Insights Series

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expanding-precision-medicine

The New Normal

COVID-19 testing in the vaccine era

Challenges and solutions for healthcare executives

A thought leadership paper on how to 'Expand precision medicine'

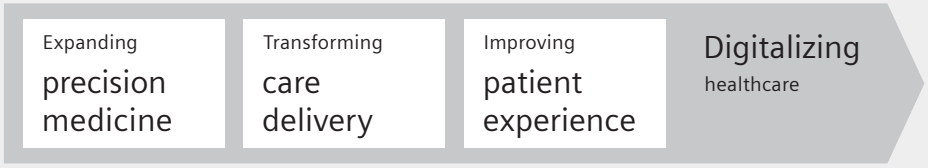
SIEMENS Healthineers

Preface

The Insights Series

The Siemens Healthineers **Insights Series** is our preeminent thought leadership platform, drawing on the knowledge and experience of some of the world's most respected healthcare leaders and innovators. The Series explores emerging issues and provides you with practical solutions to today's most pressing healthcare challenges.

We believe that increasing value in healthcare – delivering better outcomes at lower cost – rests on four strategies. These four principles serve as the cornerstones of the **Insights Series**.



The New Normal

The New Normal is a special edition of our **Insights Series** focusing on the COVID-19 pandemic. This series provides recommendations on how to confront the current SARS-CoV-2 outbreak and its implications, as well as strategies and ideas on how to emerge from the current crisis stronger, more resilient, and better prepared to address the healthcare challenges that lie ahead.

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Executive Summary

COVID-19 testing will continue to have a substantial impact on every aspect of hospital operations throughout the current vaccination era and into the foreseeable future. Quality of care, financial performance, personnel, organizational reputation and the management of patients with other conditions can all be improved through effective management of COVID-19. Healthcare executives play a central role in developing and sustaining awareness, and providing support to their teams in the critical area of COVID-19 testing.

Testing continues to be a cornerstone in the fight against the pandemic on both an individual and societal level. The advent of vaccines and effective treatments offers new scenarios for management and requires refined thinking around testing to derive the most strategic value from it.

Four key testing challenges for executives in the vaccination era are described here:

1. Identifying infected patients accurately and quickly, for appropriate isolation and control measures
2. Infrastructure, access, and logistics complexities associated with testing
3. Tailoring testing protocols appropriate for different subpopulations of patients
4. The inevitable unknowns: virus mutants, the efficacy, duration and persistence of vaccines, and the role of immunity passports

Solutions to these challenges include: appropriately using COVID-19 tests; establishing appropriate clinical and non-clinical processes to meet testing demand; refining testing protocols that address infection prevalence based on clinical and social determinants; and planning for rapid responses to significant changes in the pandemic.

We recommend that healthcare executives take these four key action steps to prepare their institutions for effective long-term management of the COVID-19 pandemic:

1. Emphasize the continuous relevance of a sound and effective COVID-19 testing strategy
2. Foster care team coordination to support appropriate testing infrastructure
3. Develop customized testing protocols to address the specific needs of each relevant subpopulation (e.g. immunosuppressed or immunocompromised, with pre-existing conditions)
4. Prepare organizations to be vigilant about considering the unknowns, including the relevance of virus variants and immunity assessment

By taking these steps, healthcare executives will enable their organizations – and the communities they serve – to better meet the evolving demands of the pandemic with precise, adaptable, and scalable testing strategies.

The challenges

The COVID-19 pandemic continues to place unprecedented strains on hospitals and other care settings. Some of these challenges are nearly universal, like higher pressure on costs, increased stress on personnel and patients, and the impact on care for other medical conditions. Some institutions must also cope with unit-specific challenges, including allocation of sufficient ICU beds and staff to deal with sudden spikes in COVID-19 cases.[1]

One thing has remained clear over the course of the pandemic: a robust testing program is one of the cornerstones of an effective COVID-19 strategy. Handling the pandemic successfully can have a positive effect across the board on healthcare organizations. It can enable better outcomes, improve quality, cost of care, and hospital finances, and enhance organizational reputation.

The critical role of healthcare executives in COVID-19 testing is sometimes overlooked because of the emphasis on technical perspectives, but healthcare executives play a decisive role in creating and executing a successful organizational approach to testing.

Administering COVID-19 tests may introduce new complexities. There is a need for precision in COVID-19 testing technology, but implementation of testing programs goes far beyond the science and technology of the tests and analyzers used. In fact, COVID-19 testing requires alignment of virtually every facet of a healthcare organization. Who should be tested, and when? Which tests are appropriate in different scenarios and contexts? What about the costs? What are the safety guidelines to protect employees conducting the tests? These questions should be answered by the organization based on the best available data. And, because the COVID-19 pandemic and the SARS-CoV-2 virus itself are both continuously evolving, strategic testing frameworks must be designed to quickly integrate new data and guidelines to continually refine testing programs. The following pages detail some of the key challenges to effective testing programs.

1 Identifying infected patients accurately and quickly

Vaccination has the power to transform the COVID-19 pandemic, but the release of effective vaccines does not mark the end of the pandemic, or end the need to test patients for coronavirus infection. Community transmission will continue throughout vaccine rollouts, and potentially after, if COVID-19 becomes an endemic or seasonal infection.

COVID-19 testing saves lives, both directly and indirectly.[2] Identifying patients with active infection enables vigilance and treatment appropriate to the specific patient. Testing also helps to protect the lives of those who have come in contact with an infected individual by ascertaining their infection and/or antibody response status. And finally, isolation or quarantine of suspected or confirmed cases prevents further community transmission.

Unfortunately, there is no one test that fits all needs, but assays that can help to identify people who are infectious are crucial to keeping hospitals operating in a safe, relatively low-risk environment.

Testing programs can reduce the burden of COVID-19 on hospitals and healthcare systems, but they require the appropriate use of precision tests.

2 Infrastructure, access, and logistics complexities associated with testing

Challenges associated with testing go beyond the tests themselves. The best test in the world is only effective if people, especially at-risk populations, have access to it, and if they receive their results in a timely manner.

Even when people have access to testing, the turnaround time between sample collection and receiving results could be reduced by improving capacity to more quickly process tests. Data published in August 2020 by the COVID-19 Consortium for Understanding the Public's Policy Preferences Across States (The COVID States Project) indicate that at that time, many people in the U.S. faced unacceptably long waiting times for results.

According to The COVID States Project, while testing turnaround on nasal swab samples has improved in the U.S., it still falls short of the preferred mark. In many parts of the U.S.:[3]

- Average wait times for COVID-19 test results was 2.2 days in December 2020 (vs 3.9 days in March 2020)
- Racial disparities persist: Hispanic and Black respondents waited 0.7 and 0.4 days longer, respectively, than white respondents, as of December 2020
- A significant lag time – 2.4 days – exists between patients seeking a test and obtaining one
- Testing remains too slow to support effective contact tracing

Additional concerns include availability of lab testing capacity, reagents, personal protective equipment (PPE), and personnel. While many of these logistical challenges have been partly overcome since the early days of the pandemic, they still require careful planning and monitoring as the COVID-19 pandemic rages on.

3 Tailored testing protocols required for different subpopulations of patients

Symptomatic patients should receive prompt testing and results for COVID-19 infection. Asymptomatic patients with known exposure should also be tested. But what are the parameters around this testing? How should community prevalence/test positivity influence testing procedures?

Who else should be tested, and how? What is the appropriate screening for plasma donors? How often should healthcare providers be tested? What about immunocompromised people?

Of particular concern is how to test populations that have factors increasing their likelihood of being exposed to COVID-19, and those who are associated with more severe COVID-19 outcomes (medical conditions like heart disease, chronic pulmonary disease, and diabetes).

In the U.S., communities of Hispanics, African Americans, and other racial and ethnic minority groups face elevated risk for COVID-19.[4] This elevated risk is attributable, at least in part, to social determinants of health, including limited access to healthcare, occupational exposure to infection (many essential workers are people of color), and more densely populated housing.

An effective testing program should be comprehensive, equitable, and tailored to the needs of each subpopulation, because poorly controlled outbreaks in any community are a threat to every community.

4 The inevitable unknowns

Viral mutations are inevitable, and the impact of those mutations is not foreseeable. Mutations can be irrelevant, or they can have clinically relevant effects on infectivity, disease severity, detectability with current tests, response to current treatment, and response to one or more vaccines. New SARS-CoV-2 variants with clinically meaningful characteristics continue to emerge.

Significant variants that were first detected in the UK (B.1.1.7), South Africa (B.1.351), and Brazil (P.1) appear to spread more easily from person to person.[5] Some data suggest that the P.1 variant may bind more readily to cells and may be more likely to evade antibodies compared to the pre-variant virus.[6] It is not yet known whether any of these variant strains affects the severity of illness or the likelihood of reinfection, but clearly this evolving situation warrants careful surveillance enabled by effective testing protocols.

The emergence of such new variants, while expected, highlights the need for continued assessment of vaccines, continued testing when appropriate, and monitoring of tests to ensure that they continue to reliably detect the various mutated strains.

A key unknown is the long-term efficacy of vaccines, even against the currently identified strains. Testing strategies after vaccination would focus more on emerging relevant topics, like assessing immunity status, the need to accelerate diagnosis to accommodate a return to normal social and commercial activity, identifying non-immune people, identifying new mutations, and evaluating the potential need for revaccination based on clinical or social determinants of risk. And since some patients are not eligible for vaccination and others will refuse vaccination, testing them after possible exposure and/or development of symptoms is vitally important.

Solutions

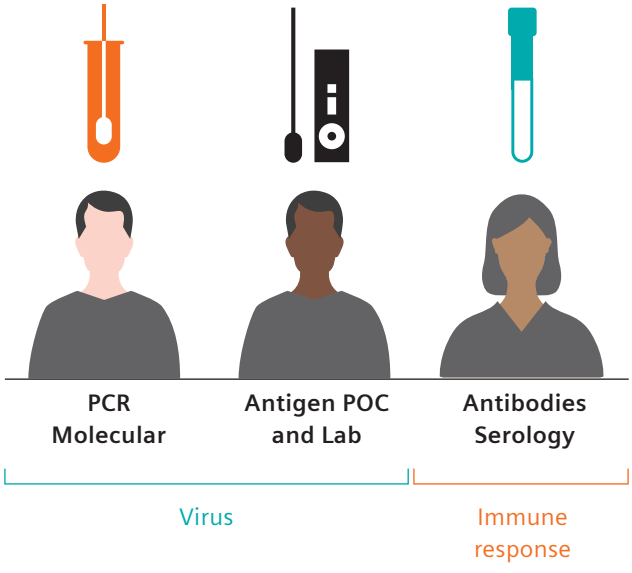
Solution 1: Tests

There is no one test that fits all needs, but assays that can identify people who are infectious are crucial to keeping people healthy and opening or keeping the world's economies open.

There are three main types of tests available. Two types detect viral material to help in the diagnosis: molecular tests (typically, polymerase chain reaction or PCR) and antigen tests. The third type of test detects not the virus, but the immune response to the infection (serological or antibody testing). These latter tests assess whether the patient has been infected with the virus, but even as they can be used as an adjunct test on symptomatic late presenters when PCR is negative, they are not conclusive for diagnosing ongoing infection.

Executives must be aware that the results of each type of test provide different information. No single test is perfect, as each has limitations that need to be considered by clinicians and patients alike to appropriately interpret the results.

A PCR test is intended to detect a portion of the genetic material of the virus, generally from a sample collected with a nasal or throat swab, and is considered the gold standard for detecting current infection. These tests are highly accurate but are not without limitations. While it is considered the gold standard, handling requirements can be stringent and most importantly, the tests may not detect nascent infections in recently exposed people (as available material may not yet be detectable). The accuracy of PCR tests depends on the appropriate sample collection process (which can be uncomfortable), as well as on the effectiveness of lab personnel in handling the sample and managing technical requirements like cycle threshold (Ct) times. In addition, a positive PCR test might indicate a recent infection, although the prolonged detection of viral RNA does not always indicate the virus is still capable of replicating or being transmitted to others.



Antigen tests have emerged as a way to quickly screen for individuals who are likely to be currently infectious. They detect the presence of specific viral proteins (antigens), can produce results in minutes after being loaded onto an instrument, and are available as both point-of-care and laboratory-based tests. Rapid point-of-care antigen tests can be performed by people without extensive clinical qualifications and without the need for laboratory equipment, which expands access significantly. While the speed with which rapid POC tests can produce results is a strength, these tests may only reliably work in the presence of high viral loads.[7]
Lab-based antigen tests are another tool emerging as a means to scale testing throughout our communities. With adequate infrastructure and personnel, communities can scale their COVID-19 diagnostic capabilities by thousands of tests per day and provide results within 24 hours and as quickly as 45 minutes. The typical sample collection is via anterior nasal swabbing, which is more comfortable than nasopharyngeal swabbing.

The other type of test is the antibody test, which can indicate recent or prior infection with the virus. Such tests are also useful for tracking community transmission and estimating total disease burden in a community, as well as detecting prior COVID-19 infection in an individual person. Results for an antibody test are often available more quickly than for PCR tests, and some tests can be run in point-of-care settings. Antibody tests can be quantitative, meaning they can track persistence of immune response over time. See figure 1 for additional comparisons of current tests.

Additional tests used in various settings include self-tests, home-based tests, saliva tests, and breath tests. They are under different phases of development and commercialization in various countries.

Different test types complement each other; they provide different information at different phases of the infection.

Fig. 1

Complementary roles of PCR and serology
With time, viral loads decrease while antibody titers increase.

Satellite Testing

Near-patient testing can be used to identify and isolate infected people more quickly.

Large-scale Testing and Diagnosis

Clinicians use diagnostic tests to determine if people have current COVID-19 infections, enabling patient management decisions.

Management and Monitoring

Management and monitoring are critical in determining the full scope of the disease, combating the pandemic, and rebuilding public confidence.

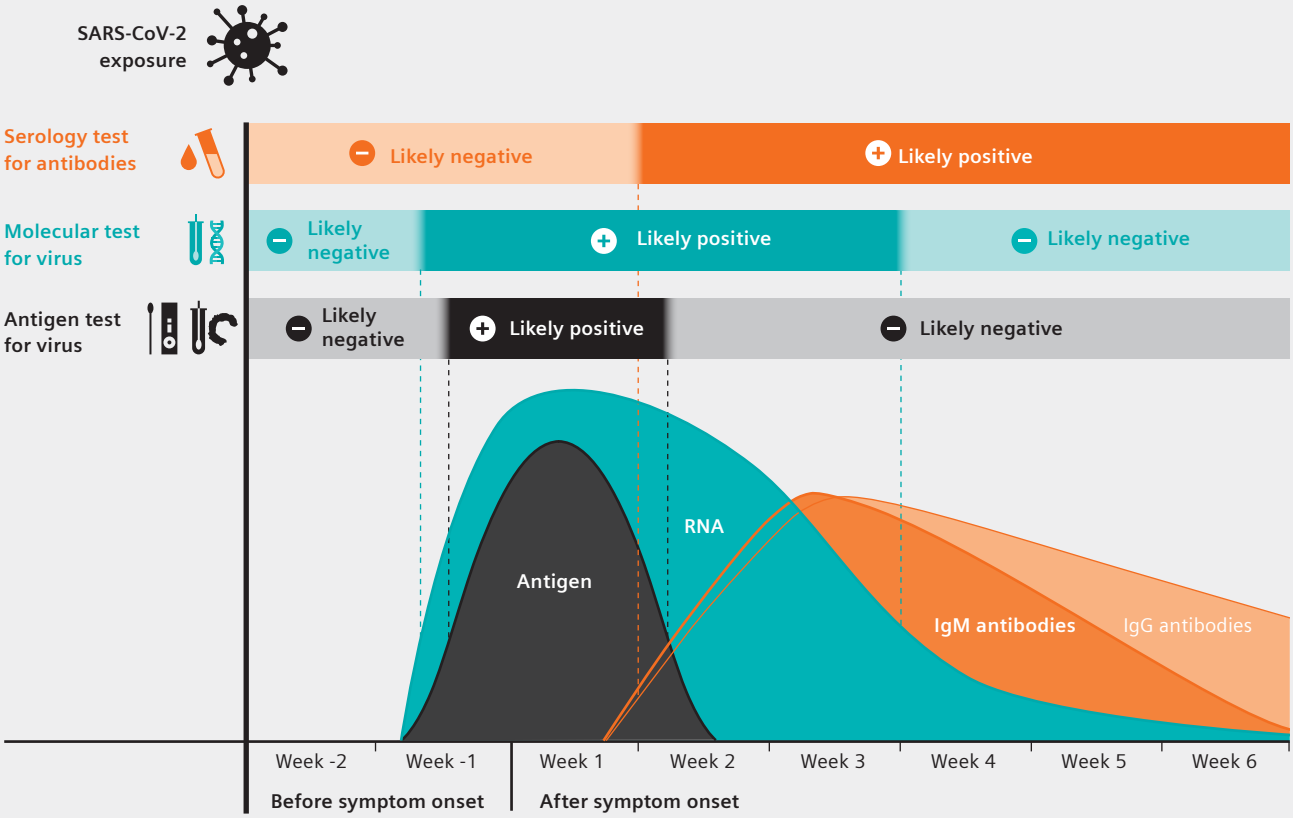
Point-of-care Rapid Antigen Testing
Rapid antigen testing can help communities to get ahead of the spread.

High-throughput Lab Antigen Testing
Intended for fast, safe and accurate, high-scale community screening.

Molecular PCR testing
Gold standard for accurate and early detection of infection.

High-throughput Lab Antibody Testing
Highly accurate for detection and monitoring of immune response through infection and in vaccination.

Point-of-care Antibody Testing



Estimated time intervals and rates of viral detection are based on data from several published reports. Because of variability in values among studies, estimated time intervals should be considered approximations and the probability of detection of SARS-CoV-2 infection is presented qualitatively.

The interpretation of a test result depends not only on the test's accuracy, but also on the likelihood that the person has COVID-19. That likelihood is determined by infection rates in the geographic area and whether the person shows symptoms. If someone from an area with currently high levels of COVID-19 has symptoms typical of the illness but gets a negative result, there is a higher chance it is a false negative, and merits double-checking with PCR testing.

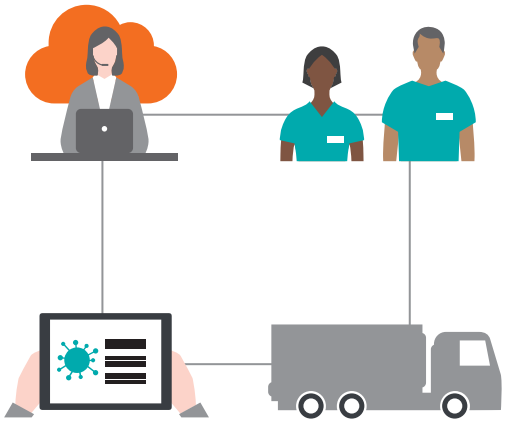
The virus can affect not only the lungs but also multiple physiological systems: the heart, the kidneys, the brain, and the blood vessels. Moreover, hemostasis (clotting) can be affected in patients with moderate to severe infection. Other tests might be used to evaluate the severity of the infection as well as the general clinical condition of the patient: coagulation testing, measuring inflammatory markers (like Interleukin-6), imaging (chest x-ray, ultrasound, CT scan), and blood gas testing. These tests can be critical in developing a complete clinical picture and assigning patients to the most appropriate care pathways.

A comprehensive testing program takes advantage of each of these modalities in a contextually appropriate way to produce the most complete picture of the individual patient as well as the size and shape of the pandemic.

Solution 2: Putting the right processes in place

Beyond the tests, there's a testing infrastructure that ought to be in place at hospitals and other clinical facilities. Personnel (clinicians, nurses, laboratory), testing education (for clinicians and patients), swabs and other supplies, PPE, transportation, and laboratory capacity must all be assembled and regularly maintained to serve the needs of a robust testing program. One weak link in the chain can severely restrict the capacity of the overall program by compromising timing, quality or access. Availability of reagents, sample collection tools, analyzers, and personnel can each be a bottleneck in COVID-19 testing. Healthcare executives can help speed the process by creating a plan for rapidly scaling up testing capacity during local or regional outbreaks.

Fortunately, logistics related to testing for COVID-19 have improved dramatically from the frustrating situations that characterized the early pandemic response in many nations. But healthcare executives must not let down their guard; there is still room for improvement.



There are also effective ways to stretch limited PCR resources:

Pooled PCR testing: A potential workaround to limited capacity for PCR testing is pooling samples from several different individuals into one sample to determine whether any of them show presence of viral particles. Only individual samples from a pool with a positive result are run separately. This method is not appropriate when incidence/positivity is high, but it can dramatically increase the speed and reach of screening in lower-prevalence situations.[8]

Point of care rapid tests: Some countries (India is one example) that don't currently have the resources for many PCR tests have been using point of care antigen tests for many months as a way to supplement their testing capacity. Other nations that have greater PCR test capacity are only just starting to roll out the rapid alternatives in a limited way, because of their concerns over accuracy.

Lab-based antigen tests: By leveraging the existing infrastructure within clinical labs, such as those in hospitals or clinics, communities can rapidly scale up their COVID-19 testing capabilities. One example would be analyzers that can generate hundreds of results per hour.

Less stringent handling requirements: Sample handling and processing errors can decrease the accuracy of reported test results. Tests that require less stringent collection and handling can be of help in stretching testing resources to cover more of the population.

Solution 3: Create detailed testing protocols for specific populations

The U.S. CDC recommends testing protocols that account for community prevalence and overall test positivity. In essence, the higher the positivity rate in the community, the more vigorous the testing efforts should be.[9]

It is important to emphasize that testing can have the greatest impact in communities that face the greatest burden from COVID-19. It is vital for healthcare executives to support and engage their teams in the creation of clear and culturally appropriate community outreach programs, along with testing protocols and sites, to facilitate testing, delivery of results, and delivery of follow-up care to members of high-risk communities.

It's critical for care teams to develop and continually monitor and modify testing protocols for specific patient populations in order to provide timely and accurate information about COVID-19 and to enable early interventions for more patients.

Fig. 2

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 NAAT tests that are postitive during the last 7 days	**<5**	**5%–7.9%**	**8%–9.9%**	**≥10.0%**
Recommended action	Focus on ensuring testing for all close contacts of cases and potentially expanding using a tiered approach to those who might have exposure	Weekly screening testing of select groups plus testing of close contacts	Weekly or twice a week screening testing of select groups plus testing of close contacts	Twice a week or more frequent screening testing of select groups plus testing of close contacts

U.S. CDC testing protocols based on community indicators

Solution 4: Being vigilant toward the unknowns

The tests described earlier in this publication are a pivotal part of the COVID-19 response. The speed with which the scientific and MedTech communities have delivered tests and vaccines is remarkable. Testing will continue to save lives by informing accurate diagnosis, thus enabling both the prompt treatment of infected patients and the mitigation of community spread.

The pandemic has persisted for so long that many people may think it is over, or they may feel like giving up on the mitigation efforts that have disrupted so many lives. But COVID-19 continues to evolve, posing new challenges to healthcare systems. Healthcare executives should maintain a state of vigilance and readiness in their teams, so that their organizations can respond rapidly and effectively to emerging changes in the pandemic and in the SARS-CoV-2 virus itself.

The following developing topics related to testing are not meant as guidelines, but to help as potential approaches to emergent challenges.

Testing in the post-vaccination era

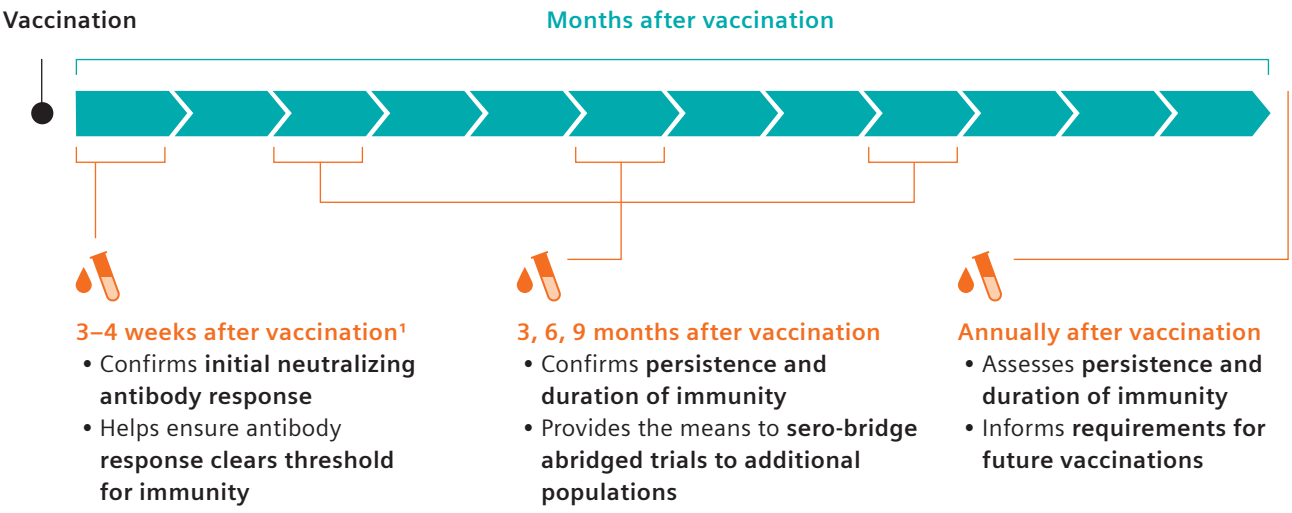
While the number of COVID-19 cases will presumably decline as more people are vaccinated, the virus remains unlikely to be completely eradicated, even if the pandemic is largely controlled. The importance of testing will continue to be high because of several factors. Some people will decide not to be vaccinated (vaccines in the vast majority of countries are non-mandatory), some people might not have access to vaccines for some time, the vaccines themselves will not always be effective (efficacy varies by vaccine and mutation), new viral variants may be resistant to current vaccines, and we don't know how long vaccine-conferred immunity might last. Increased air travel between countries also introduces additional risk of spreading the virus and mutations, depending on disparities in virus control among different regions.

Using testing to assess immunity

At this point in the pandemic, while vaccine companies are using neutralizing antibodies (the ones related more directly to the infection, especially the virus "spike"-associated proteins) to define clinical trial population seroconversion, there is no definitive threshold for antibody-mediated immunity. Ongoing research is likely to elucidate important correlations between antibody titers and immunity after infection or vaccination among different subgroups of patients and at the individual level.

Although more work needs to be done to validate tests for these purposes, measuring SARS-CoV-2 IgG antibodies in relation to vaccination may be beneficial and even necessary for (1) establishing a threshold for protection or likely immunity, (2) confirming an initial neutralizing antibody response shortly after vaccination (approximately 3–4 weeks after each dose), and (3)

The European Union's Joint Research Centre and the U.S. Centers for Disease Control and Prevention are assessing data to evaluate whether concentrations of specific antibodies in the bloodstream can help in establishing a clinical threshold for tests that could identify whether a person is likely immune.



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

tracking of antibody levels (at approximately 3, 6, and 9 months and annually) following vaccination.

The above schematic describes potential uses of antibody testing following vaccination. 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.

Other uses for antibody tests have emerged, including the use of antibody titers to identify ideal convalescent plasma donors for the treatment of patients with severe disease.

Vaccine efficacy studies together with serological surveys are potentially important tools for providing data to guide large-scale strategic decisions on managing the pandemic.

Testing and immunity passports

Testing already has been used by different countries as a passport for international travel, particularly a negative PCR test (and/or antigen test when traveling to the U.S., for example). Evidence of past infection and/or vaccination has been discussed for possible implementation in various ways by different countries, both in the public and private sectors (back to work, back to school, boarding an airplane, etc.), and to enable resumption of social, educational, professional and travel activities. This may offer opportunities for keeping economies open as safely as practical, but it may also raise ethical concerns about privacy and discrimination, among others. The use of Hepatitis and MMRV serology can offer lessons that may be applicable in this instance.[10]

Immunity passports, when implemented via targeted and ethical approaches in conjunction with proper testing and vaccine solutions, have the potential to become optional tools to control the spread of COVID-19.

On March 17, 2021, the European Commission presented a proposal to create a Digital Green Certificate to facilitate the safe free movement of citizens within the EU during the COVID-19 pandemic. Digital Green Certificates will be valid in all EU Member States. A Digital Green Certificate is digital proof that a person has either been vaccinated against COVID-19, received a negative test result or recovered from COVID-19. The Digital Green Certificate should facilitate free movement inside the EU. It will not be a pre-condition to free movement.

In a similar approach, on March 29, 2021, New York began offering a digital pass (Excelsior Pass) app that people can download to show proof of vaccination or a negative COVID-19 test. The "Excelsior Pass" will be accepted at major entertainment venues, as part of enabling more sectors of the economy to reopen more safely.

Vaccination of previously infected patients

According to the CDC in the U.S., vaccination should be offered to persons regardless of history of prior symptomatic or asymptomatic SARS-CoV-2 infection. At the same time, in a world of scarce vaccine supply, antibody testing has been used in the clinical trials of pharmaceutical companies as one way to assess vaccine efficacy. And, as is happening in Europe, antibody testing is being used to prioritize recipients. A good example is Lithuania, which considers testing in prioritizing the vaccine.

Testing and virus mutations and variants

There are approximately 8,000 SARS-CoV-2 mutations that have already been identified though genomic sequencing. The emergence of more serious variants raises concerns about their resistance to antibodies elicited from previous infection or vaccination. As the chances of new variants reducing the sensitivity of tests exist, ongoing surveillance is vital to public health as they may present new challenges to diagnosis and treatment. PCR tests targeting more than one area on highly conserved regions of viral RNA may be useful in monitoring emergence of new viral variants. Properly validated testing protocols, including genomic sequencing, should be able to help in the identification of infection with new mutants and potentially vaccine-resistant strains, should they emerge.

Precise testing, applied appropriately, is the key to managing these unknowns. Healthcare leaders should formulate strategies to deal with these possibilities now, to enable an effective response in the eventuality that emerging issues complicate management of the pandemic.

Conclusion

Testing remains a cornerstone of COVID-19 management. As the pandemic further evolves, so too must testing strategies. Continued refinement of COVID-19 tests, along with the infrastructure to support widespread testing, is vital to obtaining precise information on individual patients and about the status of the pandemic at large.

The authors see four key actions for healthcare executives as they guide their institutions through the COVID-19 pandemic:

1. Healthcare executives should continue highlighting the relevance of testing in the vaccination era, because the virus has the potential to affect virtually every clinical and operational aspect of hospitals and other care settings.
2. Executives should foster care team coordination to support testing infrastructure. Processes include identifying the right tests, providing ongoing education to staff and patients, refining and reinforcing testing logistics, and making plans to scale up testing and patient management as the situation merits.
3. Healthcare executives should lead the effort to develop and implement specific protocols for different subpopulations based on clinical and social factors.
4. Healthcare leaders should maintain vigilance and build responsive teams in their organizations to prepare for the unknown, from clinically significant novel virus strains to unexpected data on vaccine efficacy.

The common thread throughout these actions is the importance of precision testing for COVID-19. The arrival of vaccines does not signal the end of the battle, but rather a shift in tactics. Healthcare leaders who anticipate and prepare for changes in COVID-19 testing will perform a great service to the communities they serve.

Suggested follow-up on

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- Precision diagnosis in the COVID-19 era and beyond. Available at: **siemens-healthineers.com/insights/news/precision-diagnostics**
- Moving toward precision in managing pandemics – Five critical domains for success in public health. Available at: **siemens-healthineers.com/insights/news/moving-toward-precision-in-managing-pandemics.html**
- SARS-CoV-2 Serology Testing in the Setting of Vaccination. Available at: **siemens-healthineers.com/en-us/laboratory-diagnostics/assays-by-diseases-conditions/infectious-disease-assays/vaccine-position**

Information

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Dr. Luis Lasalvia, Vice President and Global Medical Officer, drives for more effective and patient centric healthcare in actual practice, by integrating medicine, technology, and finance. His clinical expertise is coupled with extensive team leader experience in the pharmaceutical and medical device industries. He has covered multiple roles as strategist, practicing physician, deal maker and negotiator, and technology scouter.

Entrepreneur and innovator with international background, Luis has participated in projects in more than 50 countries in all continents, innovating, and creating novel and action-oriented insights, by proactively collaborating, and working together with organizations and top leaders around the globe.

Dr. Luis Lasalvia has been guest speaker, panelist and moderator at approx. 500 conferences and events around the world, submitted several patents in the US and Europe, and authored more than 50 papers and articles in peer review journals and other prestigious publications.

Medical Doctor (Republic University, Montevideo), Master International Business (Pompeu Fabra University, Barcelona), and Postgraduate degrees in Business Administration and in Marketing. Completed Entrepreneurship, risk management, and innovation executive studies at The Wharton School of Business, New York University, and Harvard Business School.

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With more than 10 years' 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 work experience in China, ramping up efforts for research collaborations in China and South Korea.

He holds a degree in electrical engineering and information technology from the Karlsruhe Institute of Technology, Germany, and has studied at the Nanjing Normal University, China. His scientific background is in the field of medical imaging, where he has authored many publications and holds multiple patents.

At Siemens Healthineers, our purpose is to enable healthcare providers to increase value by empowering them on their journey towards expanding precision medicine, transforming care delivery, and improving patient experience, all enabled by digitalizing healthcare. An estimated five million patients worldwide benefit every day from our innovative technologies and services in the areas of diagnostic and therapeutic imaging, laboratory diagnostics and molecular medicine as well as digital health and enterprise services.

We are a leading medical technology company with over 120 years of experience and 18,500 patents globally. With about 50,000 dedicated colleagues in over 70 countries, we will continue to innovate and shape the future of healthcare.

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