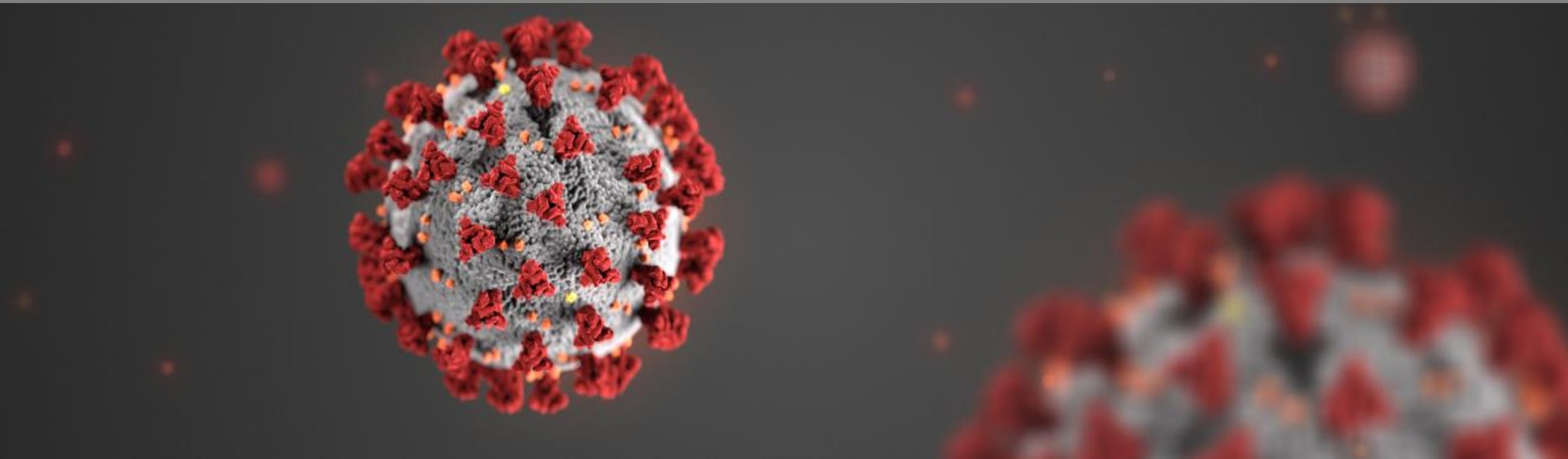
TONY BLAIR INSTITUTE FOR GLOBAL CHANGE

Moving Towards Mass Testing: Practical Advice for African Governments

September 2020



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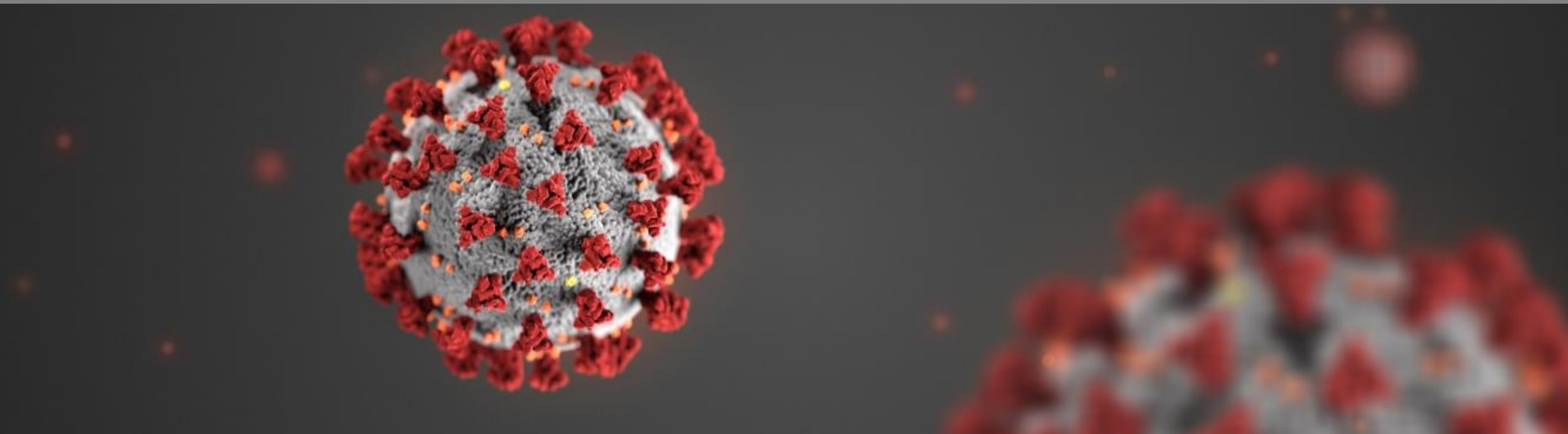
- The Importance of Testing
- Who to Test?
- Testing Strategies
- Recommendations
- Case Studies



In the absence of a vaccine, it is the scaling up of testing that will keep communities safe, allow key sectors to operate productively and keep economies open and connected.

Testing is an essential part of governments' responses to the Covid-19 pandemic, saving lives and livelihoods. **Given the time it will take to develop and scale new therapeutics and vaccines, testing provides governments with a tool to help society adjust to living with the virus today.**

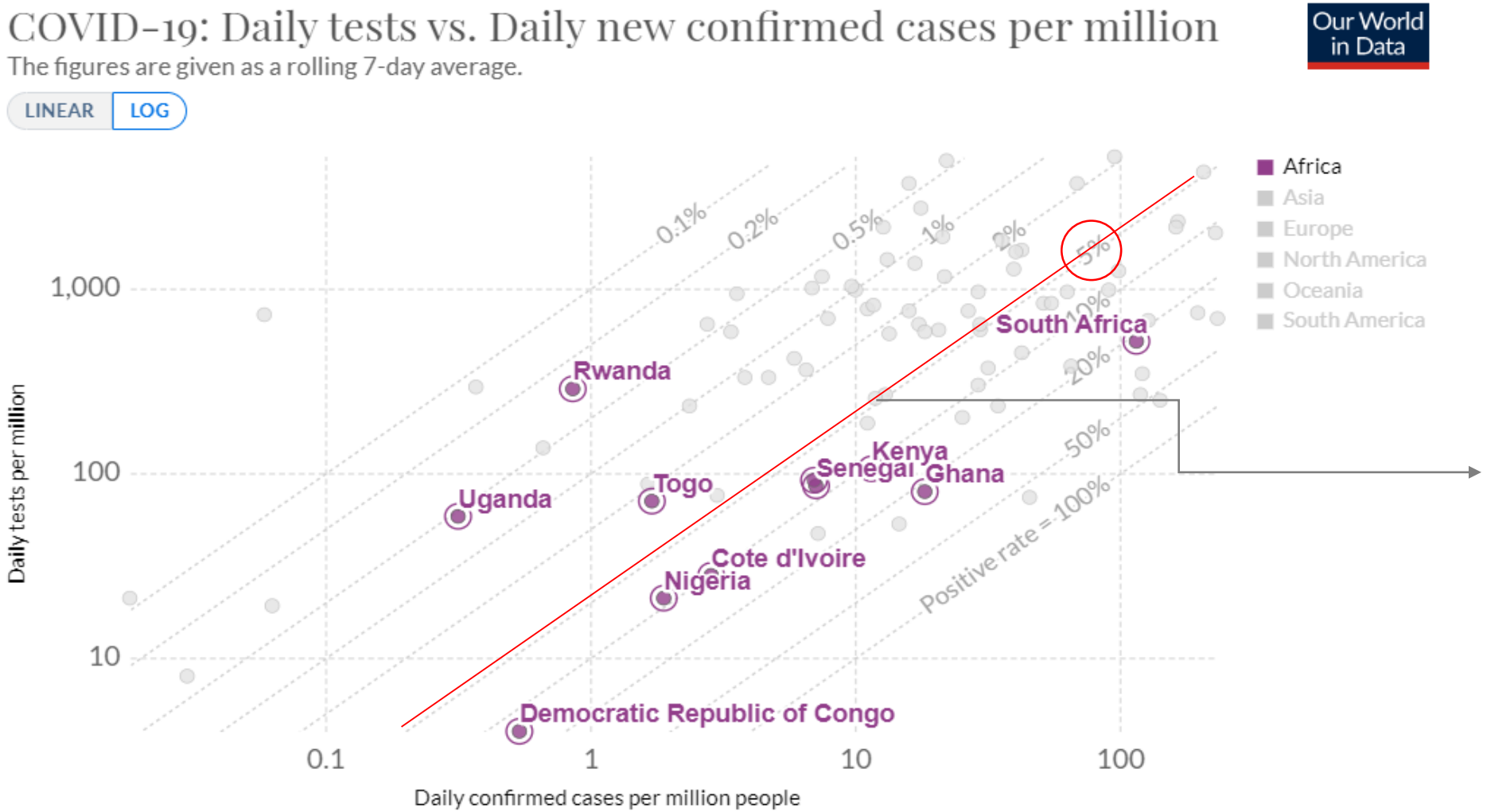
Across Africa the level of testing has not yet been scaled to reflect the size of the outbreak, meaning that while testing may be being used to identify cases of Covid-19, its expansion is not keeping pace with transmission. **This constrains efforts to fight the virus and impedes countries' efforts to reopen economies safely.**

Until now **many countries have faced poor availability of testing equipment and constrained laboratory capacity, exacerbated by a reliance on PCR swab tests,** which has hampered efforts to deliver testing strategies at scale. **However, there is a range of new innovations on the market that diversify testing technologies and create greater choice, while bringing down costs and easing supply constraints without compromising accuracy.** These technologies are already being embraced by the private sector to allow operations to continue, safely.

With an estimated 500 million Covid-19 diagnostic tests required in developing countries over the next 12 months, 75% of which will be needed in decentralised settings (eg, primary health care, community-level care or hospital triage), **the only way to test at scale is via a mixed testing strategy, using a range of tests matched to the context in which they will be used**.

Governments should develop a testing strategy that will enable them to reopen economies safely and stay globally connected, and which will bridge the gap between now and the time when a vaccine is available. This document sets out options to ramp up testing in Africa using a combination of approaches optimised for different uses.

Currently the level of testing in the majority of countries in Africa is insufficient and does not reflect the scale of the outbreak.



WHO guidance states that before reopening, **testing positivity rates should remain at 5% or lower for at least 14 days.**

Governments should **reprioritise their testing regimes to increase coverage**, especially of frontline health-care workers and other high-risk populations, and should **consider using pooled testing as well as innovations in antigen and antibody testing** to complement PCR testing.

Source: Johns Hopkins; Our World in Data (10 August)

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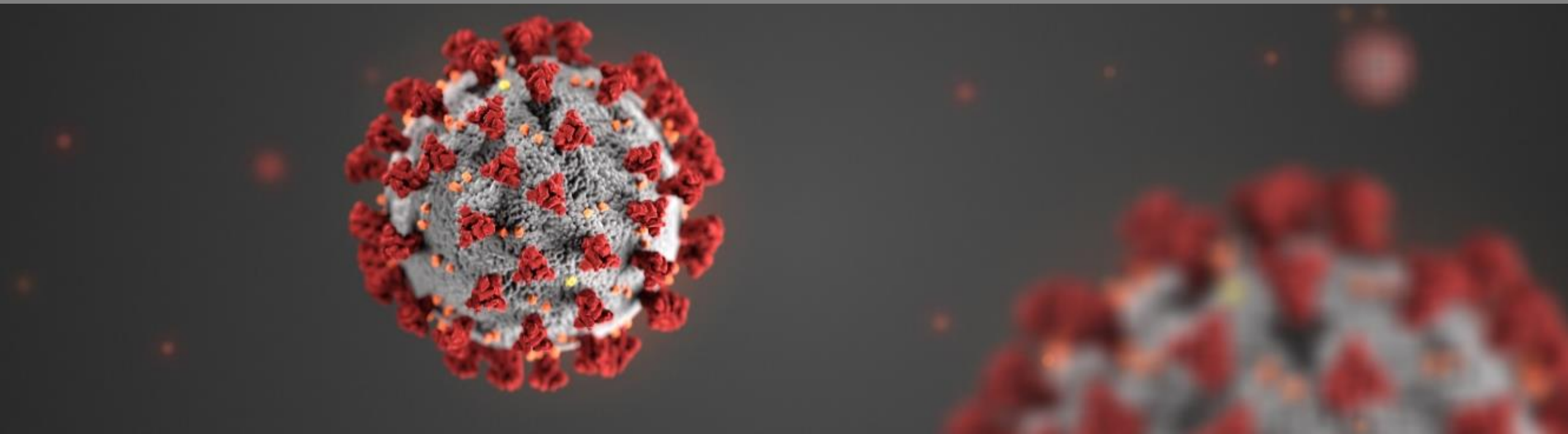
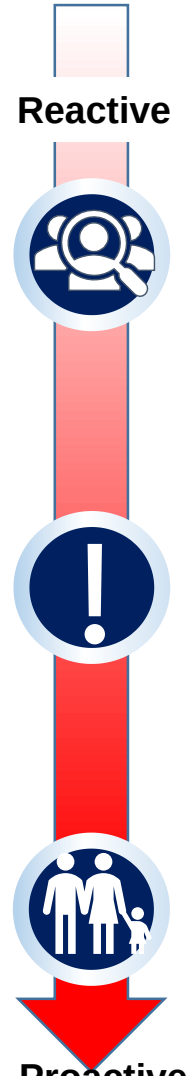


A proactive testing strategy will ensure proper identification of cases and help to actively manage transmission and risk. Scaling testing means moving away from one-off tests to testing regularly and in the right settings.

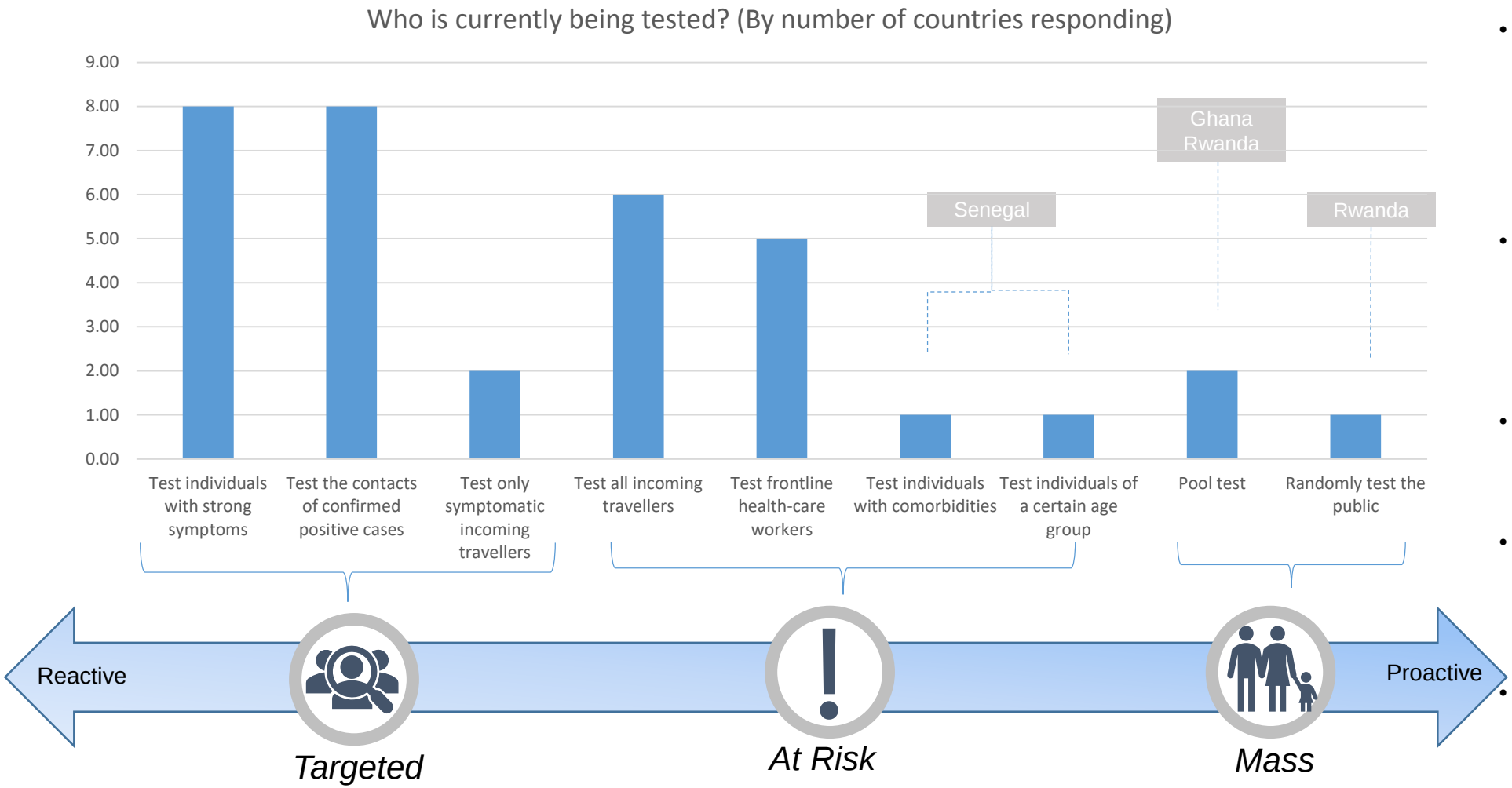


	Description/Example	+ Advantages	- Limitations
Test individuals with symptoms*	• Individuals arriving at health facilities with clear symptoms of the virus. • Identify and test all people with whom that patient has had close contact over the past 14 days.	• Identifies infected individuals for treatment or isolation. • Identifies sources for possible contact tracing.	• Excludes asymptomatic population, who spread the virus unknowingly. • Relies on individuals to self-identify as symptomatic and seek testing.
Test symptomatic contacts of confirmed cases		• Identifies additional infected individuals for treatment or isolation. • Identifies additional sources for possible contact tracing.	• Excludes asymptomatic cases. • Requires a team for contact tracing.
Test all contacts of confirmed cases		• Includes asymptomatic contacts.	• May require significant amount of testing resources and contact tracers. • Not all contacts can be traced – especially where processing times for results start to lag.
Test frontline health and other essential workers		• Reduces likelihood that individuals at highest risk of exposure will spread Covid-19 and reassures those who are safe to work. • Includes asymptomatic individuals.	• Requires regular testing sites and processing.
Test all incoming travellers	• Travellers and vulnerable people are at risk. Vulnerable people are mainly people aged 55 and above or with underlying comorbidity including type 2 diabetes and heart conditions.	• Reduces likelihood of importing cases. • Limited points of entry by air are conducive to testing.	• Reallocates resources away from domestic testing. • Volume and location of land and sea border crossings may be difficult to manage.
Test individuals with co-morbidities		• Prioritises individuals most likely to require hospitalisation, providing treatment earlier to prevent mortality.	• Relies on individuals to self-identify. • May require significant amount of testing resources depending on size of population with comorbidities.
Test individuals above the age of 55		• Prioritises individuals most likely to require hospitalisation, advancing treatment earlier to prevent mortality.	• Relies on individuals to self-identify. • May require significant amount of testing resources depending on size of population that is 55 and over.
Test new/returning entrants to a specific setting (eg, school)	• The risks of transmission are managed by mass, rapid and repeated testing	• Ensures safe environment for productive activities.	• May require significant amount of resources, with regular testing sites and processing.
Test areas with unknown prevalence		• Identifies potential unknown areas of outbreak. • Identifies potential low outbreak areas to implement and encourage behaviour for containing the virus.	• May require significant amount of resources, with regular testing site and processing
Test the public randomly		• Identifies as many cases as possible.	• Requires significant resources.

*Symptoms typically include fever and signs of lower respiratory tract illness

Source: University of Maryland; Patient Info; One medical

Testing strategies in the countries that TBI supports in sub-Saharan Africa vary, but none are currently moving to a mass-testing strategy.*



- Given scarce resources, the **majority of testing regimes are currently focused on symptomatic individuals, their contacts and select high-risk groups.** However, the amount of testing resources dedicated to each varies.
- Many countries are testing additional high-risk groups, with **six countries (at the time of responding) testing incoming travellers and five testing frontline health-care workers.**
- **Senegal is the only country strategically testing individuals with comorbidities and the elderly.**
- **Two countries have implemented pooled testing strategies**, while Rwanda has conducted random public testing.
- **Few countries are currently conducting mass surveillance,** though some are preparing to introduce a more proactive strategy.

**Based on a July 2020 survey of eight TBI countries: Angola, Ethiopia, Ghana, Kenya, Nigeria, Rwanda, Senegal, Sierra Leone; conveys current testing, does not include plans for future testing*

Source: TBI survey and analysis

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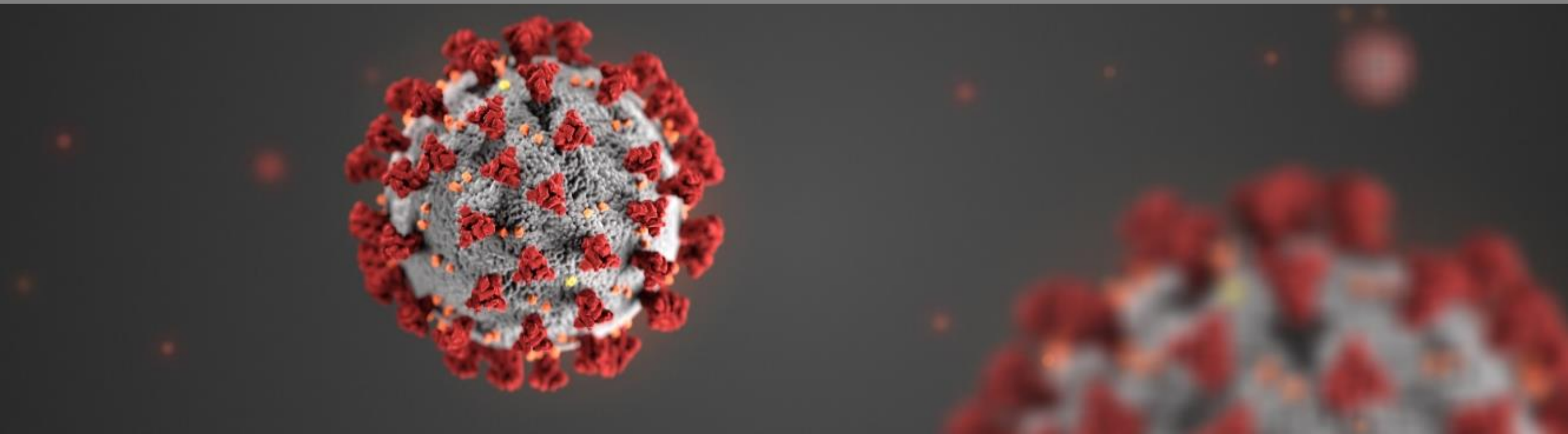


When deciding how to test, diagnostic and serological tests have different uses, but together can form a complete picture of the outbreak.

	Diagnostic		Serological	
Purpose	Tests for the presence of DNA or proteins of the virus**, indicating an active infection**		Tests for evidence of immune system response, **indicating prior infection**	
Type	**PCR***	**Rapid Antigen**	**Antibody**	**Rapid Antibody**
Extraction	Nasal or oral swab		Blood draw or finger prick	
Processing Time	Lab: 4-5 hours – days	Point of care: 20 minutes	Lab: 2-5 hours – days	Point of care: 20 minutes
Cost	$30-$100	USD <$2-$5	$5-$15	
Accuracy	98%-100%	80%-97.6%	Sensitivity: 67-93%*** Specificity: 93-100%	Sensitivity: 80-93% Specificity: 80-100%
Containment Objective	✓ Diagnostic ✓ Surveillance		✓ Surveillance ✓ Proof of immunity	
Resources	Extensive laboratory equipment, trained biomedical lab technicians	Basic kit, can be administered on site by anyone	Extensive laboratory equipment, trained biomedical lab technicians	Basic kit, can be administered on site by anyone

*WHO recommends the use of PCR tests. **WHO continues to review the evidence on antibody responses and immunity to Covid-19, proof of immunity is not yet confirmed. *** Specificity = ability to exclude false positives; Sensitivity = ability to exclude false negatives.

A combination of tests may be the most effective and efficient strategy for containing the virus

Diagnostic – rules in or out whether an individual is currently infected.
- Important for treatment and contact tracing.
- Once testing turnaround exceeds 24 hours, results become obsolete as the tested individual continues to have contacts, possibly spreading the virus or encountering it.

Surveillance – gauges the extent of community transmission and therefore the size of the outbreak.

Proof of Immunity – proves someone has recovered from the virus and may have immunity.**
- Crucial for safely reopening the economy.
- Especially relevant for frontline workers, who may be exposed on an ongoing basis.
- Research on the amount of antibodies needed in the blood to provide protection and the length of time for which protection lasts is ongoing.

Source: FDA; WHO; TBI research

Diagnostic tests are primarily used to work out whether a person is currently infected with Covid-19. They can be used for clinical purposes and, when negative, to provide assurance that someone can safely enter a protected space, eg, a workplace or school.

Diagnostic Tests

PCR		Rapid Antigen
Molecular test that looks for the RNA of the virus.	HOW IT WORKS	Detects proteins or glycans on the surface of the virus.
Deep probe to the back of the nose and throat makes sample uncomfortable to extract. The sample requires reagents to ensure stability in transit, impacting costs.	EASE OF OBTAINING SAMPLE	Anterior nasal or throat swab. Patient can collect themselves with little discomfort. Does not require reagents so less subject to issues with reagent procurement. Highly suitable for repeat tests.
While highly accurate, PCR tests can still give false results due to the sample being taken too early or late, poor sampling technique, or poor supply chain of swabs.	ACCURACY	Some tests are more likely to return false negatives than PCR, but the accuracy of latest innovations approximates to PCR (96%+ sensitivity, 98%+ specificity).*
Requires a laboratory with trained staff and biosafety provisions. Test analysis takes 4-5 hours but with transit and backlogs results can take days or weeks. Some saliva tests omit some stages.	PROCESSING AND RESOURCES	Most tests require a portable analyser and give results within an hour. Assay-type tests (like a home pregnancy test) require no instruments, give results in 15 minutes, so could be done at home
$30-$100. Additional transit, staff and laboratory costs.	COST	From $5 up (some costing less than $2 are in development). Additional analyser costs.

<u>Summary:</u> With global scarcity of reagents, constrained laboratory capacity and high costs of equipment, PCR testing is not a scalable testing solution. Once PCR capacity has reached its maximum, results will be delayed, hindering case identification and management.

<u>Summary:</u> Antigen tests are increasing in availability, improving in accuracy, are less burdensome to administer, cheaper to use, and can provide results rapidly without the need for laboratory capacity at the point of contact, reducing reliance on PCR.

* Covid-19 antigen tests are a rapidly emerging technology and the accuracy of tests currently available on the market varies widely by manufacturer. Governments should use only highly accurate tests.

Antibody tests can be used for surveillance – to understand what proportion and sections of the population have been infected – and to confirm who has recent antibodies that may signal a degree of immunity.*

Serological Tests

Lab Antibody (ELISA, CLIA)**		Rapid Antibody (Lateral Flow)
Detects presence, number and neutralising power of antibodies.	HOW IT WORKS	Detects presence of antibodies.
Blood drawn from vein by a trained phlebotomist (with plasma/serum which is separated in laboratory).	EASE OF OBTAINING SAMPLE	Blood sample from finger prick using a lancet. Patient can extract themselves and insert sample into a plastic cassette to return. A minority of tests use saliva.
Sensitivity ranges from 67-93%, specificity from 93–100%.	ACCURACY	Sensitivity ranges from 80-93%, specificity from 80–100%.***
Requires laboratory with trained staff and biosafety provisions. Test analysis takes from <1-5 hours. Large batches can be analysed simultaneously. Some kits require proprietary analyser equipment.	PROCESSING AND RESOURCES	Administered at the point of care, could be done at home. Result within 15 minutes. Most kits are self-contained. Requires safe disposal for sharps.
Most test kits range from $5-$15. Additional transit, staff and laboratory costs.	COST	Available for as little as $1. Limited ancillary costs.

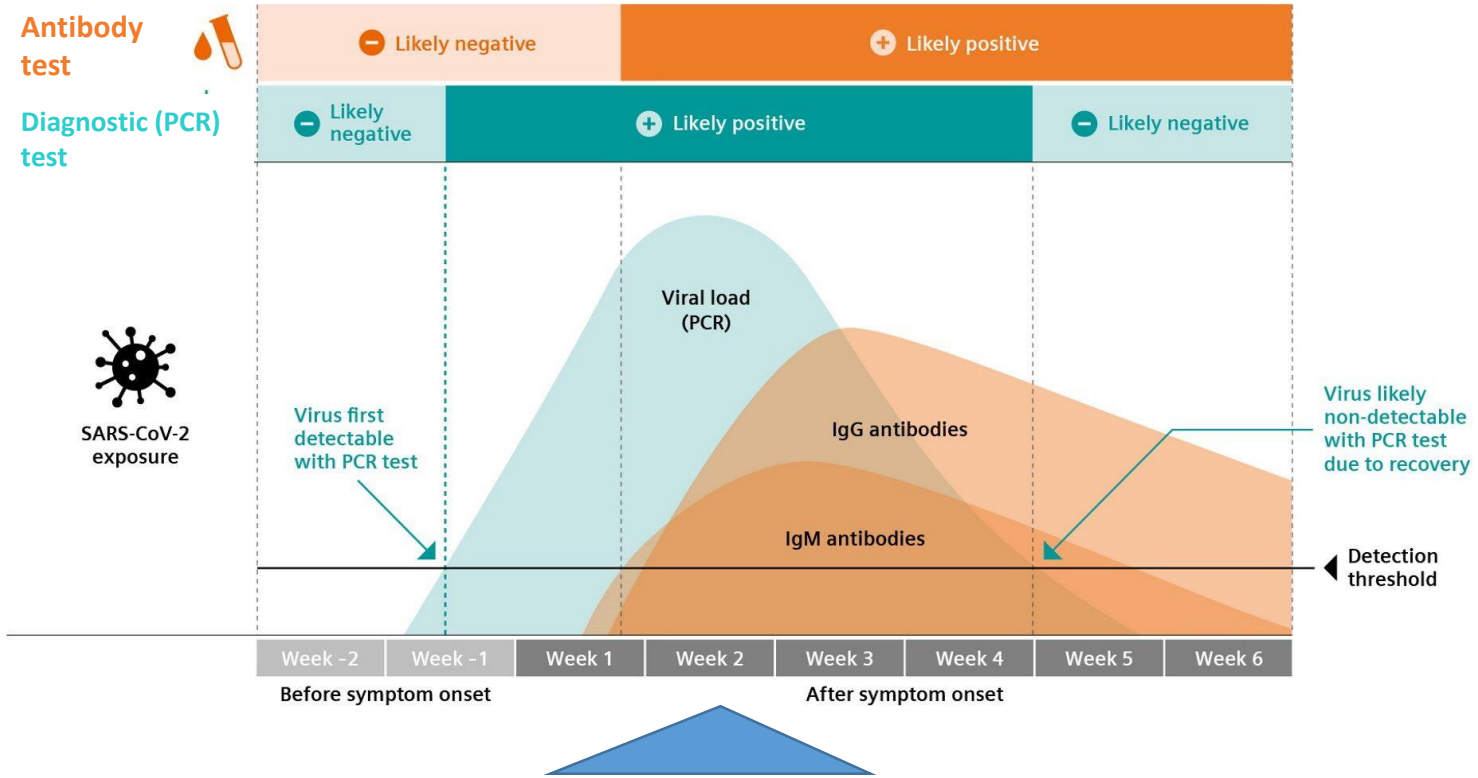
Summary: Lab antibody tests are more resource intensive. **The tests are most suited to understanding not just whether a person has antibodies, but how many are present.** It may be used to determine what proportion of a population has had the virus and how this differs across demographic groups.

Summary: As they are cheaper and easier to use than lab antibody tests, **rapid antibody tests are suited to quickly testing large potential source populations for evidence of past infection, as well as to confirm whether antibodies are present in an individual.**

* Antibodies likely to be retained for several months after recovery but duration and level of protection remains to be confirmed.
** Enzyme-linked immunosorbent assays (ELISA) and chemiluminescence enzyme immunoassays (CLIA) are laboratory-based techniques for detecting antibodies.
*** Where there is reason to expect high prevalence of infection in a particular target population, lower-performing tests might be considered.

Given resource constraints, using a combination of all test types is the most effective and efficient strategy for expanding testing – though how and when they can be used will differ.

The likely outcome of a diagnostic (PCR) or antibody test from exposure to six weeks post symptom onset



PCR and antigen tests can be used from the day of onset, although their effectiveness tails during the recovery period. IgM antibody tests show initial antibodies which could indicate either a current or recent infection, though these markers do not remain long-term. IgG antibody tests show prior infection and may indicate a level of immunity. Using tests in combination should allow an extremely effective diagnosis, as shown above.

While PCR tests have been described as gold standard, specificity (ability to exclude false negatives) **and sensitivity** (ability to exclude false positives) **vary by manufacturer.** Repeat validations of individual tests have differed in their findings.

No one test is 100% accurate, and different tests are designed for different uses. While PCR tests are currently the most widely used, governments should be conscious of their deficiencies. This is important given the critical shortage of PCR reagents and reliance on labs and lab personnel which are limited.

Rapid, point-of-care tests are increasingly effective, widely used and should be judged on their merits. Not everyone will require a laboratory test. Bringing testing to communities reduces burdens on labs and encourages frequent use. **The ability to rapidly triage and assess Covid-19 statuses**, eg, in emergency care or workplaces, **will provide assurance as sectors open.**

Tests may be used in combination. Cambridge University research suggests that PCR false negatives* can be compensated by antibody tests to give a 100% accurate assessment of a person's Covid-19 status.

Even if a test does not have optimal characteristics, it may have a place in a government's wider diagnostic toolkit. Modelling by Oxford University and Paul Romer suggest that for testing and tracing an antigen test with 70% accuracy is sufficient.

Source: Siemens; Combined point of care SARS-CoV-2 nucleic acid and antibody testing in suspected moderate to severe COVID-19 disease; The Case for Mass Testing, Tony Blair Institute.
* Caused by movement of virus from respiratory tract into lungs in mid- to late-stage of illness.

There is a wide range of tests already on the market, with promising new innovations to follow, including some that will be manufactured within Africa.

	Company	Sensitivity	Specificity	Time to result	Orders / Use	Comments
PCR	Yale	N/A	N/A	N/A	Universities and major league sports teams.	Protocol can be followed using reagents and equipment from various vendors.
RAPID ANTIGEN	SD BIOSENSOR	96.5%	99.6%	30 minutes	Purchased 1 million kits.	No instrumentation needed. WHO ordering supply for distribution in low-income countries (LICs).
	lumiraDx	97.6%	96.6%	12 minutes	500,000 tests; 300 machines.	Requires proprietary, portable analyser equipment. Emergency Use Authorisation (EUA) in US.
	Abbott	97.1%	98.5%	15 minutes	150 million units.	50 million tests a month available by October. No instrumentation. $5 a unit. EUA in USA.
	Roche	96.5%	99.6%	15 minutes	Launching late Sept.	40 million tests available per month; 80 million by December. No instrumentation. EUA in USA.
LAB ANTIBODY	BIO-RAD	100%	99.0%	>1 hour		ELISA method. Automated processing options including open ELISA platforms. EUA in USA.
	DiaSorin	97.0%	99.0%	>1 hour	At least 2.4 million kits for serological surveys	CLIA method. Assays for detection of IgM and IgG antibodies.
RAPID ANTIBODY	MOLOGIC	96.0%	98.8%	20 minutes		UK/Senegal manufactured. Available at cost in LICs. Lateral flow assay. Saliva and nose/throat swab varieties available.
	HEALGEN	100%	97.5%	10 minutes	Serological surveys	

Other manufacturers are available; the FindDX website has details of commercially available tests and those in development.
Source: TBI analysis; US Food and Drug Administration; SD Biosensor; LumiraDx; Abbott; Roche Euroimmun; Bio-Rad; DiaSorin; Healgen; Siemens

A range of innovations in sample collection and analysis are emerging with the potential to significantly increase testing capacity and reduce costs.

Tests Developed for Use With Saliva Samples

Assays are being developed to facilitate the use of saliva samples in both molecular and antibody testing. Saliva samples:

- **Can be extracted by the patients themselves at home**, potentially removing demand for testing centres and reducing contact with medical staff, limiting the risk of infection. The RUCDR Infinite Biologics test is administered at home and mailed by the patient to a lab for analysis.

- **Can be easier and quicker to analyse**. The SalivaDirect open-source protocol omits the nucleic acid extraction stage in PCR testing with little impact on sensitivity, reducing turnaround time. Other emerging test techniques using saliva samples include gel electrophoresis, which removes need for enzymes and equipment and does not require temperature-controlled supply chains, and RT lamp, which can provide a result in 30 minutes and requires a simple water bath rather than thermocycling.

- **Do not require swabs or reagents to keep stable**, reducing costs.

Rapid Tests Available at Cost for Low-Income Countries

MOLOGIC
BIG IN TINY SCIENCE

Mologic Ltd has established an independent manufacturing facility in the UK to make 40 million rapid antibody tests for sale at cost price to low-income countries.

- **Target price ceiling of $1.50 per unit,** or less at scale.

- **Non-invasive saliva and minimally invasive nose/throat swab variants** will also be available with results ready in less than 20 minutes.

- **Combined rapid antigen and antibody assay currently in development** to maximise detection rates.

- **Dedicated supply chain for sub-Saharan Africa, through manufacturing capacity at diaTROPIX's facility in Senegal.** Validations of accuracy undertaken by Institut Pasteur.

PCR Testing Without Laboratory or Sample Handling

dna nudge

The DnaNudge analysis cartridge produced by Imperial College London is a rapid, portable PCR testing solution which does not require laboratory space or sample handling.

- **Results in 90 minutes,** capable of analysing up to 15 samples per day.

- **The innovation has been licensed in the UK for use within both clinical and non clinical locations.**

- Technologies like this may have wide-ranging applications, eg, putting PCR test capacity into basic health facilities without the need for laboratories and with minimal training.

Source: Clinical Infectious Diseases; Yale University Preprint; US Food and Drug Administration; US Food and Drug Administration; US Food and Drug Administration; Microbial Biotechnology; Reuters; Mologic; DnaNudge

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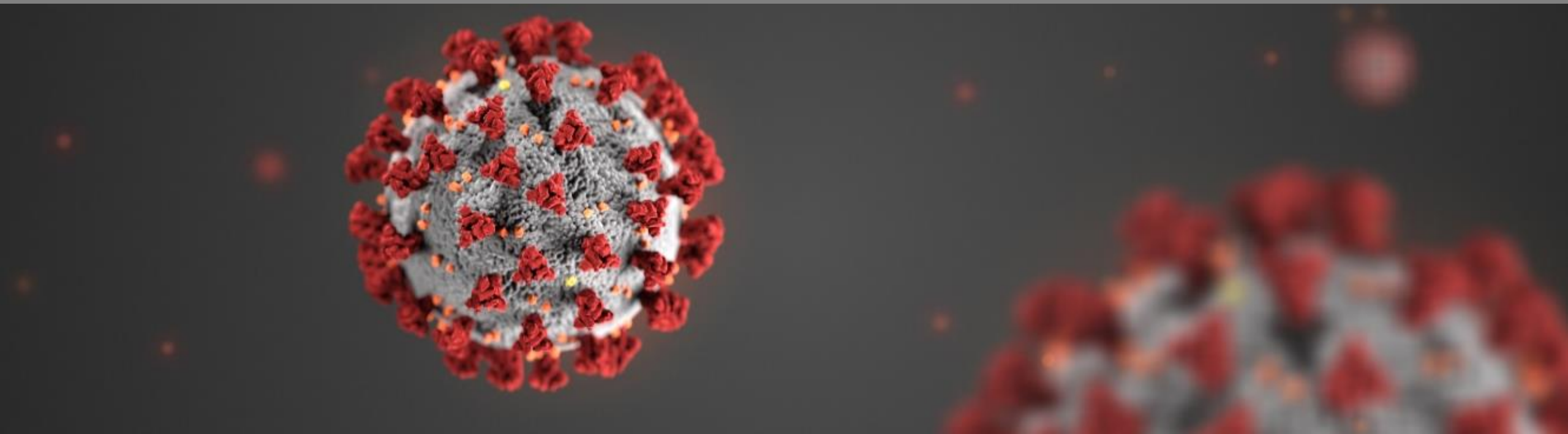
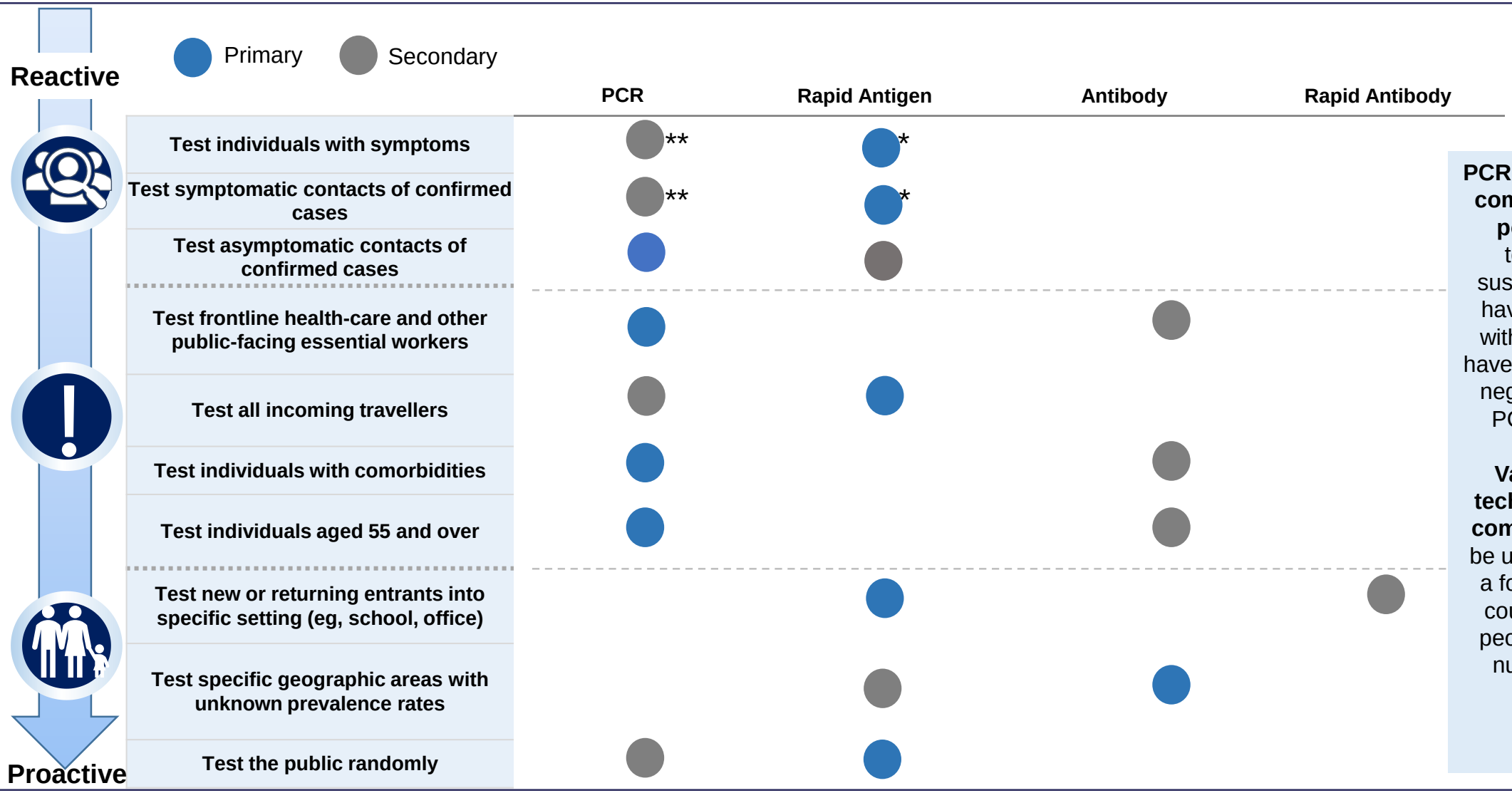


Scaling to a proactive testing strategy calls for a rethinking and reshuffling of resources, including the use of rapid antigen testing to confirm infection, where a positive result is likely, with PCRs used to confirm negative results.



PCR and antigen tests used in combination are particularly powerful. While scaling a testing strategy, strongly suspected cases (people who have sustained close contact with a confirmed case or who have strong symptoms) who test negative may also be given a PCR test as a follow-up.***

Various antibody testing technologies can be used in combination. Rapid tests may be used in the first instance but a follow-up, lab-analysed test could be used for vulnerable people who need to know the number and quality of their antibodies.

* Given high probability of positivity and high accuracy of positive results. ** PCR if rapid antigen result is negative. *** If using antigen tests in this way to confirm symptomatic cases, it is critical to use those which have very high sensitivity rates (in the high 90s). **Source:** TBI Analysis

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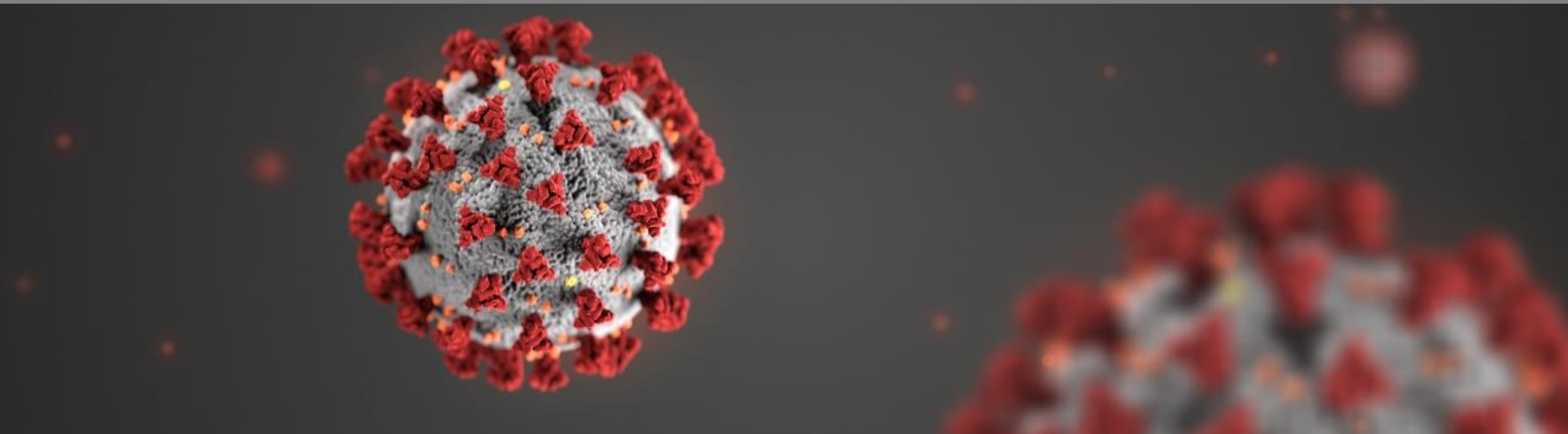
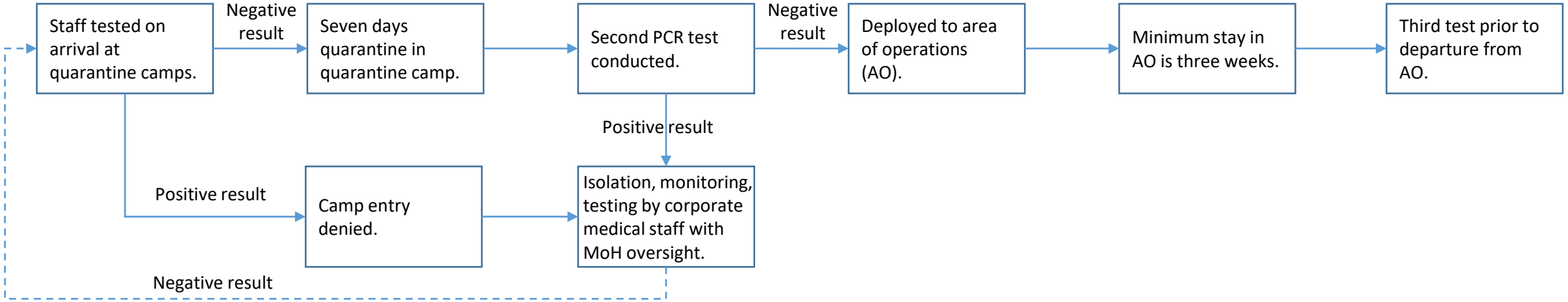


Case Study: Using Testing to Maintain Activity in the Oil and Gas Sector in Northern Mozambique

Organisation: International consortium for liquefied natural gas (LNG) development

Process for employees:



Scope: There are currently six quarantine camps which house between 50 and 150 personnel each. The AO houses a workforce of approximately 2,000 personnel.

Type of testing: PCR swab test, conducted by medical staff employed on site by the consortium under the oversight of the Ministry of Health.

Case management: Cases of Covid-19 are managed under the oversight of the Ministry of Health in isolation, as per national protocols. In the event of a positive test the individual goes through the entire testing and quarantine process again before being allowed into the AO.

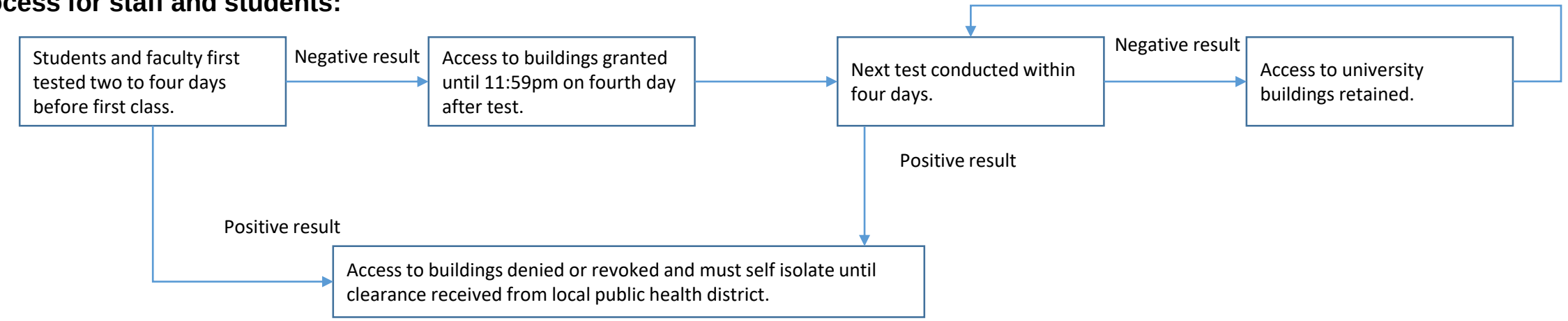
Impact: The consortium is able to protect its sizeable workforce while continuing to operate, mitigating the financial and reputational risks that would arise if it were no longer able to function.

Source: Case study provided by GardaWorld, the risk management and services partner for the consortium.

Case Study: As Pressure Mounts for Schools, Colleges and Universities to Reopen, Some are Experimenting with Compulsory and Regular Testing

Organisation: University of Illinois Urbana-Champaign

Process for staff and students:



Scope: All students and faculty are tested twice a week through an on-campus service and their results are tied to their University ID. Tests are free.

Type of testing: PCR saliva test, conducted at multiple testing sites on campus. Results are usually emailed to participants within five hours. Currently the University tests between 10,000-15,000 people per day, equivalent to 2% of the US's total tests.

Case management: Local department of public health contacts student to collect tracing information and coordinates with university to identify appropriate place for them to isolate. Isolating students may participate in classes online where they are able.

Impact: The university is able to keep 47,000 students learning safely, and take informed decisions about access, based on real-time transmission data

Source: University of Illinois Urbana-Champaign