficacy and reach. ENPA data generated from the different notification types are used to inform leadership and support decision-making around exposure risk score settings, increasing the accuracy and effectiveness of the tool.
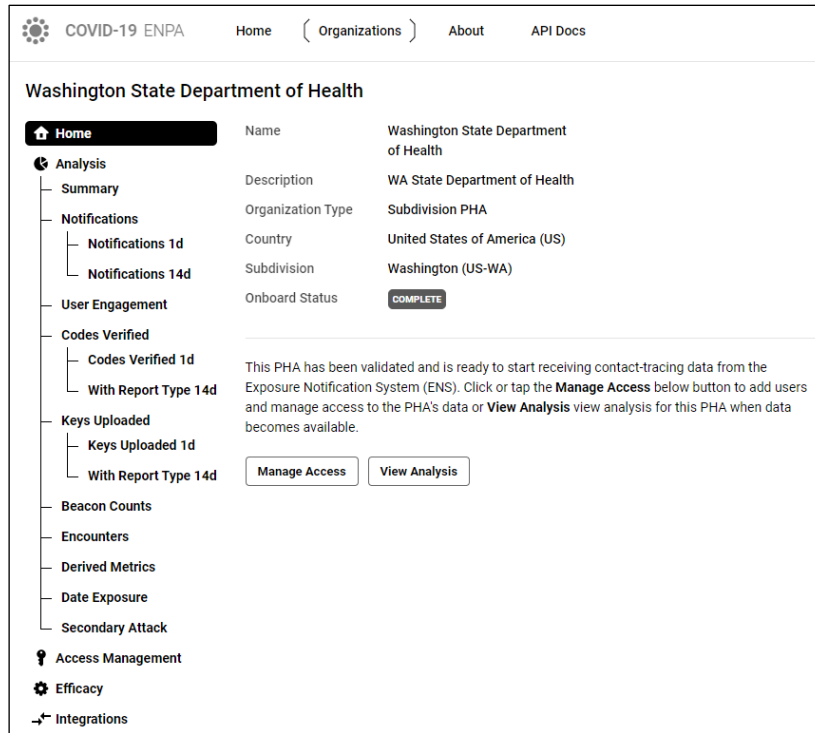
Figure 4. Screenshot of Exposure Notification Private Analytics system interface

In addition to ENCV and ENPA, another critical interface is the Apple Business Register (ABR). The ABR provides an interface for Public Health Authorities to submit changes to their respective ENX configuration, allowing customization of many aspects of the system such as exposure criteria, localized text content, optional features like Self Report or telemetry, and onboarding information.
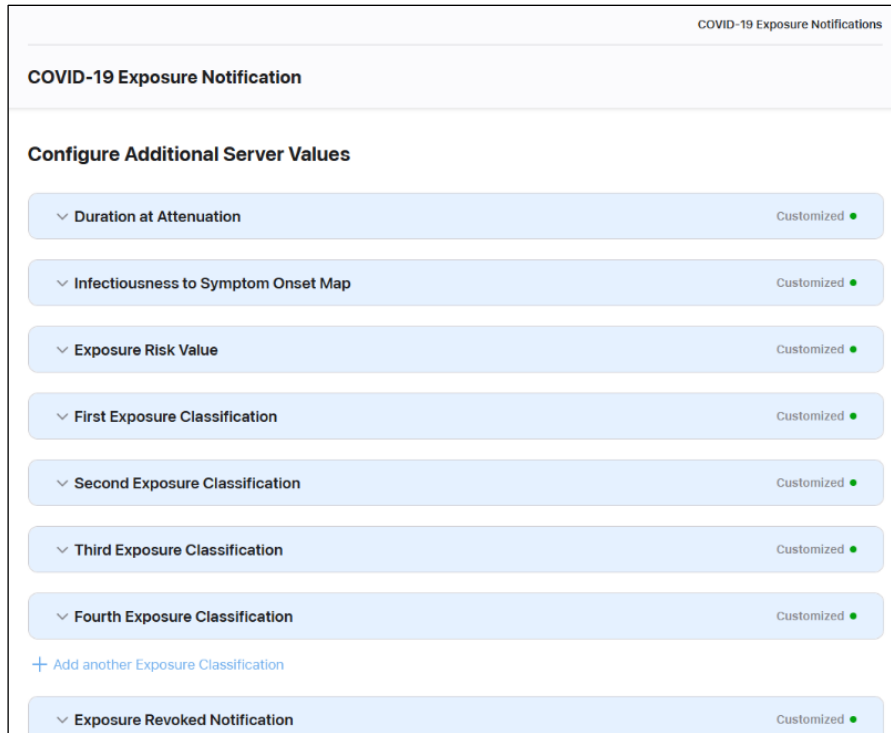
Figure 5. Screenshot of Apple Business Register Interface

DOH utilizes Tableau to monitor key metrics in dashboard format. The UW-hosted back-end data pipeline was expanded to export data in a JSON format, which is parsed and imported to a local Tableau instance via a custom Tableau Web Data Connector, hosted on the same server. This Connector securely accesses the data through a private REST API endpoint before the data is available in Tableau. A variety of visualizations are then compiled in easily digestible, semi-daily reports and distributed internally to stakeholders. Additions and modifications to this report structure will continue to be made as interest shifts and other data become available.
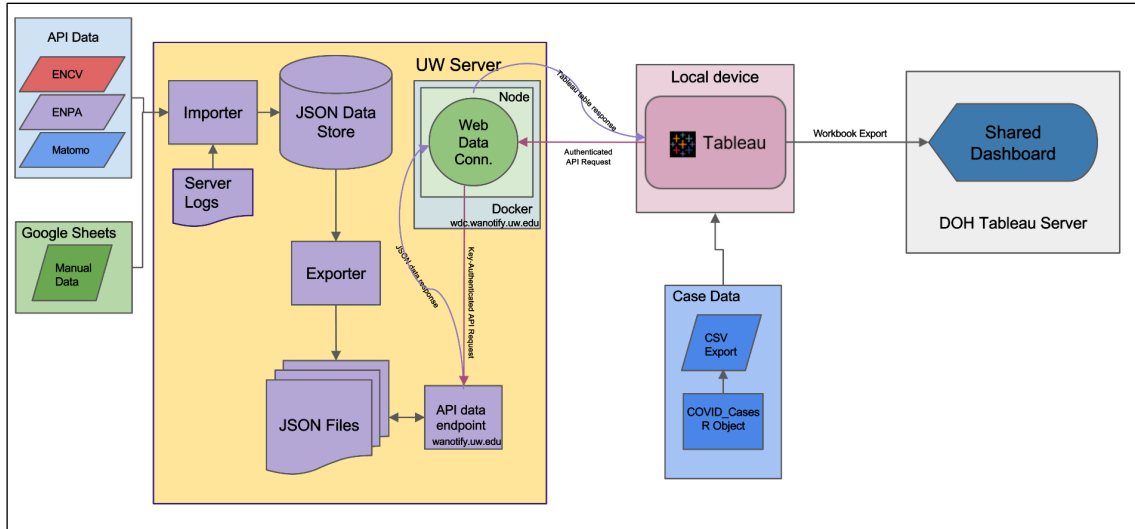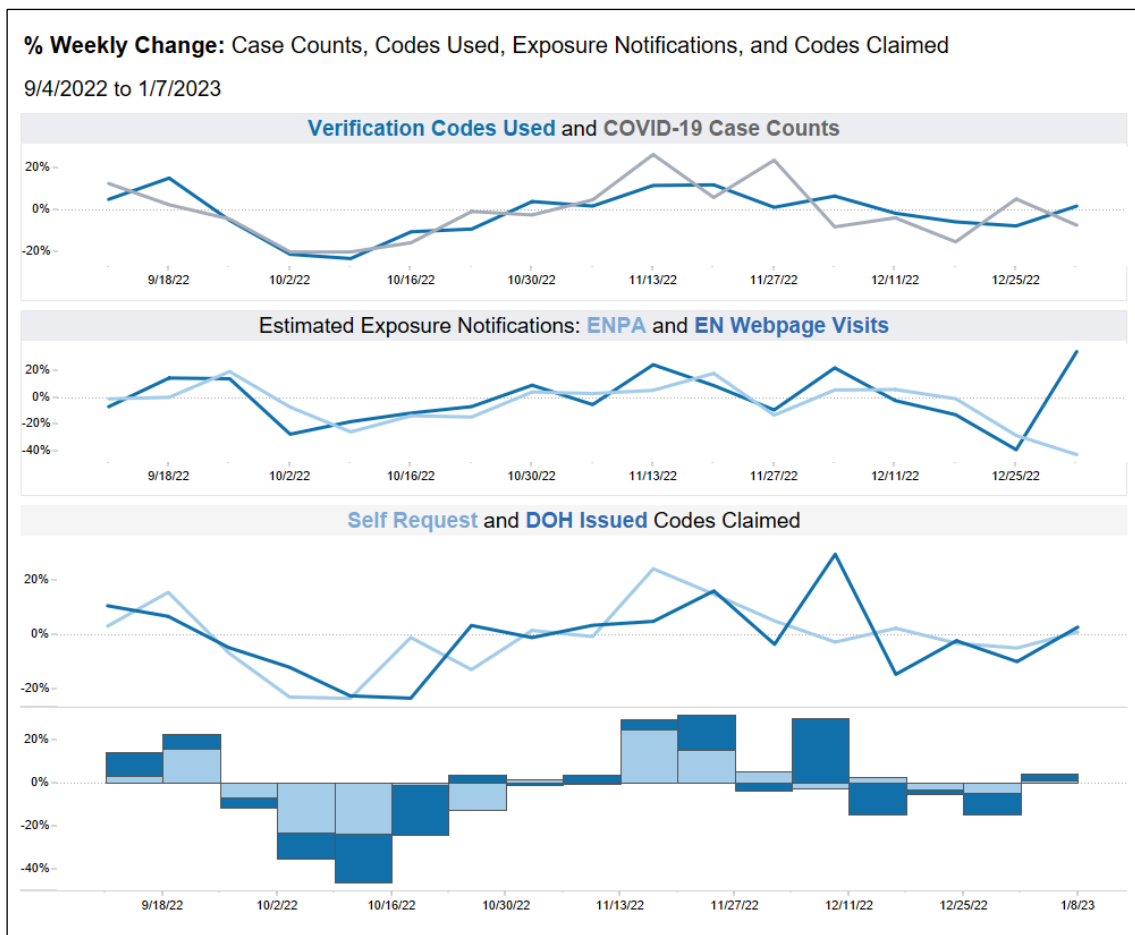
Figure 6. Tableau Dashboard Data Flow

Figure 7. Example WA Notify Tableau Dashboard

Impact on Public Health

In the two years since its launch, WA Notify has met its primary goals and impacted public health through: 1) public engagement with this novel tool, 2) new data integration, modeling, and evaluation strategies, 3) a significant number of COVID-19 cases averted (publication being finalized), 4) increased timeliness of exposure notifications, 5) distribution of alerts to contacts who otherwise wouldn't learn of exposures, 6) improvements to accessibility and user experience, 7) improved health equity and access to public health guidance, and 8) community stakeholder engagement.

When WA Notify launched on November 30, 2020, it was activated more than 1 million times in the first week. Activations continue to grow. Since it was launched, there have been more than 3.8 million activations, representing nearly 62% of smartphones in the state. To increase adoption, Washington state uses Availability Alerts (AA), which are notifications sent to devices that are not EN enabled, to provide an install link. Between November 30, 2020 – December 10, 2022, DOH scheduled four AAs to boost user adoption at strategic times, including at the launch, in conjunction with ad campaigns, and before holiday travel. Of the approximate 3,840,000 cumulative activations since launch, approximately 1,484,000 activations occurred within 5 days of the four AAs, representing nearly 40% of the cumulative activations.

Since its launch, more than 225k people who have tested positive for COVID-19 have used WA Notify to anonymously notify contacts of potential exposure. There have been more than 1.9 million visits to the exposure notification webpage that provides post-exposure guidance, which is an estimate of otherwise privacy-preserving exposure notifications generated. In recent months, the proportion of WA Notify codes used compared to reported confirmed and probable cases has increased, potentially indicating community COVID-19 levels that are not included in laboratory-confirmed reported case counts. This is particularly important for disease monitoring as public test sites become supplanted by home testing.

In their evaluation work, UW researchers have developed and refined methods to assess WA Notify's impact in mitigating the spread of COVID-19. Early analysis indicates an estimated 5,500 cases were averted statewide during the first four months of implementation (7). UW researchers are finalizing an updated analysis of estimated COVID-19 cases prevented by WA Notify during a one-year study period between March 2021-February 2022.

Other analyses conducted by DOH and UW show that WA Notify can more quickly notify users of possible COVID-19 exposures than traditional public health contact tracing methods. Additionally, WA Notify alerts unknown contacts that would not be notified through traditional contact tracing methods.

DOH and UW continually work to improve WA Notify, using available GAEN system enhancements, and communicating feature gaps in GAEN to our industry partners.

To make WA Notify more accessible and user friendly, and address an aspect of health equity, DOH continues to expand the number of languages supported in WA Notify. Currently, the app is available in 32 languages, and guidance on related webpages is translated into 47 languages. DOH makes these translations publicly available for other public health authorities to access and adopt. UW also conducts surveys on user experience, sharing the survey questions on Open Science Forum for use by other jurisdictions.

DOH and UW have collaborated to implement automatic browser language detection on the post-exposure guidance webpage, with interactive webpage features to provide personalized guidance based on user responses and a mobile-friendly design. DOH has also created a publicly accessible partner toolkit with graphics and communications materials to promote EN in multiple languages. DOH has used available "deep-links" and QR codes to easily direct users to specific workflow points in the system and includes these QR codes in social media posts and in graphic displays, including at the state's two largest airports, Seattle-Tacoma International and Spokane International.

In June 2021, DOH sought to improve the user experience and increase trust by implementing SMS text message intercept notifications with EN branding. In the month after implementation, this feature yielded a 91.7% increase in daily verifications codes claimed.

In December 2021, DOH enabled a self-request feature in WA Notify to keep up with the increased use of at-home COVID-19 tests. This feature allows WA Notify users who test positive for COVID-19 with an at-home test to quickly request a WA Notify verification code in the app. Currently, around 60% of the verification codes used are self-requested, compared to DOH-issued codes generated from laboratory-based testing. This gives us a metric to quantify the population shift to home-based testing.

This novel and effective EN technology has changed the way public health agencies conduct outbreak response and engage with community members. From the beginning of the COVID-19 pandemic, Washington state has been at the forefront of EN development, implementation, and evaluation, with a commitment to strengthening the private-public-academic partnership and multi-state community of practice that have made this tool so successful.

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HIMSS Global Conference Audience Guidance

Topic Guidance: Check three which apply to this case study

Clinical Informatics and Clinician Engagement

Clinically Integrated Supply Chain

Consumer/Patient Engagement and Digital/Connected Health

Consumerization of Health

Culture of Care and Care Coordination

Data Science/Analytics/Clinical and Business Intelligence

Disruptive Care Models

Grand Societal Challenges

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Health Information Exchange

Interoperability

Data Integration, and Standards

Healthcare Applications and Technologies Enabling Care Delivery

Healthy Aging and Technology

Improving Quality Outcomes

Innovation, Entrepreneurship, and Venture Investment

Leadership, Governance, and Strategic Planning

Social, and Behavioral Determinants of Health

<mark>Population Health Management and Public Health</mark>

Telehealth

Precision Medicine and Genomics

User Experience (UX)

Process Improvement, Workflow, and Change Management

Usability

User-Centered Design