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COVID-19 Screening: A New Model for Assessing the Efficiency of Group Testing

How best to evaluate the performance of a group testing strategy for the SARS-CoV-2 virus, which involves pooling samples from multiple individuals in order to conduct a single RT-PCR test on the whole group? To do precisely that, scientists from the CNRS, l'université Grenoble Alpes, and l'université Sorbonne Paris Nord[1] have developed a model that evaluates the efficiency of such tests. Their theoretical study accounts for both dilution effect and the detection limits of the RT-PCR test, in an effort to assess the number of potential false negatives based on pooled sample size, to optimize group size thereby minimizing epidemic risk, and finally to more accurately determine the number of contaminated individuals within a given population. It was published on March 4, 2021 in *PLOS Computational Biology*.

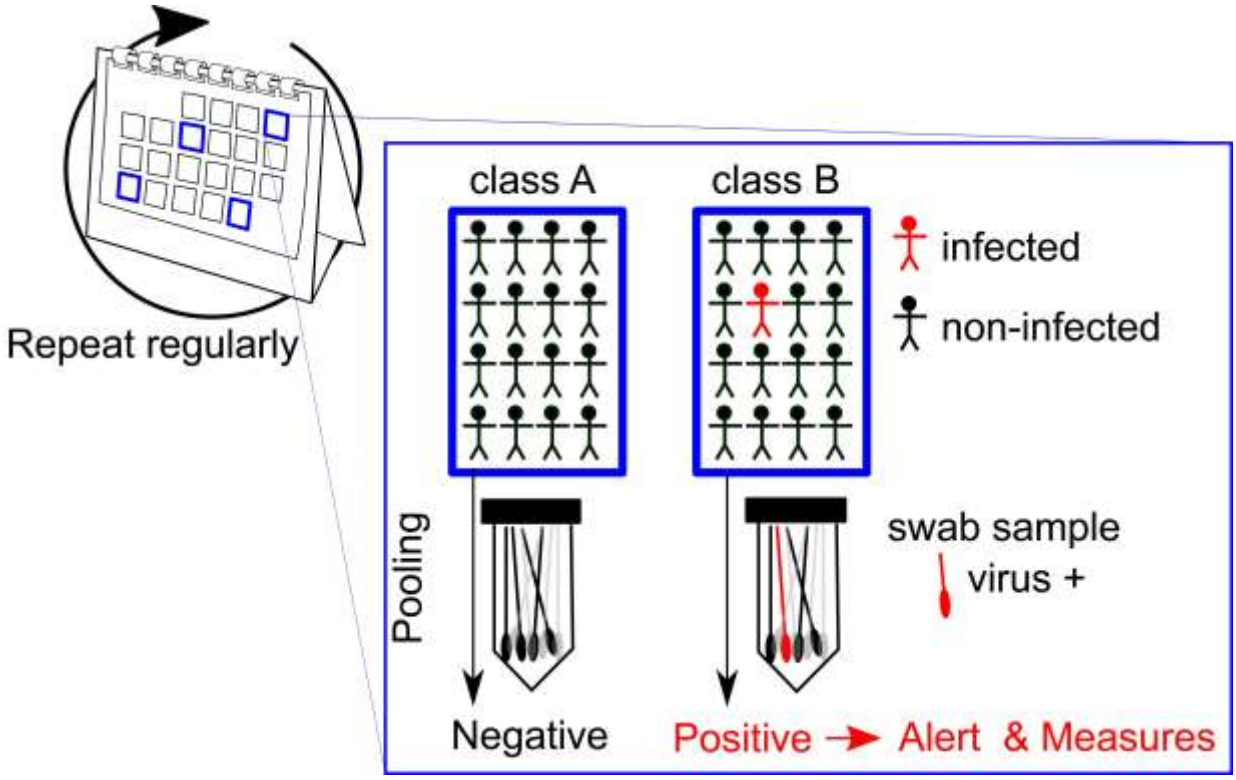
The principle of group testing is simple mathematically speaking: rather than test one hundred samples (one per individual), they can be pooled into ten groups of ten, with only one test for each group. If the test result for a group is positive, then at least one of the group's samples contains the infectious agent. Conversely, a negative result should, in principle, indicate that none of the combined samples contains the infectious agent.

Sample pooling method can reduce the cost can accelerate screening campaign, yet pooling can result in a false positive result whenever mixing samples involves a too large dilution - namely when the quantity of the virus in the tested sample falls below the test's level of detection. To assess the efficiency of screening based on a group testing strategy, a physicist and two mathematicians[1] who are members of the MODCOV19 platform[2] have developed a mathematical model that estimates this dilution effect based on sample group size. Their model can quantify the reduction of sensitivity for tests, hence the capacity of tests with larger or smaller groups to detect the presence of a contagious individual.

Unlike methods that try to minimize the number of tests needed to establish an individual diagnostic for the contaminated individual or individuals, the publication's central aim is to help optimize a collective screening strategy: how best to optimize group size in order to detect a maximum number of individuals all while limiting the risk of false negatives?

The authors also present an accurate method for measuring the proportion of individuals infected in the tested population (known as prevalence) which can guide the application of preventive measures against epidemic risk.

According to their study, group testing is of particular interest because it can quickly and regularly evaluate the presence of SARS-COV-2 within “closed” communities (such as nursing homes or university residences). Such tests were implemented in a number of research institutions throughout the world, including the 64 campuses of the State University of New York (United States), the University of Liège in Belgium, and the University of Nottingham (United Kingdom), enabling early identification of nascent epidemic outbreaks.



Pooling in a school/university setting: saliva or nose samples from students sharing the same classroom/student residence are pooled in a single tube; the virological status of the mixture is assessed by a single molecular test (RT-qPCR or RT-LAMP). A positive test indicates that at least one individual is infected with CoV2-SARS, allowing early action to be taken to contain an outbreak. The screening process can be repeated on a regular basis. © Jean-François Rupprecht, the Centre for Theoretical Physics (CNRS/Aix-Marseille Université/Université de Toulon).

Notes

[1] At the Jean Kuntzmann Laboratory (CNRS/Université Grenoble Alpes), the Analysis, Geometry, and Applications Laboratory (CNRS/Université Sorbonne Paris Nord), and the Centre for Theoretical Physics (CNRS/Aix-Marseille Université/Université de Toulon).

[2] The MODCOV19 platform was implemented in March 2020, by the National Institute for Mathematical Sciences and their Interactions of the CNRS, to coordinate modelling activities in France in connection with the multiples facets of the crisis. Learn more: https://modcov19.math.cnrs.fr/

Bibliography

Group testing as a strategy for COVID-19 epidemiological monitoring and community surveillance. Vincent Brault, Bastien Mallein, Jean-François Rupprecht. *PLOS Computational Biology*, March 4, 2021 2021. DOI : http://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1008726

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