MIT SafePaths Card (MiSaCa): Augmenting Paper Based Vaccination Cards with Printed Codes

Abstract

Here we describe a user-centric, card-based system for vaccine distribution. We explain the use of digitally signed QR stickers and their use for phased vaccine distribution, vaccine administration/record-keeping, immunization verification, and follow-up symptom reporting. Furthermore, we describe a complementary scanner app system to be used by vaccination clinics, public health officials, and immunization verification parties in order to effectively make use of this card-based framework. We believe that this system provides a privacy preserving, efficient framework for vaccine distribution in both developed and developing regions.

1 Introduction

Without an effective curative or preventative measure, the unprecedented coronavirus disease 2019 (COVID-19) pandemic has led to a significant amount of human deaths. However, now that multiple vaccines to prevent the spread of virus have been developed and approved, challenges associated with strategic vaccine distribution arise.

First, it is essential that the vaccine recipients are dynamically prioritized to ensure an equitable reach. In addition, once a citizen's first dose is administered, they must follow through with their second dose as well. A communication plan must also be put in place to combat inevitable rumors, misinformation, and conspiracy theories aiming to disrupt citizen engagement in the vaccination process. It must also address the mistrust of vaccines in society, especially within previously marginalized minority populations. This is why we must take a user-centric approach that preserves trust — vaccines are meaningless if citizens aren't willing to take them. Lastly, the health outcomes (effectiveness, safety, long-term effects, etc) of the vaccines must be effectively monitored in a privacy preserving way.

In today's society, multiple technological systems are being utilized by the Center for Disease Control (CDC) to combat these challenges. For example, the Vaccine Administration Management System (VAMS) streamlines the vaccine distribution process for jurisdictions, employers, and healthcare providers. In addition, it's an effective user-centric system as it allows for vaccine recipients to schedule appointments, receive records of their visit, and receive reminders for a second dose [3]. The Immunization Information Systems (IIS) are a group of privacy preserving database systems that track all vaccinations within various areas [1]. Lastly, the Vaccine Adverse Event Reporting System (VAERS) is the prominent system for the monitoring of health outcomes [2].

In our previous work, we detail the MIT SafePaths app-based protocol for vaccine distribution. In this paper, we introduce a separate user-centric card protocol that uses printed codes as a supplement to traditional paper based vaccination cards.

Please view our repository with more information, screenshots, and videos about the our system: `https://github.com/Path-Check/vaccine-diary`.

2 Card Flow

2.1 Overview

Here we present a vaccine distribution system utilizing simple physical SafePaths cards and four digitally signed QR code stickers (henceforth termed “coupon”, “badge”, “passkey”, and status). Here the digital signing of a QR code is simply a secure process of verifying the authenticity of the information contained in the QR code.

2.2 Vaccine eligibility confirmation

To accommodate the several-stage vaccination policies that countries have begun to employ, SafePaths cards will be distributed containing one initial digitally-signed coupon QR code. This would be provided by a central government agency such as the CDC and made available to users either by an employer or local government location. A pseudorandom identifier generated for this coupon serves as the identifying information for the user throughout the remaining workflow.

2.3 Vaccine administration

Check-in at a vaccination clinic would require the verification of the authenticity of a user’s QR coupon.

Upon vaccination, the vaccination clinic would create a digitally-signed record of immunization and print it as a badge QR code sticker. This badge sticker would contain information regarding vaccine lot, manufacturer, and first/second dose information. This sticker would also contain information regarding the time, date, and location of vaccination. Finally, the vaccination clinic would also create a unique encryption key to encrypt recipient personal identifying information (PII) such as name, age, sex, etc. into this badge sticker. This information would only be possible to decrypt using the unique encryption key for an individual which would be printed onto a passkey QR sticker.

At this stage, a vaccine recipient would then have coupon, badge, and passkey QR stickers.

2.4 Record-keeping and second dose

User records could be linked by anonymized upload to a centralized system such as VAMS using the pseudorandom identifier associated with a user’s coupon sticker along with an encrypted version of the user’s badge sticker. The user’s passkey sticker and information would not be uploaded to the CDC for decryption of PII without consent. When a user attempts to receive a second dose of a vaccine, a vaccination clinic would be able to use a user’s passkey and badge sticker to determine the appropriate vaccine type and dose. Again, the user passkey sticker contains information that solely exists on the physical card carried by a user. Use of this sticker is required to decrypt PII for a patient contained in the badge sticker. Once final vaccination has been performed, the vaccine clinic would create a fourth and final status sticker for a recipient’s SafePaths card, which would inform a verifier that the holder of the card had been vaccinated.

2.5 Vaccination verification

Vaccine verification would follow the receipt of a second COVID-19 dose. Information regarding an individual’s vaccination status would be digitally signed by the vaccine clinic onto the status sticker. When scanned, this sticker would provide a verifier with information regarding whether or not an individual has been vaccinated. If further verification of identity is required, a verifier could make use of a consenting individual’s passkey sticker to decrypt the holder’s name. In this way, a user would have multiple levels of information that they might be willing to share beginning simply with vaccination status in the unencrypted status sticker, basic personal information such as name that must be decrypted using the passkey sticker, and finally full personal vaccination information encrypted in the badge sticker.

2.6 Safety and efficacy monitoring

Long and short-term monitoring of health outcomes would rely on self-reporting schemas in the context of digitally-signed QR code passes. These passes could still facilitate the anonymous transfer of information by interacting with existing centralized systems such as VAERS or V-Safe while bypassing PII input. All health and symptom information could instead be tied to a user's pseudorandom ID. We also propose a scanner app solution that might aggregate symptom reporting and vaccine record data anonymously in the scanner app section below.

3 Scanner Flow

3.1 Overview

Here we discuss the systems that must be built for vaccine clinics and distributors in order to enable the use of the SafePaths card framework presented above. Here we present several relevant protocols as well as the functionality of a proposed vaccine distributor/verifier scanner app.

3.2 Vaccine eligibility confirmation

Phased vaccination using the SafePaths card system requires the distribution of SafePaths cards containing digitally signed coupon QR codes to appropriate subsets of the population during each stage of vaccination. There are several ways that this might be achieved.

1. Disseminate to businesses to provide to employees (eg: hospitals, restaurants, etc. as appropriate)
2. Make available at local government building (similar to DMV process of obtaining a driver's license)
3. Mail out to individuals based on employment/other factors (via background check systems, centralized databases such as IRS)

3.3 Vaccine administration

In order to confirm an individual for vaccination scheduling/check-in, a clinic must verify the authenticity of a vaccine recipient's QR coupon. The ability to scan a vaccine recipient's QR coupon to determine authenticity and prevent use of a single coupon by multiple individuals would be the first function of our proposed scanner app. This would be achieved by confirming the digital signature present on a SafePaths coupon.

Creating digitally signed badge and passkey stickers for a recipient post vaccination would be the second function of our proposed scanner app. This would make use of our previously described algorithm for secure recording of vaccine information and PII into the badge sticker, encrypted using the encryption key present in the passkey sticker. After creating these stickers, the proposed scanner app would not store any information regarding a recipient's encryption key; that information would only exist within the passkey sticker.

3.4 Record-keeping and second dose

Another critical function of our scanner app would be the ability to integrate with existing systems such as VAMS in the United States. Our app would ideally be able to automatically provide vaccination record information to VAMS while replacing PII with pseudo identifiers.

Alternatively, our scanner system would also have the capability to directly aggregate vaccination record data in an anonymized fashion, retaining population-level statistics such as vaccination prevalence in a given jurisdiction that might be important for public health policy development. Details concerning clinic location, vaccine dose, and vaccine manufacturer could be stored by the scanner app and aggregated for public health official viewing.

Second dose administration functionality would be implemented into the scanner app in the same manner as described in the previous section for initial vaccination. A status sticker would be created by the scanner app in a similar manner to the badge sticker, also drawing on the methods described in our cryptographic protocol [4].

3.5 Vaccination verification

Our proposed scanner app would enable vaccination verification simply by reading immunization status contained in a user's status sticker. The scanner app could also use an individual's passkey sticker to decrypt further PII contained in the status sticker for identity verification in conjunction with a form of ID (such as driver's license). The scanner app would not store this information following completion of the immunization confirmation.

4 Conclusion

Here we present a complete protocol for a physical card-based system for phased vaccine distribution, individual vaccination, second-dose adherence, and symptom follow-up. Due to their physical nature and simplicity, digitally-signed QR codes may be a convenient and non-intrusive modality for some users seeking vaccination. Digitally-signed QR stickers enable verification of authentically created immunization records, and the encryption schema presented using a unique passkey sticker ensures that user PII can only be decrypted with a user's consent. This information is stored physically on a user's SafePaths card in a decentralized manner wherein a user must provide their physical passkey sticker for decryption of PII. These cards also are able to extend privacy-focused protocols to low-resource areas and populations, equalizing disparities in access to individual-centric solutions and frameworks for COVID-19 vaccination.

References

[1] Center for Disease Control (CDC). *About Immunization Information Systems (IIS)*, 2020. `https://www.cdc.gov/vaccines/programs/iis/about.html`.

[2] Center for Disease Control (CDC). *VAERS | Vaccine Safety | CDC*, 2020. `https://www.cdc.gov/vaccinesafety/ensuringsafety/monitoring/vaers/index.html`.

[3] Center for Disease Control (CDC). *VAMS | COVID-19 Vaccination Reporting Systems | CDC*, 2020. `https://www.cdc.gov/vaccines/covid-19/reporting/vams/index.html`.

[4] Abhishek Singh, Ramesh Raskar, and Anna Lysyanskaya. Safepaths: Vaccine diary protocol and decentralized vaccine coordination system using a privacy preserving user centric experience, 2020.