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Researchers say those recovered from SARS-CoV-2 can be a societal shield

The idea is to find those who have developed immunity and put them in essential jobs.

John Timmer - 5/14/2020, 3:30 AM

Enlarge / View of blood collection tubes in a rack awaiting SARS-CoV-2 antibody testing.

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While many societies remain locked down in various forms of isolation and

social distancing, there's a growing population for whom these measures may be irrelevant: those who have had a SARS-CoV-2 infection and cleared it. While we haven't yet ascertained these people's susceptibility to repeated infections, many clearly have antibodies to the virus, and we're finding that some antibodies seem to neutralize the virus. So, there's a reasonable chance that it's safe for these individuals to circulate more widely within the population.

A group of researchers largely based at Georgia Tech have looked at whether this population might be helpful for limiting further infections. The researchers used an epidemiological model to test what would happen if we started placing the formerly infected individuals in the key jobs that we've deemed essential for society to function during social isolation. The results suggest that this "shield immunity" is somewhat effective on its own and significantly enhances the impact of social isolation.

Lots of caveats

As of right now, there are a number of things we don't know about the progression of a viral infection that will be essential for this to work. One is how long it takes for the person to stop being infectious and how that relates to our ability to detect viral RNA in samples from these individuals.

The second is the degree of immunity that an infection generates. For other coronaviruses, this varies from under a year for those that cause cold-like symptoms to a much longer immunity for those who have survived a SARS-CoV-1 infection. While a number of antibody tests have been generated that can determine whether an immune response has been mounted to SARS-CoV-2, the accuracy on some of these tests isn't all that great, and we don't know how well the detection of antibodies correlates to actual immunity.

While those issues should sort themselves out with further research, there are other potential hurdles to the concept. For one, the people who have been infected may not be the same people who occupy jobs we consider essential. We can't just take a random person and throw them into a supermarket or medical equipment-manufacturing plant and expect that they will understand how to make the business function. The same is true for things like the medical field, where many jobs require highly specific training.

All of which is to say that we have a lot of work to do to make this sort of program effective. But, given the fact that the pandemic seems to be spreading widely within the United States, we'll clearly have time to work these issues out.

Back to the models

With any unreasonable hopes dashed, what does the new research actually indicate? The authors assumed the availability of an accurate post-infection test that could identify those who have been infected based on the existence of antibodies to SARS-CoV-2. They also assumed that individuals identified through these tests could safely interact with both infected and uninfected individuals without passing the virus from one group to the other. With those assumptions in place, they turned to an epidemiological model.

The type of model they worked with is called a SIR, for Susceptible, Infected, and Recovered. In essence, it divides the population into these three pools and models the rates at which people move among these groups. So, when the number of infected individuals is small, the rate at which people move from susceptible to infected is low, but it grows as the infected pool expands. And, over time, an increasing number of people move on to the recovered pool, from which they can't transition back.

In this case, the team modified a typical SIR model to include infected pools with and without symptoms as well as the isolation of those with symptoms. The researchers could also switch social isolation on and off, affecting the rate at which people moved from the susceptible to the infected pool. With all that in place, they started model runs with a single infected individual in a population of 10 million and let the infection run its course.

In the key experimental part of their model, they changed the behavior of the model once the recovered group accounted for 0.1 percent of the total population. At that point, some of the recovered population starts being used to replace people who have critical roles that involve them interacting with the infected and susceptible populations. Here, the authors suggest, their immunity can act like a shield. They term the process of getting them into these positions as "interaction substitution" and to the concept as "shield immunity."

As we noted earlier, not everyone can just step into every one of the jobs we've deemed essential, so the authors account for this with what they term an "interaction preference." That's simply a factor that they can vary to increase or decrease the probability that a susceptible individual will interact with an immune one rather than a potentially infected one.

A strong shield

Overall, their method works. In a model that assumed a relatively low baseline rate of infection and a moderate degree of interaction substitution, the total number of deaths was 50,000 out of the 10 million starting population. Without interaction substitution, that number was over 71,000. If we're better at finding ways of ensuring interaction substitution, the death toll can drop to only 20,000.

The authors found that, when combined with social distancing, the effects were even larger. The impact of shield immunity became more pronounced as social distancing was less effective, a scenario that appears to be increasingly relevant in many areas of the US. Finally, the researchers ran a model in which those with immunity were preferentially shifted into positions where they'd interact with the elderly. This resulted in a larger drop in the mortality caused by the infection.

The one challenge that the models revealed was that, as both social distancing and shield immunity were effective, the population of recovered individuals grew much more slowly, which limited the overall effectiveness of the interaction substitution.

It would be nice to see this idea tested in models that are structured differently from the SIR model used here. But it's difficult to suggest a scenario where, given the authors' assumptions about immunity, this sort of interaction substitution would be ineffective. Beyond the potential biology issues, however, the approach would require a level of social engineering that many societies may not be comfortable with.

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Correction: clarified length of SARS-CoV-1 immunity.