

An Overview on Covid 19 Pandemic and its Impact on Forensic Investigations



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Abstract

The novel corona virus or COVID 19, created a pandemic throughout the world due to its transmissibility, highly virulent nature and severe pathogenicity. It has been established that it transmits through liquid droplets during coughing, sneezing, loud speaking, and spitting out. As per the World Health Organization (WHO), the viral particles persist on the various surfaces up to 5 days depending upon the environmental conditions and nature of surfaces. These long-lasting persistence and airborne transmission of Corona viral particles impose serious threat for forensic investigators as well as for all the law enforcement agencies. In this article, we explore the impact of COVID 19 pandemic on forensic investigation at the scene of a crime, sample collection, transport, storage, and laboratory examination. This article also helps to understand the overview of the novel corona virus and to adopt the best biosafety practices by the forensic science community and other law enforcement agencies, which will help in the balancing to conduct the investigations and protection against novel viral infections by following the safety guidelines formulated by the concerned central and state government.

Keywords: COVID19; Forensic investigation; WHO; Legal system; Safety guideline

Abbreviations: SARS: Severe Acute Respiratory Syndrome; ORF: Open Reading Frame; CD4: Cluster Differentiation T cells 4; ICMR: Indian Council of Medical Research; NIV: National Institute of Virology; SOP: Standard Operating Procedure; BSL2: Biosafety Level 2; PPE: Personal Protective Equipment

Introduction

Origin and spread of COVID 19

The aggressive and highly transmissible nature and severe pathogenicity of the novel Severe Acute Respiratory Syndrome (SARS) - coronavirus-2 (SARS- CoV-2) created the global pandemic situation, is also referred to as novel corona virus (2019-nCoV) or SARS- CoV-2 or COVID 19 [1]. The SARS- CoV-2 or COVID 19 originated from Wuhan city of China in December 2019. Several initial patients suffering from pneumonia have visited the wet seafood market of Wuhan city of China and later on, molecular diagnosis of these human patients showed the presence of novel corona virus. This novel virus first described as 2019-nCoV and World Health Organization (WHO) renamed it COVID 19 and due to an exponential increase of confirmed COVID patients WHO declared it, a public health emergency of international concern on 30th January 2020 [2]. After this declaration of international public health emergency, a pandemic situation was created across

the world and all the countries focused their total attention to this critical condition to break the chain of spreading of this virus by adopting various safety measures and formulated the safety guidelines at the national level along with awareness and educating the people. As on August 19th, 2020 as per WHO, global cumulative COVID 19 cases are 21,756,357 and 771,635 deaths have been reported. Across the globe, the United State of America (USA) has the highest number of COVID 19 cases and deaths, i.e. 5,354,013 and 168,999 respectively, and community transmission stage. Brazil comes in the second position with the number of COVID 19 cases and deaths, i.e. 3,340,197 and 107, 852 respectively. India is the second most populated country aligned with diversified populations residing in urban and rural areas of the country [3,4]. Across the globe, India is the 3rd country to the total number of COVID 19 confirmed cases, deaths and active Covid 19 cases i.e. 2766410, 53334 and 676,528 (Figure 1) & (Table 1).

Table 1: COVID19 data of Indian states and Union Territories as on August 19th, 2020 [Data source: <https://covidindia.org>]

State/ Union Territories	Number of Confirmed Cases	Number of Recovered Cases	Number of Deaths
Andaman and Nicobar Islands	2529	1421	30
Andhra Pradesh	306261	218311	2820
Arunachal Pradesh	2875	1949	5
Assam	82201	58294	203
Bihar	109875	80740	558
Chandigarh	2305	1243	30
Chhattisgarh	16726	10847	158
Dadar & Nagar Haveli; Daman & Diu	1959	1519	2
Delhi	154741	139447	4226
Goa	12333	8356	116
Gujarat	80802	63703	2820
Haryana	48971	41333	557
Himachal Pradesh	4235	2923	19
Jammu and Kashmir	29326	21886	561
Jharkhand	25333	15709	265
Karnataka	240948	156949	4210
Kerala	47898	31390	175
Ladakh	2010	1395	14
Lakshadweep	0	0	0
Madhya Pradesh	47375	35713	1141
Maharashtra	615477	437870	20999
Manipur	4765	2789	18
Meghalaya	1454	683	6
Mizoram	815	372	0
Nagaland	3520	1664	8
Odisha	64533	45315	415
Puducherry	8396	4909	123
Punjab	34400	21762	898
Rajasthan	63977	48887	898
Sikkim	1207	755	2
Tamil Nadu	349654	289787	6007
Telangana	93937	72202	711
Tripura	7424	5404	62
Uttar Pradesh	162434	109607	2585
Uttarakhand	12961	8724	164
West Bengal	122753	92690	2528
Total	2766410	2036548	53334

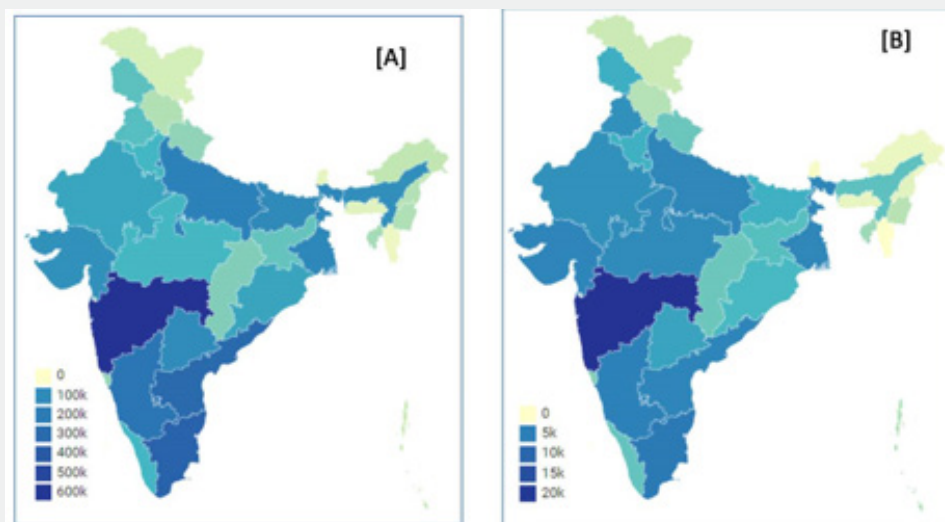


Figure 1: The statewide COVID19 confirmed cases [A] and death cases [B] in India as on August 19th, 2020. The data was obtained from the <https://www.covidindia.org/> and plotted through (<https://app.datawrapper.de/>).

Table 2: Details of primers and probes of E gene and RNaseP gene assay.

Assay	Oligonucleotide ID	Sequence (5'-3')
E gene	E_Sarbeco_F1	ACAGGTACGTTAATAGTTAATAGCGT
	E_Sarbeco_R2	ATATTGCAGCAGTACGCACACA
	E_Sarbeco_P1	FAM-ACACTAGCCATCCTTACTGCGCTTCG-BHQ
RNaseP	RNaseP Forward	AGATTTGGCCTGCGAGCG
Gene	RNaseP Reverse	GAGCGGCTGTCTCCACAAGT
(internal Control)	RNaseP Probe	FAM-TTCTGACCTGAAGGCTCTGCGCG-BHQ

FAM: 6 carboxyfluorescein, BHQ: Black Hole Quencher

A general account of COVID 19

The COVID 19 or SARS-CoV-2 virus genome is 30,000 base pairs (bp) size, which encodes large non-structural poly-protein, which further cleaved into 15/16 proteins; 5 accessory proteins i.e. Open Reading Frame (ORF) 3a, ORF6 to ORF9; and 4 structural proteins i.e. spike glycoprotein, membrane glycoprotein, envelope protein and nucleocapsid protein which are essential for the structure and infectious nature of COVID 19 [5-7]. COVID 19 or SARS-CoV-2 virus is the 7th member of corona virus (CoVs) family which infects the human. The other six members of CoVs family are HCoV-229E, HCoV NL63, HCoV-OC43, HCoV-HKU1 which are causing agents of common cold; and SARS-CoV and MERS-CoV are causing agents of severe pneumonia [8]. The surface spike glycoprotein of Corona virus binds with Angiotensin-Converting Enzyme 2 (ACE2) receptors, which are found in the lower part of the respiratory tract of the humans [9,3]. It is established that novel SARS-CoV-2 or COVID 19 has 10-20 times more affinity than the SARS-CoV spike proteins to bind with the human ACE2 receptor, which is the cause of high transmission rates [10,11]. After the entry of the virus into the alveolar epithelial cell of the respiratory

system, SARS-CoV-2 replicates in the host cell and undertakes the host cell regulation, which causes severe triggering of immune response resulting in hypercytokinaemia and pulmonary tissue damage and ultimately reflected into Acute Respiratory Distress Syndrome (ARDS) and multiple organ failure [12-15]. In the COVID 19 infection immune system weakened by decreased and/or functionally exhausted total T cells, Cluster Differentiation T cells 4 (CD4), and Cluster Differentiation T cells 8(CD8) [2].

Transmission, incubation, and susceptibility of COVID19

The novel COVID19, sporadically transmitting virus among the humans through the respiratory tract via liquid droplets during coughing, sneezing, loud speaking, spitting out, and close contact in the environment with high aerosol concentrations. Direct and indirect contact of infectious agents or surfaces to the mucus membranes of nose, mouth, and eyes are the most common entry route of COVID19 into the body [16,17]. Recent studies showed that the digestive tract is also a potential route of COVID 19 [18]. After entrance the viral particles in the human body, it incubates in the body with the mean incubation period

ranged from 2- 14 days with the symptomatic and asymptomatic condition and both categories of infected people can act as a super spreader of the various [19,20]. The symptom of the infection of this virus expressed or not depends on the health condition of an individual. It has been established that the lower immunity people, pregnant women, newborn children, and old age people are more susceptible to this infection [21,22,15].

Confirmatory test of COVID 19

In the country, the Indian Council of Medical Research (ICMR) and National Institute of Virology (NIV) jointly formulated a standard operating procedure (SOP) for the detection of novel corona virus 2019-nCoV in suspected person using the rRT-PCR assay. In this assay TaqMan fluorogenic probe-based chemistry that uses the 5' nuclease activity of Taq DNA polymerase and enables the detection of specific PCR as it accumulates during PCR cycle. ORF 1b, RdRp gene assay, E gene Assay, and N gene assay have been recommended by ICMR- NIV. Primers and probes used for E gene and RNaseP assay are listed in Table 2. (<https://www.who.int/health-topics/coronavirus/laboratorydiagnostics-for-novel-coronavirus>).

Discussion

Impact of COVID 19 on the forensic investigation

It has been established that the novel corona virus rapidly transmits through liquid droplets spread during coughing, sneezing, and loud speaking, spitting which supports the airborne transmission [23]. The viral particles found in body fluids, viscera of COVID19 positive individuals; and long-lasting persistence of viral particles on various surfaces are the serious concern for forensic community, police, and legal system. In this pandemic situation, many forensic science laboratories as being remain fully functional and have significant role in the criminal investigation system with the inception of crime to the conviction of criminals in the court of law, along with several challenges. The inevitable challenges for the forensic fraternity from the scientific investigation at the scene of a crime, laboratory examination and testimony in the court of law, that need to be addressed to adopt best practices with the self-protection from the novel viral infection as well as deal with the qualitative forensic examination of evidential materials [23-25].

Sample collection and transport to the forensic laboratory

At the scene of crime, scientific evidential material might be subjected to novel viral infection due to COVID 19 infected victim, suspect, or other related individuals. The biological fluid, i.e. blood, semen, saliva, tissues, and other evidential exhibits found at the scene of a crime, might be prone to novel viral infection, leads the risk of direct infection to the forensic experts [23]. Therefore, forensic experts must follow the safety guidelines formulated by the national level and must wear the Personal Protective

Equipment (PPE) kit, i.e. standard mask, gloves, face shield, body cover (full sleeve gown), The evidential exhibits must be collected according to standard procedure formulated by the laboratory; additionally, the sealed packet must be externally covered in the water-resistant outer covering to sanitize the packet at every stage of handling. Similarly, the samples are taken during the medico-legal examination of the victim and suspect of sexual assault cases, during post-mortem examination, etc., the sample must be collected according to standard procedure, sealed with additional outer water resistant surface to sanitize the samples at every handling stage. If the victim, suspects, and deceased have been confirmed of SARS-CoV-2 infection, then their samples must be labeled properly and sealed in such a way to sanitize the outer surface every step of handling. Our laboratory has passed a guideline for the samples forwarded to the laboratory, in which it is stated that the forwarding letter along with other relevant letter must be packed in the sterilized zip-lock polybag, and its outer surface should be sanitized before sending to the laboratory and should be sanitized again at the time of receiving. The samples must be carried with the special messenger with PPE kits and sanitized before at every handling step. A competent authority should issue a certificate of proper sanitization of the samples before sending to the laboratory. This will lead an effective step to reduce the risk factor of this novel viral infection in the forensic community during this pandemic situation.

Laboratory examination of the COVID 19 suspected samples

WHO recommended that every sample to be analyzed in the laboratory and collected during this pandemic must be considered as a potential source of infection? This assumption must be followed at the time of forensic examination of the evidential exhibits, and the laboratory should be followed in a Biosafety level 2 laboratory working conditions, and all the laboratory personnel must treat their work at a high risk of infection. The case opening room of the laboratory must be disinfected with extensive care. The biosafety cabinet II must be used for opening the case and all the downstream examinations. This practice leads to a low risk of air born transmission of the SARS-CoV-2 virus. Before the examination, preprocessing steps should be adopted in the examination, in which the sample must be handled with extra care, and before opening the packets sanitization of the outer surface of the packets must be assured. After the sampling for examination, the remnants of the samples must be discarded by following the recommendations of the Biosafety level 2 laboratory. Before the pandemic situation, the forensic samples were examined at the standard laboratory open benches without the use of special protective equipment's. To prevent the cross infection among the laboratory personnel, social distancing at least 2 yards must be maintained and must follow the guideline formulated by the WHO, national, and state level. After the examination of forensic exhibits sealed properly additionally water resistance outer cover and sanitized before sending to the concerned authority. The

report must be sealed properly and kept in a zip-lock polybag, sanitized before sending it to the competent authority. It has been established that long period wearing of PPE kits create various problems, such as discomfort, the heat, loss of normal sense of smell, loss of tactile sensation, difficulties in hand movements, impaired visibility, stress, anxiety, and problems in verbal communication [21]. Keeping these challenges in the minds, the rotational duties for short duration must be followed by the administration in this pandemic situation. The laboratory work should be categorized into various groups and work responsibility must be undertaken according to the COVID 19 infection risk factors. The laboratory personnel who are above the age of 50 years or low immunity person and the pregnant women must be kept away from the high-risk zone. All the laboratory personnel must maintain proper social distance at least 2 yards and follow the guidelines formulated by WHO, National level, and State level. By rotational way crime scene must be an investigation along with extended care of handling the high-risk articles [26,27].

Conclusion

To prevent the spread of the novel SARS-CoV-2 virus, we must strictly follow the safety guidelines and use of PPE kit during the handling of infection-prone exhibits or sites. Routine forensic laboratories should extend their laboratory condition according to the Biosafety Level 2 (BSL2) laboratory. Rotational working conditions will lead to reducing the chance of risk factors for infection. This article will be helpful for the forensic community as well as other law enforcement agencies to understand the infectious nature, pathogenicity, rapid transmission, and challenges that arise during this pandemic situation and safety measures to be adopted during a forensic investigation.

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