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Letter to the Editor

Biodetection dogs for COVID-19: an alternative diagnostic screening strategy

Airports are considered to be the major hotspot for coronavirus disease 2019 (COVID-19) importation across international borders. To reduce the spreading of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2, the causative agent of COVID-19), several preventive measures have been established, both on board airplanes and at the entry-exit points of airports.[1] Infrared thermal image scanners are now used for identifying potential patients with COVID-19 and fever.[2] However, modeling studies revealed that thermal screening can miss more than half of infected individuals, as many of them can be presymptomatic or asymptomatic.[3] Moreover, another report showed that thermal screening of passengers at airport entry-exit points would not detect 46% of infected travelers,[4] further demonstrating that the effectiveness of thermal screening depends on the incubation period and proportion of asymptomatic cases. Thus, the symptom-based surveillance systems may not be the most effective strategy for identifying passengers with presymptomatic and asymptomatic SARS-CoV-2 infection.[1] The currently available rapid antigen test may also miss half of the infected patients as is 10^5-fold less sensitive than the standard diagnostic approach based on the reverse transcription-quantitative polymerase chain reaction (RT-qPCR), detecting only 11.1–45.7% of RT-PCR–positive COVID-19 cases. As it is practically impossible to test all incoming passengers using highly sensitive RT-qPCR, a rapid, non-invasive, and highly sensitive test is still necessary for conducting preliminary screening of the large numbers of symptomatic and asymptomatic passengers arriving and departing from the airports, as well as from other public transportation systems.

Dogs are known for their extremely sensitive olfactory system that can even detect substances at concentrations as low as 1.5 parts-per-trillion.[2] Humans have used trained sniffer dogs for detecting explosives, illicit substances, and for forensic purposes. Dogs have also been used for helping to identify cancer, as well as bacterial and viral infections.[5,6] Recent trends suggest an increased interest to use biodetection dogs for medical diagnosis purposes as an alternative to molecular tools. Indeed, the feasibility of using biodetection dogs was previously investigated as a mobile diagnostic approach for detecting individuals with asymptomatic malaria.[7]

Volatilome, which comprises all volatile organic compounds (VOCs), reflects the unique metabolic state of an organism. Technologies are being developed to non-invasively detect VOCs for medical diagnosis and therapeutic monitoring.[8] The unique VOCs present in the secretions of individuals infected with SARS-CoV-2 may represent a unique feature detectable by trained dogs.[9] In the case of patients with COVID-19, VOCs are also present in picomolar concentrations in the gaseous phase of exhaled breath in addition to common gases such as N_2 and CO_2.[10] Therefore, breathomics may also be considered as an important strategy for detecting SARS-CoV-2 infection with the help of biodetection dogs.

The dogs that are used for COVID-19 diagnosis are rigorously trained for odor detection, a process that includes a step-by-step learning protocol that will enable the dog recognize the target scent. The successful identification of positive samples is always supported by positive feedback, usually a treat or a toy as reward.[5] The biodetection dogs are trained to detect the specific odor in the tracheobronchial secretions, saliva, or sweat of patients with COVID-19. Findings from a randomized, double-blinded, controlled study indicated that trained detection dogs have the ability to discriminate between SARS-CoV-2–infected samples and negative controls with an average sensitivity of 82.63%.[9] In this study, the training protocol was carried out in an unbiased manner using the Detection Dog Training System (Kynoscience UG, Germany), which uses an automated system to randomly present the samples and reward the dog upon correct identification of SARS-CoV-2 infection. Another study conducted in France explored the possibility to use axillary sweat samples to identify COVID-19–positive individuals. Although the study cohort was very small, the study concluded that patients with COVID-19 have a unique armpit sweat odor that could be used to differentiate them from uninfected individuals with the help of detection dogs.[11] As dogs are susceptible to SARS CoV-2 infection, saliva or tracheobronchial samples need to be inactivated to prevent the risk of virus transmission to the dogs or their handlers. Detection using sweat odor has the advantage that it can be performed faster than the saliva or tracheobronchial test, as it does not require the inactivation step. Fig. 1 illustrates the COVID-19 diagnosis protocol by biodetection dogs that can be implemented in countries with limited access to advanced molecular diagnostic tests. Considering the potential utility of biodetection dogs, canines are being trained all round the world to detect COVID-19 infections. They have been trained to smell samples especially the sweat and will sit or paw the floor once they have detected the infection.[12]

It is important to highlight that dogs, being a trained animal, are subjected to fatigue, hunger, boredom, and other external distractions,[5] factors that can affect their ability to detect positive cases, thereby reducing the overall detection sensitivity of this approach. In addition, the individual personality of the dogs might also affect the diagnostic sensitivity. Therefore, biodetections dogs cannot be considered as a replacement to highly sensitive molecular diagnostic tests, such as RT-qPCR. Instead, they can be used as a preliminary screening method to help in the early identification and

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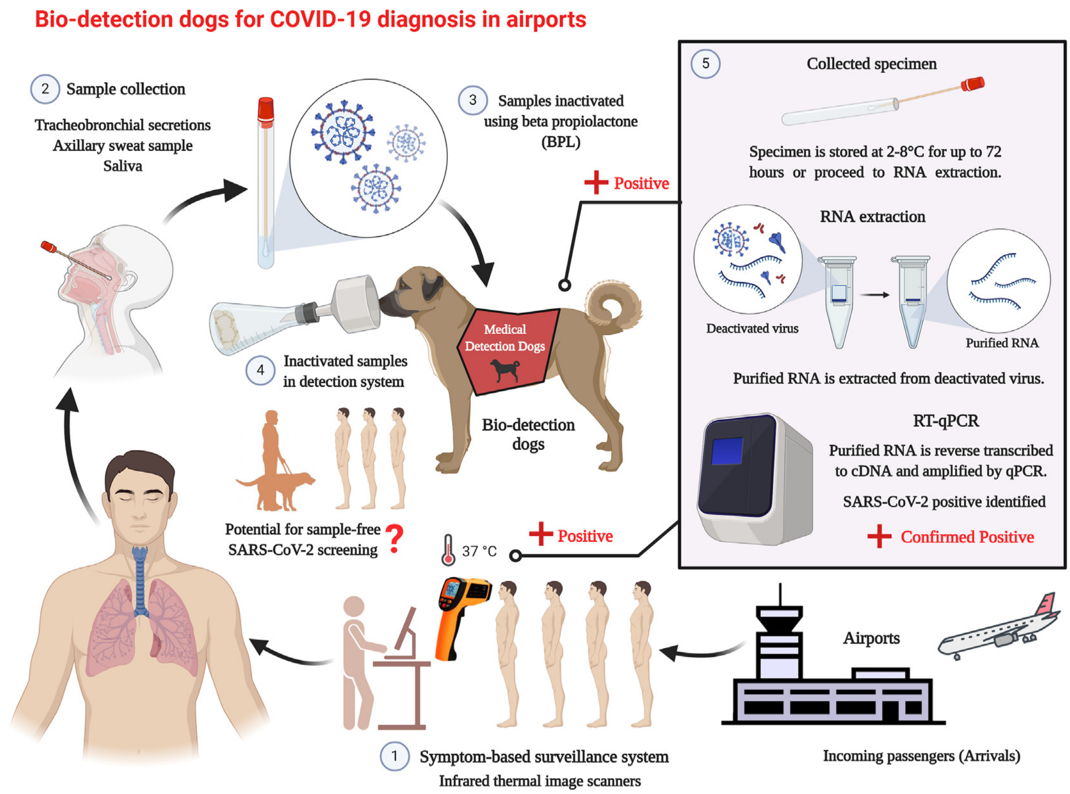

Fig. 1. (1) Airports are equipped with symptom-based surveillance systems that use infrared thermal image scanners to screen oncoming passengers with symptomatic coronavirus disease 2019 (COVID-19). (2) Biological samples are collected from the passengers, including tracheobronchial secretion, axillary sweat sample, and saliva. (3) All samples are inactivated using beta-propiolactone to prevent infection of the dogs and their handlers. (4) The samples are then analyzed by trained biodetections dogs. (5) The samples flagged as positive by the dog will be given preference for infrared thermal image scanning or to be tested by reverse transcription-quantitative polymerase chain reaction (RT-qPCR) to confirm the diagnosis.

segregation of potential asymptomatic SARS-CoV-2–infected passengers from susceptible individuals at key entry points, such as airports and sea ports. Furthermore, biodetection dogs have great potential for screening SARS-CoV-2–infected people in public places, including shopping malls, train stations, bus stations, particularly in countries with limited access to advanced molecular diagnostic tests. Biodetection dogs can also represent a robust diagnostic tool as each trained dog can screen ~250 people per hour.[2] Nevertheless, validation studies are still warranted to ensure that the trained dogs are able to differentiate actively infected individuals from recovered patients. Preliminary trials are already being conducted at the airports of Lebanon, United Arab Emirates, and Finland. Trained dogs are used to identify COVID-19–positive passengers with the help of sweat samples and then checked against conventional tests.[12] The findings from the trials conducted in Finland and Lebanon suggest that dogs are able to identify positive cases days before conventional tests picked up the virus. Therefore, biodetection dogs can detect SARS-CoV-2 infection even before the onset of symptoms. Although preliminary studies conducted using biodetections dogs indicate greater potential for diagnosing COVID-19, further double-blind studies with bigger cohorts are still necessary to evaluate the sensitivity of this detection method.

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Author contributions

All the authors substantially contributed to the conception, design, analysis, and interpretation of data, checking and approving the final version of the manuscript, and agreed to be accountable for its contents.

Data availability statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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