Health Passport System

This is a system with an associated mobile application to help reduce disease spread and give people confidence to more fully engage in normal life.

The system will help to identify people who are sick and who are at risk of being sick with the goal of quickly providing treatment to these people and isolating these people to minimize the spread of the disease, in accordance with locally accepted measures. The system consists of two main parts. The first is self diagnosis tools to help quickly identify when someone becomes infected. This will chiefly be done with daily temperature measurements. The second part is contact tracing to assist in controlling the spread of the disease.

The main output of the system is a health status for each user. This status is under control of the user's medical provider. In addition to being used for testing and treatment, the status can also be displayed in the user's mobile application and can, if deemed necessary, be used to control access to high risk environments.

By requiring the application for entry into high risk environments, this serves to reduce the chance of an infected person being present and it also ensures each person present will be included in contact tracing at the establishment.

Users will measure temperature daily. The purpose is to both detect a high temperature measurement and to get an accurate baseline of the individual's temperature profile so changes from it are more easily detected. As determined by the medical community, additional or fewer temperature readings may be required. Optionally, it can be required that periodically measurements are done by an external party, such as an establishment a user is visiting.

Contact tracing will be done using the protocol developed by Apple and Google. This records contacts with other people and stores it privately. The app also periodically accesses a list of people who are sick and it will determine if the user came in contact with any of these people.

The system can be implemented with different levels of enforcement, depending on the current risks and the prevailing community sentiment. The system can be entirely opt-in and used solely for its diagnostic capabilities. Or, to varying degrees, use of the application can be made mandatory for specific high risk locations or groups.

Actors

The following are the actors in the system referenced in this paper.

- User - A person using the system for whom a health status is measured.
- Medical provider - The medical provider is responsible for judgements regarding the health state of a user. Each user will have a medical provider registered in the system. If the user does not have a health care provider, one will be given.
- Administrative Region - There will be an administrator for the application in a given region. This will typically be government or some non-government organization. The administrator will be referred to as the administrative region. They are responsible for policy strategies related to the different health statuses. This includes any measures for enforcement related to these policies.
- Establishment - This is a business or other place where a user can visit. The health status of a user, using a registered mobile application, can potentially be used to control access to the establishment. A specific policy for how this is done ultimately comes from the administrative region, if may be optional at a user's or establishment's discretion or it may be required.

Health Status

The main output of the application and system is a user health status. It is broken into the following categories:

- Standard - This is a person who is not infected and who has no known risk of being infected.
- Immune - This is a person who has immunity from contracting and transmitting the disease. This status must be determined by the user's health care provider.
- Infected - This is a person who has been confirmed as being infected with the disease.
- Potentially Infected - This is a person who has displayed disease symptoms, such as fever, but has not been confirmed as being infected.
- Potential Contact - This is a person who has had contact as measured by contact tracing with an infected or potentially infected person.
- Housemate - This is a person who has no signs of infection but is living in a shared space with an infected person.
- Unknown - This is the status given to a person when the system can not adequately interpret their state. An example of this may be when the user first starts using the application or if he/she has not provided adequate temperature readings.

Health Status Determination

Initial State

When the user first enters the system he will be given a status of "Unknown". The user will not be able to enter the STANDARD state until all of the following have been met:

- Clearing Period Elapses - A sufficient period has elapsed to ensure the user status is known. This should be determined by the medical community, balancing risk of infection with getting users into the system sooner. Most conservatively the period would exceed the disease incubation period. For COVID-19 the incubation period is typically about 5 days. A period often sited for quarantine is two weeks to ensure the person does not have the disease.
- Temperature Baseline Set - The user must provide daily (potentially multiple) temperature readings to establish a temperature baseline and to ensure he/she does not have fever symptoms.
- Testing for disease is Negative - This is optional, pending the amount of testing resources available.

Assuming the user safely meets the criteria for having no contact or infection, the user will be changed to the STANDARD state.

According to the rules discussed below, the user could alternatively be transitioned to other states if the criteria for those states is met.

Standard State

The STANDARD state is the baseline state for an individual with no detected risks. The users will stay in this state as long as that continues to be true. The criteria for exiting the STANDARD state or returning to it are defined in the other states.

Potentially Infected State

If the user is in the STANDARD, HOUSEMATE or UNKNOWN state, they will transition to the POTENTIALLY INFECTED state if disease symptoms are detected. This will be done with the temperature measurements, if a potentially bad reading is detected.This state can also be entered if a user self detects other disease symptoms.

When the user enters the POTENTIALLY INFECTED state, he/she should contact the system registered healthcare provider to begin determination of if there is an infection.

During the time in the POTENTIALLY INFECTED state, the user should isolate, according to the isolation rules.

When the user is in the POTENTIALLY INFECTED, this does not trigger transitions to other people (meaning it does not trigger POTENTIAL CONTACT and HOUSEMATE status).

Potential Contact State

The user enters the POTENTIAL CONTACT state if they get a contact reading according to the contact tracing system.

There are potentially multiple strategies for actions taken by those in the POTENTIAL CONTACT state. This will depend on the judgement of the decision makers for the administration region for the system.

Some potential options:

- There are no required actions by the user when he/she enters the POTENTIAL CONTACT state. It is at the discretion of the user for higher vigilance. The user will be informed of the time of contact so he/she is aware of the period when it is most likely for the disease symptoms to start showing.
- When the user enters the POTENTIAL CONTACT state he/she will have to isolate. However, this will not trigger transitions of other people. In this sense, it is similar to the POTENTIALLY INFECTED state in the actions taken by the user, with the exception that the user does not do immediate testing to determine infection. (However, testing could be administered after a sufficient incubation period.)
- When the user is in the POTENTIAL CONTACT state, this will limit entry to the highest risk establishments while allowing continued entry to lower risk establishments.

The user will exit the POTENTIAL CONTACT state and return to the STANDARD state after a sufficient period has elapsed with no disease symptoms. At any time the user can transition to an alternate state, such as POTENTIALLY INFECTED, if criteria are met.

Infected State

The user enters the INFECTED state if the health care provider determines the user has the disease.

Upon entering this state the user should isolate, according to the appropriate isolation policy. Also, this will trigger transitions of users who came in contact according to the contact tracing algorithm and for people cohabitating with the infected person.

The time period over which contact is judged to trigger a transition will be determined from the period the user was in danger of transmitting the disease as judged by the medical provider.

The user exits the INFECTED state when he/she is cleared by the medical provider. At that point they may be returned to the STANDARD state or, if the medical provider determines, to the IMMUNE state. (There must be adequate confidence in immunity.)

Housemate State

It is often not practical to completely isolate a person when they have become infected. They may still have to or opt to live with others such as a spouse or children. In this case, those other people are put in the HOUSEMATE state. This will apply not only to people who live together but also other people who have continued close contact.

As with the POTENTIAL CONTACT state, there are multiple strategies that can be used for people with HOUSEMATE status. A common option will be to treat those people similar to POTENTIALLY INFECTED.

Immune State

Presumably people are immune from catching or transmitting the disease if they have recovered from the disease or if they are vaccinated, when a vaccination is developed, for a given amount of time. The medical provider will determine when people are immune, according to rules established by the medical community.

People in the immune state are not a risk to others.

The medical provider will also determine when a user is no longer immune. (Possibly there should be multiple immune states, corresponding to the probability of immunity which may decrease over time.)

Unknown State

The judgement of the state of the users is ultimately the assessment of the medical provider. They can determine that the state of the user is UNKNOWN.

One reason the user can be put in the UNKNOWN state is they did not provide valid temperature readings.

The unknown state is not intended to indicate a known risk the user may be infected. It is intended only to indicate there is not enough information to establish the proper state of the user.

The user will exit the UNKNOWN state as soon as proper information to identify user state is available.

The policy for handling the UNKNOWN state again is up to the system's administrative region. As with the POTENTIAL CONTACT state, there are a number of different options and the choice selected will depend on local conditions.

Using the Health Statuses

Isolation

When a person is in the INFECTED state, and optionally other states too, the user will isolate to avoid contact with other people.

In practice this is difficult to do. As a baseline, a user in isolation should not leave their residence in a way there is a risk of contact with another individuals, where the definition of risk of contact is determined by the medical provider.

The most common challenge to isolation will be when multiple people live together. There may be other cases where a person must be in contact with some other people, even if they are not living together. These cases are why there is the HOUSEMATE state.

To make isolation workable, the administrative region should make certain assistance available, such as the following:

- Delivery of essential goods - Any person in isolation should have delivery service available to them so they can get any essential goods. This should go beyond the delivery services available to the general population since those services are not guaranteed.
- Substitute Resources - In cases where a person takes part in essential services, wherever possible the administrative region should help provide substitute resources so the person can isolate. This may mean providing a replacement worker or requiring the employer to allow sick leave.
- Financial Assistance - When a person can not make money if they are isolated the administrative region should provide assistance so the person can remain in isolation.
- Isolation Housing - In cases where a person is living with others at high risk, the administrative region should provide alternate isolation quarters to allow a person to isolate. This may be done through temporary isolation quarters or through hotels that participate in the system. When isolation housing is provided, it should be insured that all essential services, such as food, are available to the isolated person.

Entry To Establishments

The use of the health status in controlling user entry to establishments can be done in many ways and should be determined by local conditions including the active infection rate, the type

of establishment, prevailing local sentiment and also the health goals of the administrative region. Some options:

- The health status can be kept private and used solely at the discretion of the user. In this case It is hoped an infected or at risk user will self isolate.
- Selected groups may opt in to use the system, such as a employees at a retail store, office or school. This can be done to help display the safety precautions of the establishment for customers.
- Establishments may be allowed to require the use or the application, along with specific health status requirements, for entry to the establishments. This again could be done to make customers feel safer about entering the establishment.
- The administrative region can set and enforce specific requirements by establishment type. Entry to higher risk establishments may require the application and certain health statuses. Alternately entry to all establishments may require the use of the application and specific health statuses.

The policy for use of the app can change over time as disease conditions change and as public sentiment changes. Initially a conservate approach can be taken. If there is a problem with a second wave of infection or if business activity is impaired by a lack of customer confidence, the requirements on the use of the app can be increased

Conclusion

The system presented in this article attempts to identify a reliable and actionable health state for individuals based on self measurement of temperature and contact tracing. The intention is to reduce disease spread and give people confidence to more fully engage in normal life activities.

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