

Science You Can Use

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Dear Science: I hear that the new coronavirus that started in China isn't well understood. The US and other governments are placing people who could have been exposed to the virus, but have shown no symptoms, in quarantine for 14 days. How can we be sure that somebody who could have been exposed to the virus but shows no symptoms for 14 days won't get the virus and infect others? -- Buck R.

Dear Buck: The short answer is that so far, there are no known cases of people who have been potentially been exposed to the new coronavirus, but who have shown no symptoms for 14 days, contracting the disease or passing it to others. Furthermore, *if* this coronavirus turns out to be similar to previous coronaviruses, a 14-day quarantine period is sufficient.

Here's more detail.

What is the new coronavirus? The new coronavirus, called COVID-19, is a respiratory virus first observed in humans in China in December 2019. Coronaviruses are not new. They were first found in human populations in the 1960s. Close relatives of coronaviruses exist in some species of bats, snakes, and pangolins.

The early symptoms of infection by COVID-19 look much like those of flu or even the common cold. The disease appears to be primarily transmitted between humans through the air (e.g., through coughing). In many cases, people who contract the disease have relatively mild symptoms and recover within a week to ten days. People with weak immune systems, especially the very young and very old, may run a high fever and have difficulty breathing, and may die. As of February 2020, there was no vaccine or virus-killing drug for COVID-19 infection.

The current COVID-19 epidemic appears to have originated in the city of Wuhan, China, near a market that sold certain wild animals (for food) that can carry coronaviruses. To date (mid-February 2020), roughly 80,000 people worldwide (most are in China) have been infected by COVID-19, and about 2,000 have died because of it. This means that $(2,000/80,000 =)$ about 2.5% of those people who have been infected have died. (That death rate is about 25 times the percentage death rate due to flu in the US this flu season.)

To try to help control the spread of the COVID-19, the Chinese government imposed strong quarantines on Wuhan and nearby cities several weeks ago. Factories were closed (as of mid-February 2020 some are re-opening), and access to retail stores has been severely restricted for several weeks.

Is the outbreak under control? To answer this question, epidemiologists – experts who study epidemics – classify members of given population in small set of categories that are closely related to the different kinds of control activities that could be brought to bear on an epidemic.

Although there are a few variations of these classification schemes, one of the most useful has just four categories: Susceptible, Exposed, Infected, and Recovered.

Individuals in the Susceptible category are those people who could be, but have not been, exposed to a given pathogen. Individuals in the Exposed category have come into contact with the pathogen but have not been infected by it. Individuals in the Infected category have been infected by the pathogen but have not recovered from that infection. Individuals in the Recovered category have recovered from infection by the pathogen.

At the beginning of an epidemic that doesn't kill everyone in the population, there will typically be individuals in each of the Susceptible, Exposed, and Infected categories, and possibly, some in the Recovered category. As the epidemic progresses, some fraction of the individuals in the Susceptible category moves at some rate (e.g., at 5% of the Susceptible population per week) to the Exposed category. Similarly, some fraction of the individuals in the Exposed category moves at some rate to the Infected category. And some fraction of the individuals in the Infected category moves at some rate to the Recovered category. These rates typically change with time. Reducing any of these rates helps to control the epidemic, so knowing what these rates are is fundamental to effective epidemic control. A relatively simple mathematical model describes the relationships among these quantities well enough for public-health monitoring and prediction purposes.

In favorable cases, the Susceptible-to-Exposed rate can be lowered by quarantine. That is, if we keep people who could potentially be exposed from contacting one another, we could in theory stop an epidemic before it started. Quarantine is never perfect, however. If started late in an epidemic, quarantine typically has a much smaller effect on the course of an epidemic than quarantine started early. The Exposed-to-Infected, and Infected-to-Recovered, rates can be lowered in most cases only by effective disease-specific vaccines and pathogen-killing drugs, administered in a timely way.

It requires a healthcare infrastructure as advanced as the US's to accurately gather information on, and to effectively respond to, most epidemics. As of mid-February 2020, it is too early to know with confidence what effect the measures taken in China to combat COVID-19 have had.

For further information, see <https://www.cdc.gov/coronavirus/2019-ncov/about/transmission.html>? and <https://instituteofdiseasemodeling.github.io/Documentation/general/model-seir.html>.

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