

FORENSIC DNA PROFILING DURING & POST COVID-19

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THE rapid spread of the SARS-CoV-2 infection has meant worldwide lockdowns and millions of deaths. However, crimes of varied nature are still being reported.

Samples required for DNA profiling examination are of biological nature and perishable. Hence, to avoid any loss of evidence over time, these biological evidences are collected and submitted at various forensic laboratories for examination. Most of the biological exhibits are collected from living human beings (victim/suspect) or dead bodies. In today's context and both instances, the

source individual may be a patient or asymptomatic carriers of the virus.

Hence, in the current scenario, the biological exhibits cannot be processed as routine cases as examined earlier pre-COVID. Appropriate precaution needs to be taken while dealing with biological samples in a forensic DNA laboratory. The DNA examination process thus needs to be adapted to minimize possible exposure to the virus.

As per the current World Health Organization (WHO) guidelines, corpses do not pose a major health risk to cause an outbreak. However, in an instance recently, in Bhopal a person

who died due to cardiac arrest displayed no symptoms of COVID-19. However, since the person was from a containment zone, the mandatory test was conducted and after two days of death was found to be COVID positive. In such instance, many people who come in contact with the individual or the samples collected from the individual for forensic DNA profiling investigation may cause a serious threat. Hence, co-collection of the virus in DNA evidences cannot be ignored completely.

For generation of DNA profiling, blood and buccal swab samples are widely used as reference samples. Though the virus causes infection mostly in the upper and lower respiratory tract, the viral RNA has been detected in the whole blood and saliva. When the reference sample is collected from an infected person or an asymptomatic carrier, the chance of infection of the virus inside the laboratory will be high. Similarly, saliva samples as well as clothing containing saliva stains may pose a huge threat to the DNA examiners.

In sexual assault cases, vaginal and seminal fluids are the primary questioned articles for DNA profiling examination. Though limited studies are available on such sample types, none of them showed COVID-19 positive result in infected persons. Similarly, no SARS-CoV-2 vertical transmission from mother to the fetus has been reported till date. Thus, in the current scenario, the questioned fetus samples born from an infected mother, collected and isolated immediately after birth are relatively safer exhibits for DNA profiling examination.

Soft tissues preserved in normal saline solutions are also common exhibits in forensic profiling studies. Though tissues pertaining to upper and lower respiratory tract have shown the presence of the novel virus, no such finding is available till date regarding the presence of the virus in deep soft tissues as well as hard tissues such as bones. Similarly, no report is available till date to claim the finding of SARS-CoV-2 virus in hair samples.

Teeth samples are also received for forensic identification purpose. Due to their location in the buccal cavity, the presence of saliva containing the

infected virus cannot be ignored in this sample. However, prolonged detection of nCoV-2019 viral RNA, as well as whole virus in the faecal sample, puts the anal slide/swab samples in the red list during forensic analysis.

Besides biological exhibits, inanimate objects associated with cases also possess potential health hazards from SARS-CoV-2. Before reaching the laboratory, the documents are handled by a series of persons, such as the sample donor to give his/her consent, medical officer who collects the samples, investigating officer, case forwarding officer and the messenger who carries the documents, and others. The chance of transmitting the virus from any of the handling points cannot be ignored subject to the availability of a healthy virus carrier or infected person.

Similarly, the biological exhibits collected for DNA examination are packed and sealed in envelopes made of paper, cloth and/or polythene. Though paper and cloth are non-living surfaces which do not allow viral multiplication, it is highly important to know its persistence on such inanimate surfaces. On different surfaces, the virus remains infectious for 2 hours to 9 days. Higher temperature of 30°C to 40°C reduces the persistence of the virus, whereas temperature as low as 4°C increases its persistence to 28 days. Another study found SARS-CoV-2 to be more stable on plastic and stainless steel than copper and cardboard for a maximum of 72 hours after application of the virus on these surfaces.

However, no study was found to compare the persistence time of SARS-CoV-2 on biological exhibits routinely received in DNA profiling laboratories. With the availability of numerous host cells in the form of biological exhibits and optimal growth temperature of 37°C, the virus can sustain for a longer time on those exhibits stored at room temperature till DNA profiling examination. When perishable exhibits containing virus are stored at 4°C, the survival of the virus tends to increase further. Thus, utmost care needs to be taken with the exhibits as well as the documents received at DNA profiling laboratories during and after SARS-CoV-2 global pandemic.

Apart from the potential health hazard perspective, the interference

of the possible viral presence on DNA profiling results needs to be understood completely. The genetic material of SARS-CoV-2 is positive-sense single-stranded RNA, whereas the primary requirement of DNA profiling experiment is human DNA. Extraction of DNA using any protocol minimizes the chance of co-extraction of viral RNA, limiting its interference in further down-stream processes. Looking into the life cycle of SARS-CoV-2, the S1 domain of envelope spike protein mediates the receptor binding and S2 domain helps in membrane fusion through human angiotensin-converting enzyme 2 (ACE2) receptors. After infection to a host cell, it undergoes lytic life cycle to subsequently infect other host cells. Though the limited study is available till date, the biological samples heavily infected from the virus may carry potential PCR inhibitors resulting from virus protein coats.

When an exhibit or document with suspected viral content reaches a DNA laboratory, it should be handled with the utmost care at every level. Inside a forensic DNA profiling laboratory, the administrative staff checks the documents and the exhibits prior to the registration of a case. In such instances, the chance of personnel getting infected from the virus is increased.

To overcome this problem, UV light source can be used to sanitize the paper documents as well as the surfaces of the exhibits. Though SARS-CoV-2 virus is not specifically studied for UV susceptibility, study on other coronaviruses showed the promising result as UV light induces photodimers in viral genome. Thus, for the purpose of surface disinfection, portable UV sanitization carts, UV hand lamps, tabletop UV light or any other available instrument can be used.

Next, when a DNA examiner is assigned to open a case for examination, he/she needs to be extra careful to deal with these biological samples with possible viral contamination. To avoid infection, the exhibits should be opened in a laboratory with Biosafety level 3 (BS3) facilities. The concerned personnel should wear Personal Protective Equipment (PPE) along with an N95 mask. Special precaution should be taken to avoid touching the outer

surface of the tube containing sample aliquots, as trace amount of the invisible virus may be present there. To overcome this problem, outer surfaces of the tubes can be sanitized with 70% ethanol or 0.1% sodium hypochlorite.

The lysis step as well as other manual DNA extraction steps should also be performed within the biosafety cabinet wearing PPE and N95 mask. For automated DNA extraction procedure, the same precaution should be followed besides decontaminating the inner surface of the system using UV light or disinfectants regularly. Post DNA extraction, there exists a limited chance of infection from the suspected virus as the nucleic acid of the virus if co-extracted along with human DNA is not infectious in nature. Thus, further down-stream processing steps can be carried out as per the routine guidelines prescribed for a DNA profiling laboratory.

Before resuming work in a closed DNA profiling laboratory, the laboratory building, working area, as well as the instruments, need to be properly sanitized. Regular cleaning of the floor using surface disinfectants such as 0.1% sodium hypochlorite (NaOCl) is highly recommended. When spillage of any biological samples containing suspected virus occurs, the working area should be cleaned with 1% NaOCl.

Regarding the biological wastes generated from the laboratory containing suspected coronavirus, no specific guidelines have been formulated, as currently no evidence has been found suggesting an additional packing of the laboratory wastes (CDC, 2020). Hence, the routine waste disposal system recommended for a DNA profiling laboratory should be followed.

Being a part of the criminal justice system, the forensic DNA examination has been included as an essential service in many countries. Thus precautions in sample and document handling and proper maintenance of guidelines will ensure a safe working environment for the forensic DNA examiners inside the laboratory.

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