

Precision COVID-19 Testing in the Vaccine Era: Solving challenges for 2021 and beyond

By Luis M. Lasalvia, MD, MIB and Reto Merges, Siemens Healthineers

Executive summary

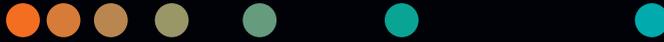
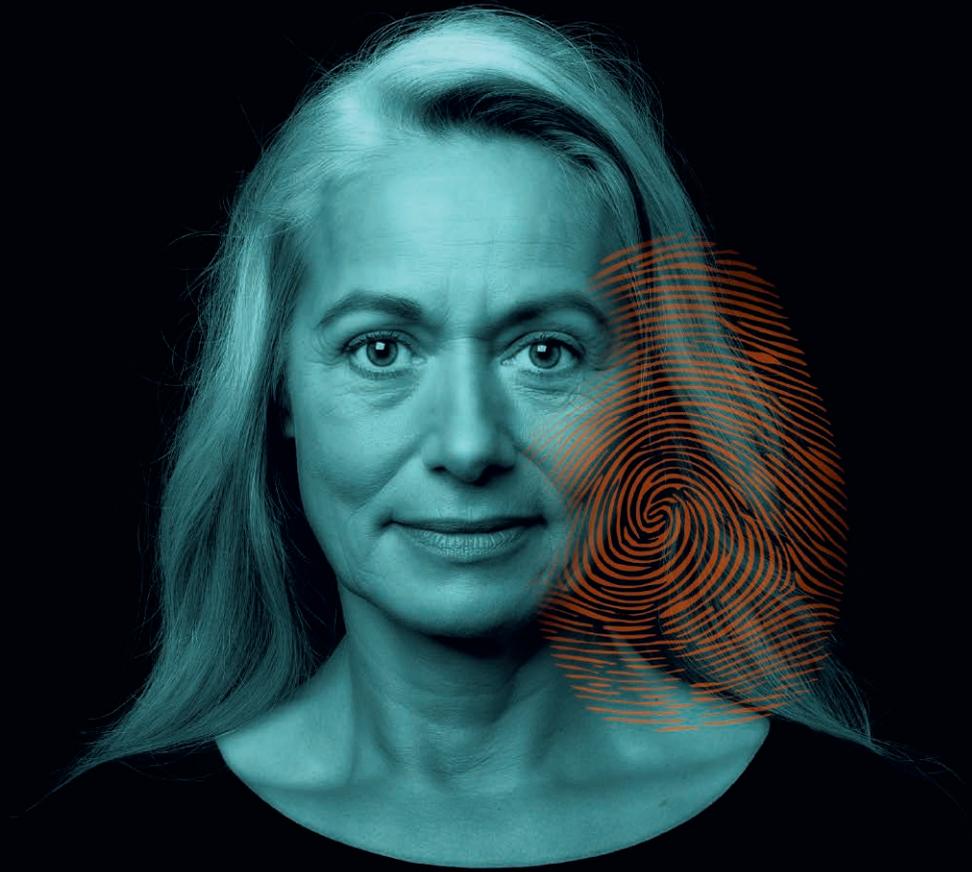
Precision testing is critical for effective COVID-19 management in the vaccine era. Despite the impact of vaccines, COVID-19 testing remains important for a variety of reasons, including limited availability of vaccines in various countries and regions; vaccine refusal, delay, or hesitation; the potential emergence of vaccine-resistant variants; and the unknown duration of infection and vaccine-conferred immunity in different populations.

Four key testing solutions to the current and future challenges of COVID-19 are:

1. Developing and optimizing precision testing programs, complementing the strengths of COVID-19 tests
2. Developing a scalable, team-based testing infrastructure to provide timely access, processing, and communication of results
3. Tailoring precision testing protocols for specific populations
4. Encouraging leaders within organizations to stay vigilant on the unknowns associated with COVID-19, particularly the impact of virus variants and the duration of immunity, both vaccine-generated and natural

By taking these steps, healthcare organizations can meet the evolving demands of the pandemic and protect the health of their communities. ▶

Expanding precision medicine



We believe that medicine will become more precise. However, medicine today is generally based on a “one-size-fits-all” practice, and where targeted therapies are possible, it is impractical to scale.

The goal of expanding precision medicine is to provide the right treatment at the right time for every patient. Tailoring treatment starts with a highly-specific diagnosis without unwarranted variation. Based on data integrated from existing

sources, adding genomics and radiomics enables a holistic understanding of the individual. These unique characteristics steer the personalization of treatment. A precise understanding of a patient’s condition is the most effective approach to deliver outcomes favorable to all stakeholders.

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The ongoing impact of COVID-19 on healthcare organizations

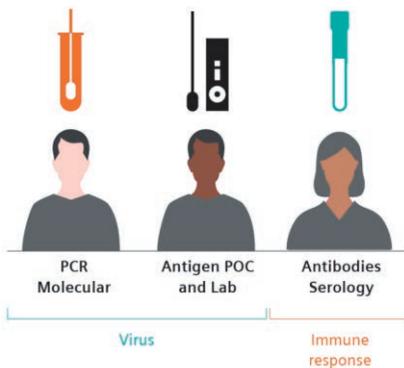
While the advent of effective vaccines has been a game changer, it does not mean that testing programs are no longer needed. In this paper, we will examine four current and future COVID-19 testing challenges and solutions to overcome each one of them. Applying testing solutions to best effect requires the application of principles of precision medicine – in this case, getting the right test to the right person at the right time.



Challenge 1: Accurate, timely diagnosis

COVID-19 infections will continue to occur, and the disease may become an endemic or seasonal infection, warranting precision testing programs for the foreseeable future.

Testing saves lives, both directly and indirectly.¹ Timely diagnostic testing information enables both appropriate treatment of infected patients, and the overall protection of the community.



Solution 1: Precision programs to maximize the impact of testing

There are several COVID-19 tests now available, with a wide variety of use cases. When deployed with precision, these tests increase our understanding of the pandemic and shape our response to it on a local, regional, and international level.

Each test contributes to a more complete, precise picture of COVID-19 in individual patients and the dynamics of the pandemic in the community at large.

PCR testing is highly accurate and is the best

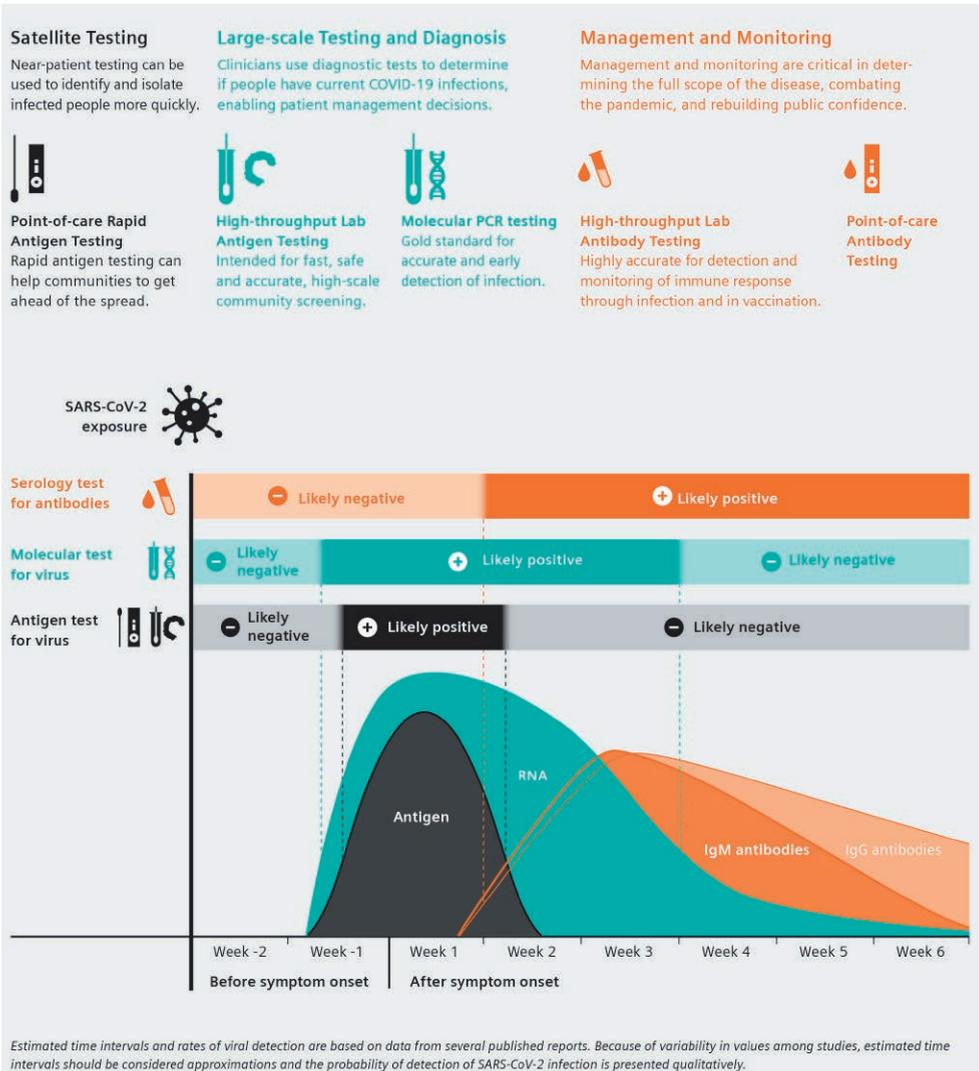


Figure 1: Complementary roles of PCR, antigen, and antibody testing²

option for early detection. However, it is possible to be infected with SARS-CoV-2 but not have enough virus to be detected, and the test comes with stringent handling and processing requirements.

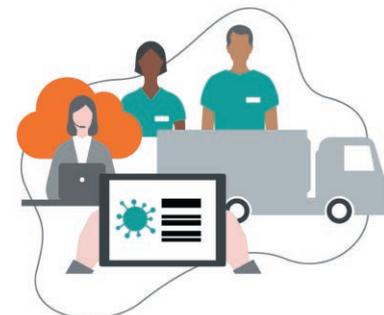
Antigen tests can quickly screen for potentially infectious individuals at point-of-care and central laboratory settings by detecting viral proteins. They generally require high viral loads to detect infection.³

Point-of-care rapid antigen testing does not require laboratory processing and can deliver results in 15-30 minutes. For addressing a larger number of patients within a short amount of time, laboratory-based antigen tests offer a way to rapidly scale up COVID-19 testing capabilities using high-throughput analyzers capable of generating hundreds of results per hour.

Antibody testing can track community transmission and previous infection but are not valid for diagnosing current infection. In addition, antibody titer levels may prove to be useful data

points marking the duration and magnitude of immunity after infection or vaccination.

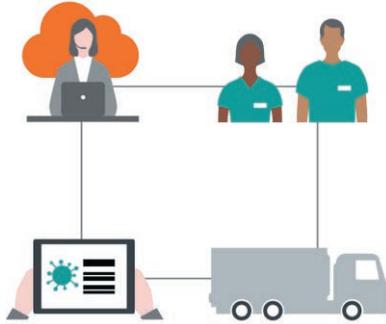
Additional tests, including home-based tests, saliva tests, and others that are in development, may play important roles in the future.



Challenge 2. Complex logistics around access and supply chains

The arsenal of tests described above is only valuable if healthcare professionals and populations have

timely access to accurate test results. In the U.S., the COVID States Project showed that testing infrastructure can be compromised for several reasons. Restricted availability of tests, lab testing capacity, reagents, personal protective equipment (PPE), as well as limited personnel readiness all contribute.⁴



Solution 2: Develop and optimize team-based and scalable testing infrastructure

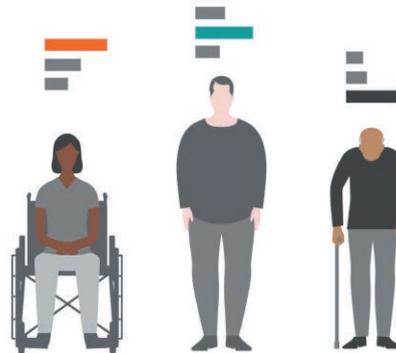
Infrastructure, team-based work, and logistics related to testing for COVID-19 have improved dramatically from the situations that characterized the early pandemic response in many nations. But healthcare executives must not let down their guard.

Since the emergence of the pandemic, a few ways of “stretching” testing resources – especially PCR resources – have emerged:

Pooled PCR testing: Samples from several individuals can be pooled and tested to determine whether any of them show presence of viral material. The individual test samples from a positive pool can then be run separately to identify the people infected. This method is not appropriate when incidence/positivity is high, but it can dramatically increase the speed and reach of screening in lower-prevalence populations.⁵

Lab-based antigen tests: Communities can rapidly scale up their COVID-19 testing capabilities by leveraging lab-based analyzers that can generate hundreds of results per hour.

Point-of-care rapid antigen tests: Communities that do not have the resources for many PCR or lab-based tests are using point-of-care antigen tests to supplement their testing capacity.



Challenge 3: Different subpopulations require different testing protocols

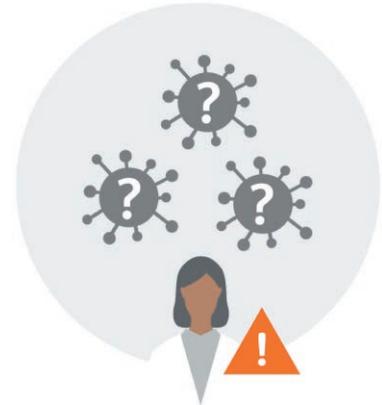
Healthcare personnel, teachers, essential workers, plasma donors and immunocompromised people, as well as racial and ethnic minority groups, present varied circumstances that should be addressed.⁶ The specific characteristics of these populations call for customizable approaches to maximize the impact of available tests.



Solution 3: Create precision testing protocols for specific populations

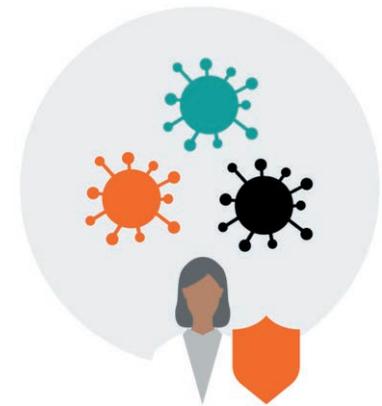
Clinical presentation, risk of exposure and access to healthcare are just some of the necessary considerations when developing specific protocols.

Beyond these individual aspects, community prevalence is another key factor to consider. Communities’ positivity rates can be categorized as indicated in **Figure 2**.⁷



Challenge 4: The unknowns: mutations, durability of immunity, and more

Clinically significant SARS-CoV-2 variants continue to emerge. Variants first identified in the UK (B.1.1.7; Alpha), South Africa (B.1.351; Beta), Brazil (P.1; Gamma), and India (B.1.617; Delta, Kappa), as well as others that could potentially emerge, may be more infectious and/or cause more severe disease than earlier viral strains.⁸



Solution 4: Prepare to face the unknown

Every healthcare institution will face these challenges in the coming years. Precision testing plays a central role in preparing to manage the unknowns.

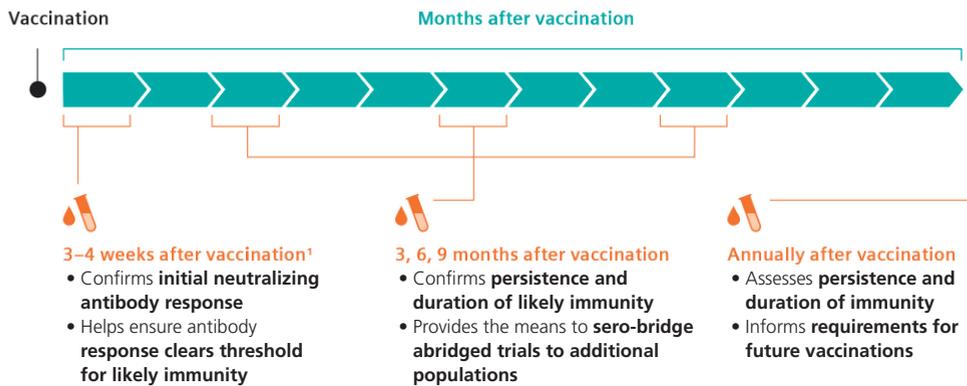
Assessing immunity through testing

There is no definitive evidence about the extent or duration of antibody-mediated immunity. Ongoing research, it is hoped, will quantify correlations between antibody titers and immunity after infection or vaccination.

The Joint Research Centre (EU) and CDC (U.S.) are evaluating whether concentrations of specific antibodies in the bloodstream can help establish a clinical threshold for COVID-19 immunity.

Indicator	Low	Moderate	Substantial	High
Cumulative number of new cases per 100,000 persons within the last 7 days*	<10	10-49	50-99	≥100
Percentage of NAATs that are positive during the last 7 days*	<5%	5%-7.9%	8%-9.9%	≥10.0%

Figure 2: CDC community indicators



¹ For a 2-dose regimen, the proposed timing is after each dose.

Figure 3: The above schematic describes potential uses of antibody testing following vaccination, especially for assessing duration of immunity in various populations as part of planning for long-term vaccine booster needs. Effective implementation of this pathway into clinical practice will require the establishment of a recognized threshold of immunity and the validation of antibody tests for these purposes.

Efficacy studies and serological surveys will guide large-scale strategic decisions on managing the pandemic in the coming years.

Identifying emerging viral variants

Thousands of SARS-CoV-2 mutations have been identified. Some variants may be resistant to antibodies associated with previous infection or current vaccines; others may reduce the effectiveness of antibody-based treatments or the sensitivity of existing tests. Tests that target multiple and/or highly conserved regions of the virus would be better able to identify new variants.

Constant vigilance and ongoing adaptation of precision testing programs to the evolving dynamics of COVID-19 are at the foundation of effective management throughout the pandemic vaccine era.

Conclusions

COVID-19 cases, hospitalizations and deaths are expected to drop sharply as countries roll out vaccinations. Testing programs must evolve to meet changing conditions and ensure that we capitalize on our forward progress.

Four solutions for the testing challenges posed by COVID-19 are:

1. Develop and optimize precision testing programs, complementing the strengths of COVID-19 tests
2. Develop a team-based approach and scalable infrastructure to provide timely access to processing of tests, and communication of results
3. Tailor precision testing protocols to specific populations
4. Encourage organizations to be vigilant regarding the unknowns associated with COVID-19, particularly the impact of virus variants and the duration of vaccine-generated immunity

While we have learned much about this evolving pandemic and this virus, there is still more to learn. Testing programs that continue to meet clinical, organizational, social, and evolving technological needs are, along with vaccines, the cornerstones of executive management of the COVID-19 pandemic. [JpPM](#)

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Luis M. Lasalvia, MD, MIB

Vice President and Global Medical Officer, Siemens Healthineers

Dr. Luis Lasalvia has participated in about 500 events and conferences around the world as key-note speaker, panelist, and moderator. He has submitted

multiple patents in Europe and the U.S. and authored more than 50 papers and articles in peer-reviewed journals and other prestigious publications.

Luis has led numerous teams in innovation and commercialization, in several clinical fields. He has developed new ventures and partnerships, advised start-ups, and led more than 30 large programs in the U.S. as well as several countries in Europe.



Reto Merges

Global Head, Expanding Precision Medicine, Siemens Healthineers

With more than 10 years of leadership experience in healthcare marketing, Reto Merges has a strong track record in building effective teams for

clinical and innovation marketing. In addition, he has four years of experience in China, ramping up research collaborations in China and South Korea. He holds a degree in electrical engineering and information technology from the Karlsruhe Institute of Technology in Germany and has studied at the Nanjing Normal University in China. His scientific background is in the field of medical imaging, where he has authored many publications and holds multiple patents.

Suggested reading

- COVID-19 testing in the vaccine era
- Precision diagnosis in the COVID-19 era and beyond
- Moving toward precision in managing pandemics: Five critical domains for success in public health
- SARS-CoV-2 Serology Testing in the Setting of Vaccination

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