South Africa's coronavirus testing strategy is broken and not fit for purpose: It's time for a change

The COVID-19 epidemic in South Africa (SA) is now in its exponential phase,[1] and the focus needs to be on mitigation of severe illness and death rather than aspiring to containment. Cases are increasing rapidly in many areas, most apparent in Western Cape Province, where the testing rate per capita exceeds all the other provinces, and testing is more targeted and focused on suspected 'hotspot' communities. The doubling time of mortality in the Cape Town metro is now 8 - 9 days,[2] and although the health system is better prepared as a result of the initial lockdown, major cracks are starting to show, causing a deterioration in clinical service that will threaten the country's response to the epidemic if not stemmed. The Western Cape is only the forerunner, and urgent action needs to be taken now, to re-focus the testing platform.

Diagnosis of COVID-19 relies on a reverse transcriptase-polymerase chain reaction (RT-PCR) test that is simple but laborious. The turnaround time (TAT) of the test, i.e. the time from the sample being taken to communication of the result, is influenced by the speed at which the sample reaches the laboratory, the laboratory's capacity to run the test (access to reagents and test kits, number of analysis machines, availability of staff, errors leading to need for retesting), and the communication process for results. Although early reports by the National Health Laboratory Service (NHLS) CEO indicated that the NHLS would be able to test 36 000 per day by the end of April 2020,[3,4] this has not materialised. Reasons for this failure include factors internal to NHLS planning, as well as the realities that SA is dependent on foreign companies for testing materials and kits, for which there is a high demand globally, leading to serious shortages.

Currently, the number of tests received exceeds all capacity of the centralised NHLS laboratories earmarked to do testing, and results are not being made available within 12 - 24 hours of sampling. In many parts of the country, including in the Western Cape, TAT has increased from <24 hours to 5 - 14 days[5] as a result of a number of failures in the pathway of tests getting to laboratories and overwhelming of the laboratory capacity. For instance, at Greenpoint Laboratory in Cape Town, which has capacity for 1 000 tests per day and is working 24/7, 10 000 untested samples from the community and hospitals were waiting to be tested as of 7 May (Dr M Hsiao, personal communication).

Laboratory TAT is critical in determining success of both the community screening and testing (CST) programme and hospital management of cases. SA's ambitious CST programme relies on identifying infected persons, isolating them, tracing their contacts, and isolating or quarantining them. This has the potential to slow the rate of transmission of the virus, especially if implemented effectively at an early stage of the outbreak. The house-to-house-based visiting strategy is unsustainable, however, and has limited potential to interrupt community transmission on multiple fronts. Foremost, a single household visit, while identifying or excluding the presence of a symptomatic case at a point in time, has limited value if such visits are not undertaken regularly (probably every 3 - 4 days), which is not realistic even in the short term. This is manifest in the fact that, despite up to 28 000 field workers having been mobilised to undertake screening at households, each field worker will on average need to take on the responsibility of screening >500 of the 14.5 million households in SA. In practical terms, each field worker is likely only to be able to undertake screening of ~30 households per day, so, repeat household visits will at best take place 6 weeks (rather than 3 - 4 days) later. Also, sustaining this sort of approach over what is expected to be at least 2 - 3 waves of outbreaks over the next 2 - 3 years is not feasible. The situation is compounded by 50 - 80% of individuals infected with SARS-CoV-2 being asymptomatic,[6] so they would not even be identified as needing testing.

Nevertheless, identification of even only a quarter of infectious cases, coupled with adequate tracing of their contacts and ensuring isolation (of cases) and quarantine (for up to 14 days) of test-negative contacts, could assist in slowing the rate of (not preventing) community transmission of the virus and mitigate to some extent the anticipated surge in severe COVID-19 cases occurring over a very short period of time. By doing so, healthcare facilities may be somewhat better equipped to deal with the anticipated surge of COVID-19 cases in the current wave of the SARS-CoV-2 epidemic over the next 2 - 3 months in SA.

However, for this CST strategy to be effective requires a clear line of sight in terms of efficiency of testing, isolation of cases as quickly as possible (within 12 - 24 hours of being tested), and effective and immediate tracing of their close contacts. An average person may have ~20 close contacts (defined as someone who spends more than 15 - 30 minutes within 1.5 m of the person) per day. Assuming that isolation occurs on day 3 after symptom onset, and close contacts occurred from at least 2 - 3 days before the onset of symptoms, for each case there would be ~120 close contacts to be followed up. For this strategy to assist with slowing the rate of spread of the virus, tracing (and physical contact for screening for symptoms) of ~80% of contacts is required.[7] Although possibly achievable in the initial phase of the epidemic during the attempt to contain community transmission, it becomes an unrealistic goal to aspire to when identifying 400 'new cases' each day, as that would require tracking and physical tracing of ~80% of the 5 200 contacts.

As the inevitable occurs and community transmission continues, even if at a lower rate, aspiring to achieve what was not attainable prior to the lockdown when cases were few and only ~20% of contacts were actually traced, would be setting up for failure in the context of addressing this goal of testing. This is exacerbated when there is a delay of 5 - 14 days in the TAT for delivery of results. In essence, identified cases are being placed into isolation (if based on when the test result becomes available) at a time point when they are no longer infectious.[8-10] Rather, considering the delay in TAT, the current 'new' cases reported in SA reflect cases that were probably sampled about a week ago. Although, if there is uniformity in rates of testing across different settings, this could be informative in geospatial mapping of the epidemic, the same could be achieved, and would be subject to less biases between settings, using rapid and less costly serology assays that have now been licensed in SA. However, this accepts that the strategy of actively searching for infectious cases is now likely to yield little value, and that there is acceptance that transmission will be ongoing (and will not be reversed by going back into a harsher lockdown).

The focus should rather be getting public buy-in to adopting the non-pharmaceutical interventions of maintaining physical distancing, avoiding 'mass gatherings', meticulous performance of

hand hygiene, wearing of cloth masks and good cough etiquette by everyone to reduce the risk of transmitting contaminated droplets, and decontaminating regularly used surfaces. These measures can be supplemented by asking people with symptomatic respiratory infection to self-isolate, and possibly go for testing (if resources permit) to make a decision on early return to daily activities before the 14-day isolation period expires.

The key focus of diagnostic testing by RT-PCR needs to shift to patients being admitted to the hospitals, both to inform management of the patient and to limit the likelihood of nosocomial spread of SARS-CoV-2. The TAT for this cannot be anything more than 12 - 24 hours if it is to achieve any of these goals of testing. When a person with COVID-19 is admitted to a hospital, it is critical that they do not infect uninfected patients and staff. In hospitals, we achieve this by triaging patients into those who are COVID-19 suspects (a 'person under investigation' – PUI) and those who are not. We manage patients in PUI and non-PUI wards. If the test result is positive, that person will be cared for in a dedicated COVID-19 ward or intensive care unit (ICU), and if it is negative they will be nursed in a completely separate ward or separate ICU.

Our hospitals have a finite number of beds and can only function without overflowing if patients can be diagnosed and treated rapidly, allowing smooth patient flow and discharge. If the SARS-CoV-2 RT-PCR TAT is slow, delay to diagnosis increases the number of persons on the PUI wards, new PUI wards need to be opened, and a bottleneck begins. The longer the TAT, the worse the situation gets. As the epidemic accelerates in SA, the number of patients needing to be admitted to hospital as PUIs and subsequently COVID-19-confirmed cases is rapidly rising, and the system is becoming overwhelmed in high-prevalence areas. If this testing, triage and management system in hospitals were to be abandoned in favour of inferring that all patients are PUIs, our personal protective equipment resources would rapidly become overwhelmed and healthcare worker (HCW) infections would probably increase dramatically, threatening the workforce and the integrity of the health system. We therefore need to prioritise testing in suspected severe COVID-19 that requires admission to hospital.

In short, the breakdown of clinical services and the inability of CST to achieve its goal due to the prolonged testing TATs leaves us with a broken system in high-prevalence areas such as the Cape Town metro, and other predominantly metro areas of the country. We believe that a wholesale change is needed, and propose the following immediate action:

1. Stop the testing and contact tracing components of the CST programme in high-prevalence areas of the country where the capability to contact trace has been diminished and is unable to influence the epidemic. As the epidemic accelerates across the country, the prevalence of infection would need to be monitored for, in all geographical areas, and rolling changes would need to be made. In its place, community health workers can continue to screen, reinforce messaging around non-therapeutic interventions to slow the rate of virus transmission, and advise management in the most vulnerable districts without sending persons for testing. In tandem, self-reporting of symptoms via an app-based programme on mobile phones countrywide should be adopted, to allow monitoring of disease activity and self-isolation of symptomatic persons for 14 days on the probability of COVID-19. We believe that cellphone coverage in SA is wide enough to provide useful data, and there are already apps fit for this purpose. Where resources allow, testing to confirm negative status to allow early return to work sooner than 14 days could be undertaken, but not at the expense of undermining TAT in hospitalised patients. Low-prevalence areas of the country, where TAT of ≤24 hours is possible, could continue CST until such time as prevalence dictates a change.
2. Characterisation of community seroprevalence of SARS-CoV-2 infection (i.e. using antibody detection assays), not to be confused with identification of infectious cases (RT-PCR for virus RNA detection), should be done via systematic and repeat seroprevalence studies using validated rapid serology assays. Doing this would assist in geospatial mapping of the epidemic that could inform a more measured approach for developing district or regional strategies to reduce the rate of community transmission, and help anticipate demands on healthcare services.
3. Focus testing resources on specific groups within the population, for which a rapid TAT (12 - 24 hours) result will effect significant change:
   a. Hospitalised patients, to allow rapid diagnosis, optimal clinical and infection prevention management of suspected severe COVID-19, and patient flow to enable hospitals to cope with escalating numbers as we climb the exponential curve to the peak.
   b. Symptomatic HCWs and their close contacts, to rapidly streamline isolation and quarantine to limit hospital outbreaks and protect the integrity of the health service. The same could be applied to other essential services personnel.
   c. High-risk group surveillance and testing, including patients and staff at long-term care facilities, which international studies indicate are hotspots for outbreaks.[11]
4. Convene an intersectoral government task force to analyse the barriers to operational flow of the entire testing system and make recommendations for a new testing strategy.

Worldwide, nations are learning how to manage the COVID-19 pandemic in real time and within their, and the world's, resource constraints. Adaptation to the global and local situation is critical. Our current testing strategy, while useful in the very early days of the epidemic in SA, is no longer fit for purpose and now needs to be adapted to protect the integrity of our health system during the mitigation phase of this wave of the pandemic.

The authors have no conflicts of interest to declare.

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