ABSTRACT

Objectives: To determine the public health surveillance severe acute respiratory syndrome coronavirus 2 (SARSCoV 2) testing volume needed, both for acute infection and seroprevalence.

Methods: Required testing volumes were developed using standard statistical methods based on test analytical performance, disease prevalence, desired precision, and population size.

Results: Widespread testing for individual health management cannot address surveillance needs. The number of people who must be sampled for public health surveillance and decision making, although not trivial, is potentially in the thousands for any given population or subpopulation, not millions.

Conclusions: While the contributions of diagnostic testing for SARS CoV 2 have received considerable attention, concerns abound regarding the availability of sufficient testing capacity to meet demand. Different testing goals require different numbers of tests and different testing strategies; testing strategies for national or local disease surveillance, including monitoring of prevalence, receive less attention. Our clinical laboratory and diagnostic infrastructure are capable of incorporating required volumes for many local, regional, and national public health surveillance studies into their current and projected testing capacity. However, testing for surveillance requires careful design and randomization to provide meaningful insights.

As the coronavirus disease 2019 (COVID 19) pandemic enters its sixth month in the United States, much of the public health and prevention discourse focuses on the need for increased diagnostic testing. The purposes of testing, however, receive less attention, leading to confusion about the testing capacity required. Different testing goals require different numbers of tests and different testing strategies.

There are many distinct roles that testing aims to address, including: (1) health care management for individual patients, (2) identifying exposed individuals through contact tracing to inform quarantine, and (3) disease surveillance.

Sufficient tests are generally available to meet the personal health needs of individual patients, and most of the nearly 16 million (as of May 28, 2020) molecular tests administered to this point have been for this purpose. Health policy experts argue that effective contact tracing requires drastic increases in testing capacity.1 For instance, one highly publicized plan developed by a consortium of experts recommends 20 million tests per day.2

In contrast, testing strategies for national or local disease surveillance, including monitoring of prevalence, receive less attention. As a result, there is uncertainty surrounding basic questions: What proportion of the population in a given area is currently infected? What proportion of the population already has been infected? Is acute infection prevalence increasing as shelter at home guidance relaxes? Despite the widespread testing for individual patient care, testing to date cannot answer these questions. Without evidence of the infection dynamics in the population, policy makers are in the difficult position of making decisions without a clear picture of the true prevalence and mortality rate of the virus.

The number of tests required for disease surveillance is manageable but requires carefully designed random testing. This report seeks to provide guidance for public health officials, local governments, and large employers developing testing strategies to track disease prevalence in their respective communities. The central message is that accurate monitoring of disease prevalence can be achieved by testing a relatively small number (typically, thousands) of randomly sampled individuals.

The Current Testing Landscape

Currently there are 3 types of diagnostic tests available: molecular assays (polymerase chain reaction [PCR]), serology assays, and antigen tests. Each test has specific applications for personal health management and public health surveillance. This discussion focuses on the first 2, because the antigen test has only recently received emergency use authorization from the Food and Drug Administration and is not yet widely available.3 Molecular and serology testing complement each other, and both are necessary to paint a complete picture of the current state of the pandemic.

The molecular test identifies people currently infected with severe acute respiratory syndrome coronavirus 2 (SARS CoV 2), the virus responsible for COVID 19. Those who test positive, whether symptomatic or not, are presumed to be contagious and risk transmitting the virus; however, some patients who test positive later in the course of infection may have noninfectious viral remnants detected.4 These tests can be used to monitor active infection in the population and assess how infection dynamics change in response to policy modification (eg, opening schools) Table 1. However, testing for public health surveillance must be conducted in a careful and targeted way. Testing conducted for personal health or prevention cannot be used for public health surveillance. For example, in the initial phases of

the pandemic, only the sickest patients were tested with the molecular test (due to limited availability). Using these test results to measure the number of positive cases drastically underestimates the extent of infection because many patients are asymptomatic. Furthermore, morbidity and mortality rates among tested individuals overestimate the true morbidity and mortality rates of COVID 19 because the denominator, rather than reflecting the total number of individuals infected, only incorporates those who were tested.

Serum based serology tests identify people who were previously infected or who are recovering. These tests demonstrate an immune response by most patients as they recover from infection. While it is unknown how long antibodies to SARS CoV 2 will be detectable, based on data from SARS CoV and MERS CoV it is likely to be at least a few years.5,6 Serology testing can identify how many people have been infected by SARS CoV 2 and provide greater insight on exactly how harmful and deadly the virus actually is Table 2. This will help refine estimates of the true morbidity and mortality rates for different populations, evaluate the prevalence of an immune response following infection, and identify populations or locations with greatest spread. It will also help identify particularly resilient populations. If, for example, a large enough portion of people under 40 years of age are asymptomatic and the mortality rate is sufficiently low, this population could play a larger role in the initial stages of reopening the economy, provided they are not personally or living with individuals at increased risk.

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Although not fully proven, experts expect that those with antibodies have immunity, at least in the near term.6,7 Thus, serology testing can also be used to monitor immunity in the population. At present, the primary application for serology testing is to monitor prevalence in communities, not to inform personal care or behavior of individual patients.5

To date, several studies have been conducted for the purpose of disease surveillance in communities. Studies conducted in large metropolitan areas found seroprevalence levels of 4.6% in Los Angeles County,8 2.8% in Santa Clara County,9 and 21% in New York City.10 If accurate, these studies have large public policy implications. First, they suggest that the total number of infected individuals could be far higher and the death rate far lower than official records. Second, despite the devastating toll the virus already has had on society, these findings suggest that most people remain at risk. Experts expect that herd immunity, the level of immunity required in the community for disease spread to be unlikely, is not achieved until at least 55% to 60% are immune.