BioMed Research Journal
BMRJ, 5(1): 299-304
www.scitcentral.com

ISSN: 2578-8892

Review Article: Open Access

Covid-19: A Pandemic Threat to Public Health

Arun Kumar Srivastava[1*] and Vinay Kumar Singh[2]

[*1]*Department of Zoology, Shri Guru Goraksha Nath P.G. College, Jogia, Ghughli, Maharajgan, Uttar Pradesh, India*

[2]*Department of Zoology and Environmental Science, DDU Gorakhpur University, Gorakhpur, Uttar Pradesh, India*

Received July 24, 2020; Accepted August 03, 2020; Accepted August 05, 2020

ABSTRACT

A novel coronavirus, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), causing the Coronavirus Disease 2019 (COVID-19), has emerged in late 2019 and ongoing pandemic in many countries and territories. It was first identified in Wuhan City, Hubei Province, China. It can be transmitted from human-to-human by respiratory droplets from sneezing, coughing and aerosols, with symptomatic people being the major source of transmission. Coronaviruses make up a large family of viruses that can infect birds and mammals, including humans, according to World Health Organization (WHO). A coronavirus is an enveloped virus having non-segmented positive-sense RNA genome and belongs to the family Coronaviridae and the order Nidovirales. Coronaviruses are spherical in shape with club-shaped spike projections emanating from the surface which look like halos or a crown under the electron microscope and hence the name coronavirus. Amongst positive-strand RNA viruses Coronaviruses have the highest known frequency of recombination. Coronaviruses infect a wide variety of host species. Coronavirus infection in humans is commonly associated with mild to severe respiratory diseases that are characterized by high fever, severe inflammation, cough, and internal organs dysfunction that can even lead to death.

Keywords: Pandemic, SARS-CoV-2, Zoonotic, Antibody, Mutations

INTRODUCTION

In present moment, a novel coronavirus, the SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) causing the Coronavirus Disease 2019 (COVID-19), has emerged in late 2019, which has posed a global health threat with its ongoing pandemic in many countries and territories [1]. Health workers worldwide are currently making efforts to control further disease outbreaks caused by the novel CoV (originally named 2019-nCoV) that was first identified in Wuhan City, Hubei Province, China, on December 12th, 2019 [2]. On February 11th, 2020, the World Health Organization (WHO) announced the official designation for this current CoV associated disease to be "COVID-19", caused by the SARS-CoV-2 [3]. Alpha CoVs and beta CoVs originated from bats and rodents while delta CoVs and gamma CoVs have their origins from avian species [4]. The beta CoVs including SARSCoV-1 was isolated from bats in 1992 with civet cats being the intermediary host; MERS-CoV was isolated from dometry camels in 2003; and of course, the currently circulating SARS-CoV-2 formally referred to as 2019 novel coronavirus (2019-nCoV) causing COVID-19 [5]. SARS-CoV-2 has a pleomorphic and circular structure with a diameter of about 60-140 nm. It can be transmitted from human-to-human by respiratory droplets from sneezing, coughing and aerosols, with symptomatic people being the major source of transmission [6]. CoVs belong to the family Coronaviridae (subfamily Coronavirinae), the members of which infect a broad range of hosts, producing symptoms and diseases ranging from a common cold to severe and ultimately fatal illnesses such as SARS, MERS, and, as of present, COVID-19 [7]. The SARS-CoV-2 (formerly 2019-nCoV) is considered as one of the seven members of the CoV family that infect humans (3), and it belongs to the same lineage of CoVs that causes SARS; however, this novel virus is genetically distinct [8]. Jonsdottir and Dijkman [9] reported that six CoVs were known to infect humans include HCoV-229E, HCoV-NL63, HCoV-OC43, HCoV-HKU1, SARS-CoV, and MERS-CoV. The COVID-19 that emerged in China spread rapidly throughout the country and subsequently to other countries. Due to the severity of this outbreak and the potential of spreading on an international scale, the WHO declared a "global health emergency" on January 31st, 2020 [10]. Subsequently, on March 11th, 2020, a pandemic situation was declared. At present, we are not in a position to effectively treat COVID-19 since neither approved vaccine

Corresponding author: Arun Kumar Srivastava, Department of Zoology, Shri Guru Goraksha Nath P.G. College, Jogia, Ghughli, Maharajganj-273151, Uttar Pradesh, India, Tel: +91-9792250710; E-mail: aksgkp5@gmail.com

Citation: Srivastava AK & Singh VK. (2020). Covid-19: A Pandemic Threat to Public Health. BioMed Res J, 5(1): 299-304.

nor specific antiviral drugs for treating human CoV infections are available [11]. Most nations are currently making efforts to prevent further spreading of this potentially deadly virus by implementing preventive and control strategies. Coronaviruses make up a large family of viruses that can infect birds and mammals, including humans, according to world health organization [12]. The present comprehensive review describes the various features of the COVID-19 (caused by the SARS-CoV-2) causing the current disease outbreaks, advances in diagnosis and developing vaccines and therapeutics.

GENETICS OF CORONA VIRUSES

Desforges et al. [13] reported that a Coronavirus is an enveloped virus having non-segmented positive-sense RNA genome and belongs to the family Coronaviridae and the order Nidovirales which is broadly distributed in humans, other mammals and birds causing respiratory, enteric, hepatic and neurologic diseases **(Figure 1)**. Coronaviruses are further classified into four genera namely alpha, beta, gamma and delta, of which only alpha and beta varieties are known to cause infections in humans [14]. Until recent decades, human corona viruses were considered inconsequential pathogens rarely causing any disease more severe than the common cold and four alpha HCoVs (HCoV 229E, NL63, OC43 and HKU1) accounted for 10-30 percent of colds (upper respiratory tract infections) worldwide [15]. However, relatively recently two new varieties of beta coronaviruses were discovered known as SARS CoV and MERS CoV, which are zoonotic in origin and found to cause severe lower respiratory disease with fatal consequences in humans [7]. Corona viruses are spherical in shape with club-shaped spike projections emanating from the surface which look like halos or a crown under the electron microscope and hence the name coronavirus. A coronavirus typical generic genome is 32 kilobases long and is the largest known RNA virus genome [16]. Woo et al. [17] reported that amongst positive-strand RNA viruses, Coronaviruses have the highest known frequency of recombination. On infecting a host, it rapidly and indiscriminately combines genetic information from different sources and also known for its ability to recombine using both homologous and non-homologous recombination which presumably plays a key role in virus evolution [17]. Sanjuán and Calap [18] reported that the average evolutionary rate for coronaviruses is roughly 10^{-4} nucleotide substitutions per site per year, with mutations taking place during every replication cycle. In other words, these viruses have a tendency of mutating and changing at a high rate, wreaking havoc for both, diagnosis as well as treatment and vaccine regimens.

MECHANISM OF BINDING TO HOST CELL

Coronaviruses infect a wide variety of host specie [19]. Ryu [20] reported that the life cycle of the virus with the host consists of the following 5 steps: Attachment, penetration, biosynthesis, maturation and release. Once viruses bind to host

Source: Google

Figure 1. Structure of COVID-19.

receptors (attachment), they enter host cells through endocytosis or membrane fusion (penetration). Payne [21] reported that when viral contents are released inside the host cells, viral RNA enters the nucleus for replication and make viral proteins. Then, new viral particles are made (maturation) and released [21]. Shoeman and Feilding [22] reported that corona viruses consist of four structural proteins; Spike (S), membrane (M), envelop (E) and nucleocapsid (N). Fang [23] reported that spike is composed of a transmembrane trimetric glycoprotein protruding from the viral surface, which determines the diversity of corona viruses and host tropism. Spike comprises two functional subunits; S1 subunit is responsible for binding to the host cell receptor and S2 subunit is for the fusion of the viral and cellular membranes [23]. Kuhn et al. [24] reported that the angiotensin converting enzyme 2 (ACE2) was act as a functional receptor for SARS-CoV. ACE2 expression was high in lung, heart, ileum, kidney and bladder and in lung, ACE2 was highly expressed on lung epithelial cells [24]. Following the binding of SARS-CoV2 to the host protein, the spike protein undergoes protease cleavage [25]. Jaimes et al. [26] reviewed a two-step sequential protease cleavage to activate spike protein of SARSCoV and MERS-CoV was proposed as a model, consisting of cleavage at the S1/S2 cleavage site for priming and a cleavage for activation at the S′2 site, a position adjacent to a fusion peptide within the S2 subunit. Kirchdoerfer et al. [27] reported in his journal that after cleavage at the S1/S2 cleavage site, S1 and S2 subunits remain non-covalently bound and the distal S1 subunit contributes to the stabilization of the membrane-anchored S2 subunit at the prefusion state and subsequent cleavage at the S′2 site presumably activates the spike for membrane fusion via irreversible, conformational changes. Yuki et al. [28] reviewed the characteristics unique to SARS-CoV-2 among coronaviruses is the existence of furin cleavage site ("RPPA" sequence) at the S1/S2 site and the S1/S2 site of SARS-CoV-2 was entirely subjected to cleavage during

biosynthesis in a drastic contrast to SARS-CoV spike, which was incorporated into assembly without cleavage.

ORIGIN, SPREAD AND EMERGENCE OF COVID-19

The possible origin of this novel virus and the first mode of disease transmission are not yet identified [29]. Analysis of the initial cluster of infections suggests that the infected individuals had a common exposure point, the seafood market in Wuhan, Hubei Province, China [30]. Tiwari et al. [31] reported that the Huanan South China Seafood Market also sells live animals such as poultry, bats, snakes, and marmots. This might be the point where zoonotic (animal-to-human) transmission might have occurred [31]. Although the SARS-CoV-2 is suspected to be originating from an animal host (zoonotic origin) with the further human-to-human transmission, the possibility of food-borne transmission should be ruled out with further investigations, since it is a latent possibility [29]. Aliabadi et al. [32] reported that other potential and expected routes would be associated with the transmission, as in other respiratory viruses, by direct contact, shaking contaminated hands, or by direct contact with contaminated surfaces. Bizzoca et al. [33] reported that it is still, to be better defined, yet need to be answered if blood transfusion and organ transplantation as well as transplacental and perinatal routes, would be possible for SARS-CoV-2 transmission.

CORONA VIRUSES (COV) IN HUMANS

Coronavirus infection in humans is commonly associated with mild to severe respiratory diseases that are characterized by high fever, severe inflammation, cough, and internal organs dysfunction that can even lead to death [34]. WHO [35] reported that coronaviruses can spread in the following ways: Coughing and sneezing without covering the mouth can disperse droplets into the air, touching or shaking hands with a person who has the virus can pass the virus between individuals, making contact with a surface or object that has the virus and then touching the nose, eyes, or mouth. The National Institutes of Health (NIH) suggest that several groups of people have the highest risk of developing complications due to COVID-19.

These groups include:

1. Young children
2. People aged 65 years or older
3. Women who are pregnant

Mackenzie and Smith [29] reported with the outbreaks of other coronaviruses like SARS and MERS suggests that the mode of transmission in COVID-19 can be mainly human-to-human transmission occurs through direct contact, droplets, and fomites. Doremalen and Bushmaker [36] reported that studies on the aerosol and surface stability of SARS-CoV demonstrated that aerosol and fomite transmission of SARS-CoV-2 is feasible, as the virus can remain viable in aerosols for multiple hours and on surfaces up to days. Lauer et al. [37] reported that the longest predicted incubation time of SARS-CoV-2 (COVID-19) is 14 days. Hence, suspected individuals are isolated for 14 days to avoid the risk of further spread. Dhama et al. Another study [38] reviewed that coronavirus is the most prominent example of a virus that has crossed the species barrier twice from wild animals to humans, SARS, and MERS and the possibility of crossing the species barrier for the third time cannot be ruled out in the case of SARS-CoV-2 (COVID-19). Ben et al. [39] reported that the bats are considered as the ancestral hosts in both SARS and MERS and also considered as the reservoir host of human coronaviruses like HCoV-229E and HCoV-NL63 (104). In the case of COVID-19, there are two possibilities for primary transmission; either it can be transmitted through intermediate hosts similar to that of SARS and MERS or directly from bats [29].

SYMPTOMS

Singhal [34] reported that he most common symptoms associated with COVID-19 were fever, cough, dyspnea, expectoration, headache and myalgia or fatigue and individuals with asymptomatic infections were also suspected of potentially transmitting infections, which further add to the complexity of disease transmission dynamics in COVID-19 infection. He also reported that the cold- or flu-like symptoms usually set in from 2-4 days after a coronavirus infection and are typically mild. However, symptoms vary from person-to-person, and some forms of the virus can be fatal. The main symptoms of corona viruses include: 1. Sneezing 2. Runny nose 3. Cough 4. Watery diarrhea 5. Fever in rare cases 6. Sore throat and 7. Exacerbated asthma

GENERAL PREVENTIVE MEASURES

WHO [35] reported that the corona viruses can mutate effectively, which makes them so contagious? To prevent transmission, people should stay at home and rest while symptoms are active. Prevention is, so far, the best practice in order to reduce the impact of COVID-19 considering the lack of effective treatment [11]. Ginnaro et al. [40] suggested that at the moment, there is no vaccine available and the best prevention is to avoid exposure to the virus. In order to achieve this goal, the main measures are the following: **(1)** to use face masks; **(2)** to cover coughs and sneezes with tissues; **(3)** to wash hands regularly with soap or disinfection with hand sanitizer containing at least 60% alcohol; **(4)** to avoid contact with infected people; **(5)** to maintain an appropriate distance from people; and **(6)** to refrain from touching eyes, nose and mouth with unwashed hands. **(7)** Maintain at least 1 m (3 feet) distance between yourself and anyone who is coughing or sneezing.

IMMUNE BOOSTER AYUSH KADHA

Drink herbal tea/decoction (Kadha) made from Tulsi (Basil), Dalchini (Cinnamon), Kalimirch (Black pepper), Shunthi (Dry Ginger) and Munakka (Raisin) - once or twice a day. Add

jaggery (natural sugar) and/or fresh lemon juice to your taste, if needed.

Beside this Ministry of AYUSH also recommends the following self-care guidelines for preventive health measures. These are as follows:

1. Drink Golden Milk- Half tea spoon Haldi (turmeric) powder in 150 ml hot milk - once or twice a day.
2. Drink warm water throughout the day.
3. Daily practice of Yogasana, Pranayama and meditation for at least 30 min.
4. Spices like Haldi (Turmeric), Jeera (Cumin), Dhaniya (Coriander) and Lahsun (Garlic) are recommended in cooking.
5. Take Chyavanprash 10g (1tsf) in the morning. Diabetics should take sugar free.

TREATMENT BY PLASMA THERAPY

Rojas et al. [41] reported that the clinical administration of the blood plasma from recovered covid-19 patients to those severely affected by the disease could be a safe option without adverse effects, according to a study which may lead to better treatment protocols against novel corona virus infection. Salaza et al. [42] reported in his research article that on March 28, researchers from the Houston Methodist Hospital in the US, began clinical trials to transfuse plasma from recovered covid-19 patients into critically ill patients and they noted that 19 out of 25 patients improving with the treatment and 11 discharged from the hospital.

The Economics Times [43] reported in his news that physician scientists around the world scrambled to test new drugs and treatments against the COVID-19 virus, convalescent serum therapy emerged as potentially one of the most promising strategies. Salaza et al. [42] also reported that the scientists in the century-old therapeutic approach dates back to at least as early as 1918 to fight the Spanish Flu by using convalescent serum therapy.

Casadevall and Pirofski [44] reported that convalescent plasma therapy was used with some success during the 2003 SARS pandemic, the 2009 influenza H1N1 pandemic and the 2015 Ebola outbreak in Africa. They said early on in the Covid-19 pandemic, there were a handful of critically ill patients in China who showed improvement from plasma therapy, following which their team at Houston Methodist hospital targeted the Covid-19 virus with the procedure.

Altair Data Analytics Summit [45] clearly reported in his news that, it is not clear if the 25 patients given convalescent plasma would have improved without the treatment, adding that all patients were treated with multiple other medications, including antiviral and anti-inflammatory agents. “We cannot conclude that the patient outcomes were due solely to administration of convalescent plasma”. They said a randomized clinical trial would help address some questions, including whether patients would have better outcomes if plasma transfusions were administered sooner after the onset of symptoms.

ROLE OF ANTIBODY AGAINST CORONA VIRUSES INFECTIONS

Murin et al. [46] reported that the antibody response in *vivo* is a dynamic and complex mixture of monoclonal antibodies (mAbs), which work together to target different antigenic domains on the envelope glycoprotein of the virus. He also suggested that it is very important to determine whether the antibodies are powerful in the adaptive immune responses to MERS-CoV infection. Ansar and Ghosh [47] described more than 20 kinds of monoclonal antibodies, most of which are human or humanized antibodies. Solerti et al. [48] reported that the virus uses its spike proteins as an adhesion factor to facilitate host entry through a special receptor called dipeptidyl peptidase-4 (DPP4) and this receptor is considered a key factor in the signal transmission and activation of acquired and innate immune responses in infected patients. Geng et al. [49] reported that the Human monoclonal antibody (m336) isolated from the phage display library interacts with the receptor-binding region of MES coronavirus spike protein and displays strong neutralization activity to MES-CoV *in vitro* m336 reduces the RNA titer of lung by 40,000 to 90 000 folds. He has also reported HMab m336 is found to significantly reduce the viral RNA titers and viral-associated pathological changes in rabbit lung tissue. Ishii et al. [50] reported that mice inoculated with S nanoparticles produced high-level neutralizing antibodies against homologous viruses, and these antibodies have no cross-protection with heteroviruses. After being stimulated by SARS-CoV, immunized ferrets produced more rapid and stronger neutralizing antibody reaction than the control animals; however, the strong inflammatory reaction is observed in liver tissue. The prolongation of IgG production may indicate the significance of IgG in both humoral immune response to acute SARS-CoV infection and clearance of the remaining virus sources during recovery [49].

CASES OF COVID-19 IN INDIA

India reported the first confirmed case of the coronavirus infection on 30th January, 2020 in the state of Kerala. The affected had a travel history from Wuhan, China. In less than six months, the COVID-19 outbreak in India has spread to all states and union territories, infecting more than 11.2 lakh people. The curve is not flattening as the number of active cases has still increasing, and more than 27.5 thousand people have died because of the virus infection till July 20th, 2020.

CONCLUSIONS

This study shows a holistic picture of the current research in response to the outbreak of COVID-19. Studies in this domain are urgently needed to minimize the impact of the outbreak.

Over the past 50 years the emergence of many different corona viruses that cause a wide variety of human and veterinary diseases has occurred. It is likely that these viruses will continue to emerge and to evolve and cause both human and veterinary outbreaks owing to their ability to recombine, mutate, and infect multiple species and cell types. Future research on corona viruses will continue to investigate many aspects of viral replication and pathogenesis.

REFERENCES

1. Jheng J (2020) SARS-CoV-2: An emerging coronavirus that causes a global threat. Int J Biol Sci 16: 1678-1685.
2. Zhu H, Wei L, Niu P (2020) The novel coronavirus outbreak in Wuhan, China. Glob Health Res Policy 5: 6.
3. WHO (2020) Coronavirus disease 2019 (COVID-19) Situation Report-94.
4. Ye ZW, Yuan S, Yuen KS, Fung SY, Chan CP, et al. (2020) Zoonotic origins of human corona viruses. Int J Biol Sci 16: 1686-1697.
5. Gong S, Bao L (2018) The battle against SARS and MERS coronaviruses: Reservoirs and animal models. Anim Model Exp Med 1: 125-133.
6. Anjorin AA (2020) The corona virus disease 2019 (COVID-19) pandemic: A review and an update on cases in Africa. Asian Pac J Trop Med 13: 199-203.
7. Pal M, Berhanu G, Desalegn C, Kandi V (2020) Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2): An Update. Cureus 12: e7423.
8. Sahin AR, Erdogan A, Agaoglu MP, Dineri Y, Cakirci AY, et al. (2020) 2019 Novel Coronavirus (COVID-19) outbreak: A review of the current literature. EJMO 4: 1-7.
9. Jonsdottir HR, Dijkman R (2016) Coronaviruses and the human airway: A universal system for virus-host interaction studies. Virol J 13: 24.
10. Dhama K, Khan S, Tiwari R, Sircar S, Bhat S, et al. (2020) Coronavirus disease 2019-COVID-19. Clin Microbiol Rev 33: e00028-20.
11. Kumar P (2020) Overview on coronavirus (COVID-19). Asian J Adv Med Sci 2: 15-20.
12. WHO (2020) Covid-19 strategy update?
13. Desforges M, Coupanec AL, Stodola JK, Pinard MM, Talbot PJ (2014) Human coronaviruses: Viral and cellular factors involved in neuroinvasiveness and neuropathogenesis. Virus Res 194: 145-158.
14. Miłek J, Domańska KB (2018) Coronaviruses in Avian Species-Review with focus on epidemiology and diagnosis in wild birds. J Vet Res 62: 249-255.
15. Singh S, Singh AK, Jain PK, Singh NP, Bajpai PK, et al. (2020) Coronavirus: A threat to global public health. Ind J Comm Health 32: 19-24.
16. Vijgen L, Keyaerts E, Moes E, Thoelen I, Wollants E, et al. (2005) Complete genomic sequence of human coronavirus OC43: Molecular clock analysis suggests a relatively recent zoonotic coronavirus transmission event. J Virol 79: 1595-1604.
17. Woo PCY, Huang Y, Lau SKP, Yuen KY (2010) Coronavirus genomics and bioinformatics analysis. Viruses 2(8): 1804-1820.
18. Sanjuán R, Calap PD (2016) Mechanisms of viral mutation. Cell Mol Life Sci 73: 4433-4448.
19. Lim YX, Ng YL, Tam JP, Liu DX (2016) Human coronaviruses: A review of virus-host interactions. Diseases 4: 26.
20. Ryu WS (2017) Virus life cycle. Molecular Virology of Human Pathogenic Viruses 31-45.
21. Payne S (2017) Virus interactions with the cell. Viruses 23-35.
22. Shoeman D, Feilding BC (2019) Coronavirus envelope protein: Current knowledge. Virol J 16: 69.
23. Fang Li (2016) Structure, function and evolution of coronavirus spike proteins. Ann Rev Virol 3: 237-261.
24. Kuhn JH, Li W, Choe H, Farzan M (2004) Angiotensin-converting enzyme 2: A functional receptor for SARS coronavirus. Cell Mol Life Sci 61: 2738-2743.
25. Belouzard S, Chu VC, Whittaker GR (2009) Activation of the SARS coronavirus spike protein viasequential proteolytic cleavage at two distinct sites. PNAS 106: 145871-145876.
26. Jaimes JA, André NM, Chappie JS, Millet JK, Whittaker GR (2020) Phylogenetic analysis and structural modeling of SARS-CoV-2 spike protein reveals an evolutionary distinct and proteolytically sensitive activation loop. J Mol Biol 432: 3309-3325.
27. Kirchdoerfer RN, Cottrell C, Wang N, Pallesen J, Yassine HM, et al. (2016) Pre-fusion structure of a human coronavirus spike protein. Nature 531: 118-121.
28. Yuki K, Fujiogi M, Koutsogiannaki S (2020) COVID-19 pathophysiology: A review. Clin Immunol 215: 108427.
29. Mackenzie JS, Smith DW (2020) COVID-19: A novel zoonotic disease caused by a coronavirus from China: What we know and what we don't. Microbiol Aust Mar 17: MA20013.
30. Kaushik H, Singh VK (2020) Mathematics of COVID-19 in India and their possible control by Allium sativum (L.). Asian J Adv Med Sci 2: 21-27.

31. Tiwari R, Dhama K, Khan S, Yatoo MI, Malik YS, et al. (2020) COVID-19: Animals, veterinary and zoonotic links. Vet Quart 40: 169-182.

32. Aliabadi AA, Rogak SN, Bartlett KH, Green SI (2011). Preventing airborne disease transmission: Review of methods for ventilation design in health care facilities. Adv Prev Med 2011: 124064.

33. Bizzoca ME, Campisi G, Muzio LL (2020) Covid-19 Pandemic: What changes for dentists and oral medicine experts? A narrative review and novel approaches to infection containment. Int J Environ Res Publ Health 17: 3793.

34. Singhal T (2020) A review of coronavirus disease-2019 (COVID-19). Ind J Pediatr 87: 281-286.

35. WHO (2020) Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations.

36. Doremalen NV, Bushmaker T (2020) Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. N Engl J Med NEJMc2004973.

37. Lauer SA, Grantz KH, Bi Q, Jones FK, Zheng Q, et al. (2020) The incubation period of coronavirus disease 2019 (COVID-19) from publicly reported confirmed cases: Estimation and application. Ann Intern Med M20-0504.

38. Dhama K, Khan S, Tiwari R, Sircar S, Bhat S, et al. (2020) Coronavirus disease 2019-COVID-19. Clin Microbiol Rev 33: e00028-20.

39. Ben Hu, Ge X, Wang LF, Shi Z (2015) Bat origin of human coronaviruses. Virol J 12: 221.

40. Gennaro FD, Pezzoli D, Marotta C, Antunes M, Racalbuto V, et al. (2020) Coronavirus Diseases (COVID-19) current status and future perspectives: A narrative review. Int J Environ Res Public Health 17: 2690.

41. Rojas M, Rodríguez Y, Monsalve DM, Ampudia YA, Camacho B, et al. (2020) Convalescent plasma in Covid-19: Possible mechanisms of action. Autoimmun Rev 19: 102554.

42. Salazar E, Perez KK, Ashraf M, Chen J, Castillo B, et al. (2020) Treatment of coronavirus disease 2019 (COVID-19) patients with convalescent plasma. Am J Pathol.

43. The Economics Times (2020) Covid-19 plasma therapy safe, without adverse side effects: Study.

44. Casadevall A, Pirofski L (2020) The convalescent sera option for containing COVID-19. J Clin Invest 130: 1545-1548

45. Altair Data Analytics Summit (2020) Covid-19 plasma therapy safe, without adverse side effects: Study.

46. Murin CD, Wilson IA, Ward AB (2019) Antibody responses to viral infections: A structural perspective across three different enveloped viruses. Nat Microbiol 4: 734-747.

47. Ansar W, Ghosh S (2013) Monoclonal antibodies: A tool in clinical research. Ind J Clin Med 4: 9-21.

48. Solerte SB, Sabatino AD, Galli M, Fiorina P (2020) Dipeptidyl peptidase-4 (DPP4) inhibition in COVID-19. Acta Diabetol 6: 1-5.

49. Geng Li, Fan Y, Lai Y, Han T, Li Z, et al. (2020) Coronavirus infections and immune responses. J Med Virol 92: 424-432.

50. Ishii K, Hasegawa H, Nagata N, Ami Y, Fukushi S, et al. (2009) Neutralizing antibody against severe acute respiratory syndrome (SARS)-coronavirus spike is highly effective for the protection of mice in the murine SARS model. Microbiol Immunol 53: 75-82.