SARS-CoV-2 testing for public health use: core principles and considerations for defined use settings

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With many regions of the world seeing a rise in severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) cases, borders, schools, and workplaces are partially or fully closed, and physical interactions are restricted. Although vaccine roll-out has begun in numerous countries,[1] it will take many months to complete. Meanwhile, communities are reliant on diagnostic testing in conjunction with other public health measures to keep facilities open. Until now, testing for SARS-CoV-2 has been mostly limited to use for clinical confirmation and care, but some countries are now implementing widespread testing for public health use and risk management. However, there is little guidance available to policy makers on how to translate the scientific information on SARS-CoV-2 diagnostic tests into practical policies for widespread testing in non-clinical settings.

The development of rapid antigen tests, which can be used outside of the laboratory with fast turnaround times, has made widespread testing feasible. Although there were initial concerns about test performance, emerging evidence suggests that the most sensitive tests can detect 97% of infectious cases, based on the relationship between viral load and infectiousness.[2] Moreover, modelling analyses show that frequency of testing and speed of reporting have a greater influence than test sensitivity on the effectiveness of SARS-CoV-2 infection surveillance.[3] Although the nasopharyngeal specimens required for many antigen tests are challenging to obtain, tests that utilise alternative sampling methods, such as nasal or saliva specimens, are becoming available and could provide the ease of use necessary for widespread testing.[4,5] These core principles (ie, the importance of fast test turnaround times, the relationship between test positivity and infectivity, and the ease of use for sample colletion) are applicable to all SARS-CoV-2 testing policies for public health use, along with cost considerations relating to high-volume testing.

Beyond the core principles, several factors specific to the setting in which the test is to be used should be considered when designing testing policies. Settings can be defined according to patterns of contact and level of exposure, and include: points of entry, where people transit across defined borders; semi-closed communities, where the same people come together repeatedly; and random exposure settings, where people meet for a single exposure and then disperse (figure).

The testing intensity required for entry points differs according to the level of risk of spread, which varies according to the frequency and distance of travel, and the prevalence of disease. The mode of travel strongly influences its frequency; air travel is usually planned and less frequent, whereas land crossings are more spontaneous and regular, even occurring daily. Prevalence of disease has a greater impact on risk when individuals cross from a higher prevalence area into a lower prevalence area, compared with similar prevalence areas. Long distance journeys have additional risk associated with the period of travel, as they are likely to entail means of transport involving many people (eg, aeroplanes, buses, or trains). Additionally, quarantine restrictions might need to be more flexible for commercial vehicles than for non-commercial vehicles, for economic reasons.

Currently, strategies for reducing transmission in semi-closed communities are reliant on public health measures, such as physical distancing and mask wearing, supplemented by testing symptomatic individuals and contacts in health-care settings in line with country policies. There is still a potential for outbreaks in these communities, leading to quarantines or temporary closures. Strategies for additional proactive testing to detect asymptomatic infections and prevent spread can range from testing of individuals who are at high risk of being exposed to the virus (eg, those in frontline roles), to mass-testing the whole community. Testing in semi-closed communities is more effective at preventing outbreaks when done frequently, especially for individuals with a high risk of exposure,[3,6] but the optimal frequency of testing is dependent on community-specific factors, such as total population, proportion of the population who consistently wear masks, and presence of a contact tracing programme.

Random exposure settings are particularly susceptible to the cluster-based superspreader events characteristic of COVID-19. Risk can be reduced by preventing the virus from entering the three Cs: crowded places, close contact

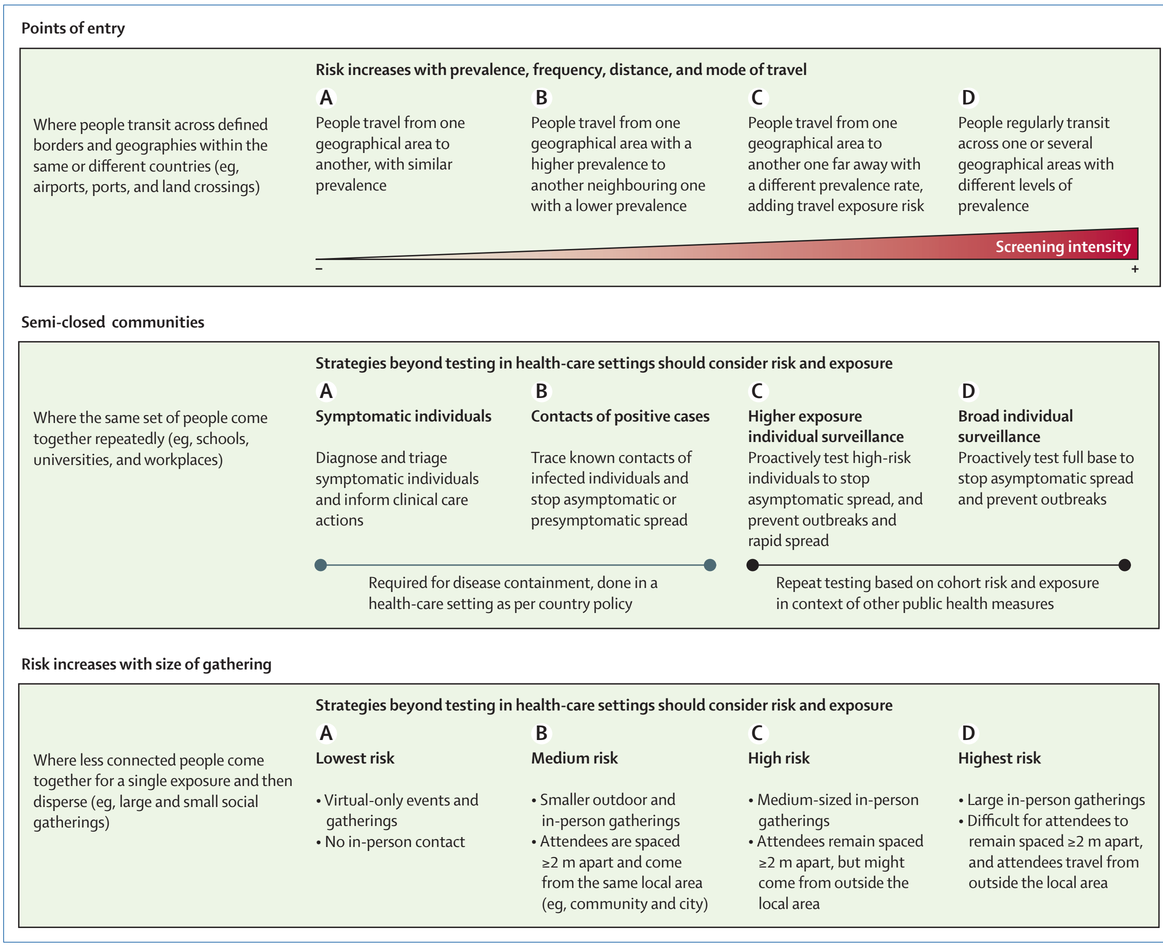

Figure: **Defined use settings for widespread SARS-CoV-2 testing and considerations for development of testing strategies**
SARS-CoV-2=severe acute respiratory syndrome coronavirus 2.

settings, and confined and enclosed spaces.[7] However, risk limitation becomes more challenging as the size of a gathering increases, because physical distancing becomes more difficult in a large crowd and individuals are likely to have travelled from areas with a higher prevalence of infection.[8] Practically, reducing amplification events in these settings would need participants to be tested before arrival, which would require diagnostic tests to be readily available to the public outside of usual health-care settings. Although communities are progressing towards decentralised testing,[9] current tools are not sufficiently reliable or affordable for routine and repeated use. Additionally, a test for use outside of a health-care setting would need to incorporate a method of presenting results, with certification to ensure authenticity (especially in light of an already emerging market for fake SARS-CoV-2 test certificates[10]). Digital integration would be crucial to such a strategy. Ultimately, commoditised and reliable home-based testing available at low cost would be key to allowing population-level mass testing.

Robust strategies for widespread testing should take into account the core principles relating to diagnostic testing, and specific considerations for each defined use. Evidence suggests that rapid antigen tests are relevant for a wide set of uses, but there is still a need to invest in the development of novel diagnostics for commoditised use beyond the health-care system.

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