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REVIEW ARTICLE

COVID 19 Pandemic; A Review on Understanding the Mode of Transmission and Application of Strategies to Delay/Stop Transmission with Special Reference to India

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Abstract:

Background:

SARS CoV-2 has globally affected more than 31 hundred thousand population with more than 2 hundred thousand deaths till date, since its inception from Wuhan, China in December 2019. World is still clueless regarding definitive treatment for this highly contagious disease. Till then we have to rely on time tested methods to delay/stop transmission of this viral disease by observing social isolation, hand hygiene and wearing face mask.

Objective:

The main objective of this review paper is to focus on different modes of transmission of this virus, comparison of this virus with previous similar analogy viral diseases like SARS and MERS and different strategies that can be planned or are ongoing to reduce/delay transmission of this virus in community contacts, especially in context to India.

Methods:

PUBMED, Google Scholar and BioRxiv search was performed with keywords; COVID- 19, mode of transmission, infection, India, BCG. Around 538 eligible papers were evaluated from time period of January 1 to 29 April 2020 and results were summarized

Results:

On analysis of different papers on mode of transmission it was found that this virus is highly contagious and spreads through air droplet, close contact, through fomites and different metallic surfaces and through aerosol in surroundings with high aerosol generating procedures only. Also, it can spread both in asymptomatic and symptomatic phase equally so early testing is essential. Also, it is mutating in different host environments so it is imperative to include different strains in vaccine preparation.

Conclusion:

Results demonstrate the fact that early screening, social distancing, isolation of symptomatic patients, respiratory etiquette are the main armaments presently to deal with this virus till effective treatment or vaccine becomes available in the near future. Furthermore, we would like to suggest the Indian government to create a National Viral Disease Management Board on lines of National Tuberculosis Elimination program to prevent and control such viral outbreaks in future.

Keywords: COVID-19, Mode of transmission, Air droplet infection, India, SARS CoV-2, MERS, SARS.

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1. BACKGROUND

Since the inception of COVID-19 pandemic; it has affected 210 countries (April 29, 2020, 10:20 GMT) with total cases 3,149,108; total deaths 218,385; recoveries 962,763 and 56,907 critical cases (https://www.worldometers.info/coronavirus) and

still rolling on. This paper is an intention to understand the various modes of transmission of this novel coronavirus from human to human and different strategies that can be adapted as to understand the most appropriate approach to delay/stop the community spread, till a confirmatory treatment or vaccine is available with especial reference to India.

2. INTRODUCTION

A virus is defined by its genomic sequence that can autonomously replicate inside cells and can transmit between cells or organisms under appropriate conditions and may or may not cause the disease [1]. The emergence of a novel Severe Acute Respiratory Syndrome related Coronavirus-2 (SARS CoV-2) in late December from atypical pneumonia patients of Wuhan city, China [2], clusters with SARS-CoVs in tree of species severe acute respiratory syndrome-related coronavirus and genus Betacoronavirus but the disease spectrum and transmission efficiency differs from the same [3 - 6]. SARS CoV -2 shows 79% homology with SARS CoV and 50% with MERS CoV [7 - 9]. SARS CoV has 8096 confirm cases with 774 deaths during 8 months period in the year 2002 [10], while MERS has 2494 confirmed cases since April 2012 with 858 deaths and 27 countries reported globally [11]. In comparison to both, SARS CoV-2 affected almost 210 countries with more than 3.1 million cases till date and mortality of 2.9% and still evolving every day. This paper intends to highlight the difference in mode of transmission of SARS CoV-2 from SARS CoV and MERS and whether these differences play some role in more widespread infection by SARS CoV-2 virus and also the strategies that can be adapted to delay/stop transmission with special reference to India.

3. METHODOLOGY

PUBMED, Google Scholar and BioRxiv search was performed with keywords; COVID-19, mode of transmission, infection, India, BCG. Around 538 eligible papers were evaluated from a time period of January 1 to 29 April 2020 and results were summarized below.

4. SEARCH RESULTS

It was found that transmission of SARS CoV-2 occurs through air droplet (particle size > 5 microns from a sick person splash the eyes, nose and mouth of another person) and through direct and indirect contact (*via* fomites) like in MERS and SARS CoV [12 - 18]. The exact patho-physiological mechanisms by which SARS CoV-2 invades human cells is still a matter of research, but various studies suggest that it mainly involves ACE-2 receptors in the human lower respiratory tract to invade lung cells. This is similar to its previous SARS virus. It also uses serine protease TMPRSS2 for priming its spike protein S for fusion with host cells [19]. Studies show that it can remain viable on metallic surfaces, card board, plastics and glass surfaces [20, 21]. SARS CoV-2 has been detected in whole blood, stools and urine but whether they can be medium of transportation is a matter of research [22]. In one study, in controlled experimental settings only, it was found in aerosol (particle size < 5 microns, germs floats in air after person talk, cough, sneeze and direct contact with infection person is NOT needed to cause infection in another person) ; so it is assumed that only aerosol generating procedures like nebulization, bronchoscopy, suctioning, endotracheal intubation, mechanical ventilation,etc can lead to aerosol transmission [23, 24]. Various studies advise the use of saliva ejectors in high risk professionals like dentist to reduce production of aerosols [25, 26]. Incubation period of SARS CoV-2 is between 1-14 days and can extend up to 24 days, suggesting a long incubation period can lead to more community spread, whereas mean incubation period of MERS virus is around 5 days and SARS is 7 days [27 - 32]. Reproduction number (Ro) is the indication of transmission of virus indicating average number of new cases generated by an infectious person in a totally new population. If Ro >1, it indicates that infection is likely to increase and if Ro < 1, then it suggests that transmission is likely to die out. A meta-analysis of 12 studies between January 1 and February 7 suggests that basic reproduction number of SARS CoV-2 virus is between 1.4 to 6.49 [33]. In comparison to SARS CoV where transmission occurs several days after onset of symptoms in association with peak viral load, transmission of SARS CoV-2 may occur with start of illness; even during early with mild symptoms or in asymptomatic phase (asymptomatic carriers) and infectivity is almost same as that during symptomatic phase [34, 35]. This suggests that the isolation of symptomatic ill individuals alone will not be sufficient but whole community has to take care and follow steps to reduce infection rate. This virus primarily affects lower throat and lungs. Symptoms include dry cough, fever, difficulty in breathing, throat pain, running nose, headache, *etc.* Later on bronchopneumonia and respiratory failure can develop. Disease is initially mild in first week and if immunity is low, can progress to severe form in second to fourth week. There is mainly lymphopenia with elevation of prothrombin time, D-dimer, procalcitonin, hepatic transaminases and leukocytocysis, Extra pulmonary, it can cause acute injuries in heart, liver and kidneys [36 - 42]. Immunoglobulin G antibodies and neutralizing antibodies are produced by B cells after infection with virus. Even after recovery, their presence in the host body prevents reactivation or re-infection, but it gradually wanes off with time. In a study, it was observed that these neutralizing antibodies were less in the younger age group in comparison elderly group due to strong innate immune response from the elderly. This also suggests a more severe inflammatory response in the elderly in comparison to the younger population. Besides, this T cell also plays an important role in cell mediated immune response against SARS CoV-2 and needs further exploration [43, 44]. The phylogenetic studies of SARS CoV-2 indicate that two main lineages co-exist L type (T28, 144 is in the codon of Leucine) and S-type (ancestor) (C28, 144 is in the codon of Serine) with 4% genetic difference; with L type being more aggressive [19]. Also, there are successive mutations and recombinations in the virus, depending on its interaction with different hosts, and phylogenetic analysis have shown variations in genomic sequencing in different countries through different periods. This also suggests that a future vaccine should contain both

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strains and is not an easy task. Bacillus Calmette Guerin (BCG), a live attenuated vaccine developed against tuberculosis; helps in preventing severe forms of tuberculosis and is the first vaccine to be given at the time of birth in immunization program of some countries, including India [45]. An experimental study done in mice suggests that BCG protects against various viral pathogens like influenza A, Herpes simplex virus type 2 [46]. These non specific effects of BCG *via* induction of innate immunity, T lymphocyte activation and enhanced cytokine production and macrophage activation (Trained immunity) [47] could help in reducing severe forms of disease by SARS CoV-2 and thereby improving recovery rate and reducing mortality rate. A recent paper by Dr Paul L fidel and Marie C Noverr [48] suggest that live attenuated MMR vaccine serves as a preventive measure to reduce septic inflammation in COVID-19 patients by inducing trained nonspecific innate immune cells for improved host response. A lot of efforts are going on throughout the world for reducing the community transmission of this virus; prominent methods adopted are home quarantine of international travellers, isolation and testing of symptomatic cases, spreading awareness regarding social distancing, hand hygiene, respiratory etiquettes, and mask wearing while going in the community and so on. Some countries like South Korea are focussing more on testing by RT-PCR, social distancing and better health care infrastructures, whereas others like India have initially adopted the strategy of lockdown, quarantine, isolation and social distancing and gradually increase the capacity for testing and building healthcare infrastructure for covid19 patients [49 - 51]. 'Kerala' in India encountered its first case on 30th January 2020 from a student from China's Wuhan; there were around 606 cases when JANTA curfew was imposed on 22nd march 2020 with a recovery rate of 7% . Later on, lockdown was extended in 3 phases till now and all states were divided into 3 zones depending on the presence of active cases (red zone), recovered cases (orange zone) and no cases (green zone). The sole purpose of lockdown was to reduce community transmission of virus with active screening and contact tracing. All essential commodity services were continued through the lockdown. This also gave the country ample time to prepare health infrastructure increasing testing facilities. Presently, there are more than 80,000 cases with a recovery rate of 35%, till writing of this paper and still improving. Also, an important step was taken to screen all migrants so as to reduce community spread in villages. Direct interaction of government with people and financial aid also helped in building confidence and moral support among citizens [52 - 54]. As case fatality is more in the elderly and people having co-morbidities like diabetes, hypertension, chronic kidney disease, and having immuno-compromised state, it is important to take care of them the most. [CDC 2020]

4.1. Measures Taken by Indian Government for Preventing/Containment of COVID-19

Indian government has taken tremendous measures on all fronts to contain SARS COV-2 virus. It includes enhancing laboratory testing facilities, contact tracing, IPC (infection prevention control) training to medical and paramedical staff and also community awareness programs;

a. Testing facilities: starting from one diagnostic lab for COVID-19 testing in January 2020, the country has 1244 operational laboratories (897 governments and 393 private) till date and still adding on. India has tested 1,37,91,869 samples till date (23 July 2020) and continuously enhancing the testing facility, which is now more than 3,59,000 samples per day [55].

b. Contact tracing: National informatics centre under the ministry of electronics and information technology has launched a mobile app on 2 April 2020 for contact tracing containing awareness videos regarding the need for social distancing, mask wearing and hand hygiene and also has a national helpline number 1075 and state help line numbers (www.mohfw.gov.in) in case of any assistance required by any citizen. Presently, door to door survey for seroprevalence by antibody testing (IgG Elisa Kit) is initiated in many districts, especially with higher number of COVID-19 patients [56].

c. Isolation and Quarantine facilities: people who are asymptomatic and believed to come in contact with COVID-19 patients are being quarantined, whereas those who are confirmed cases with mild symptoms are being isolated. Patients with very mild symptoms with no co morbidities are admitted at covid care centre (Level 1) number 7529 (5 June 2020, Indian Express news) or given option of home isolation (like in Delhi, Uttar Pradesh), patients having mild symptoms with co morbidities are admitted in covid health care centres (Level 2) number 2362 with the facility of oxygen administration and patients with complications are admitted in covid hospitals with intensive care facilities (Level 3), number 957. The government has also designated various hospitals with nodal charges, only for covid care and is trying to reserve 10% beds for covid patients in various government and private hospitals. On 24th May (Hindustan Times news), level 3 hospitals have 1,85,306 beds with 31,250 ICU beds and capacities are continuously enhancing. On 24th May, there were 9.74 hundred thousand beds for covid patients including 6.75 hundred thousand beds in covid care centres. India also has the largest covid care centre in the world (Sarder Patel covid care centre) with the capacity for more than 10,000 beds with an area equivalent to 22 football grounds and prepared in 10 days time. Indian government has also provided psychosocial toll free helpline number 0804611007 to take care of the mental health of its citizens during this pandemic.

d. Community sensitization programs: Indian government is making tremendous efforts for community sensitisation by broadcasting the importance of hand washing, mask wearing by eminent personalities of India on television and social media, promoting yoga and healthy diet for increasing immunity and healthy mental status. Local administration is making all efforts for strict implementation of maintaining social distancing in markets and shops and fine is imposed on people not wearing mask in community.

e. Measures by health care facilities to contain/prevent disease: Triage area is made mandatory in all hospitals for screening of ILI (influenza like illness) and SARI (severe acute respiratory infection) patients and suspected patients are isolated in separate areas with all facilities including oxygen and intensive care facilities and testing is performed in all cases

to confirm COVID-19. Testing for all close contacts is also performed to prevent community spread. IPC (infection prevention and control) training is provided in all medical colleges and district hospitals for both government and private practitioners and a committee is made to monitor regarding the same for both government institutes and private hospitals and clinics.

4.2. Proposal to Develop Specific Viral Designated Centres on the Same Model of National Tuberculosis Elimination Program

We propose that Indian government should work on the same model of 'DETECT-TREAT-PREVENT-BUILD" for controlling repeated outbreaks of viral infections as planned for tuberculosis elimination [57]. The same infrastructure with additional manpower will be a feasible option for controlling such viral outbreaks in the future. Detection by RT- PCR for which CBNAAT/True NAT machines can be utilized which are available in almost all districts of India; Treatment of COVID-19 is yet not available, but as treatment of other coronaviruses and H1N1 influenza virus is known, the same can be given at designated treatment centres and vaccines can be given like for influenza and pneumococcal infections; prevention of viral infections by following hand hygiene, use of masks when ill, respiratory etiquette and self isolation can be done to prevent contact transmission and last but not least by Building and strengthening enabling policies, translating high level political commitment to action and creation of National Viral Disease Management Board to contain and prevent such viral outbreaks in future (National Strategic Plan 2017-2025 for TB Elimination in India).

CONCLUSION

As SARS CoV-2 virus or novel corona virus has long incubation period with equivalent infectivity in asymptomatic and symptomatic carriers and varied mode of transmission with no definitive treatment or vaccine available till date ; it is imperative that only method to control the spread of virus is by maintaining social distance, early identification of cases and frequent hand hygiene, respiratory etiquette, frequent sanitization, universal mask wearing and environmental cleaning and disinfection. Also, it is advisable that now the time has come to create a National Viral Disease Management Board on lines of National Tuberculosis Elimination program to prevent and control such viral outbreaks in future.

AUTHORS' CONTRIBUTIONS

Conceptualization, S.S and P.S..; methodology, A.G. and M.N.K.; writing-original draft

Preparation, S.S..; writing-review and editing, S.S, A.M and B.K.A. All authors have read and agreed to the published version of the manuscript.

CONSENT FOR PUBLICATION

The legal protection of all participants was ensured and confirmed by written consent.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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REFERENCES

[1] Alberts B, Johnson A, Lewis J, *et al.* Molecular biology of the cell. Cell Biology of Infection 4th edition. 2002.comment> Available from: https://www.ncbi.nlm.nih.gov/books/NBK26833

[2] Huang C, Wang Y, Li X, *et al.* Clinical features of patients infected with 2019 novel coronavirus in wuhan, china. Lancet 2020.

[3] The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2 Nature Micro Biol 2020; 5(4): 536.ncbi.nlm.nih.gov

[4] Lu R, Zhao X, Li J, *et al.* Genomic characterisation and epidemiology of 2019 novel coronavirus: Implications for virus origins and receptor binding. Lancet 2020; 395(10224): 565-74. [http://dx.doi.org/10.1016/S0140-6736(20)30251-8] [PMID: 32007145]

[5] Zhou P, *et al.* Discovery of a novel coronavirus associated with the recent pneumonia outbreak in humans and its potential bat origin. Nature 2020. [http://dx.doi.org/10.1038/s41586-020-2012-7] [PMID: 32015507]

[6] Zhu N, Zhang D, Wang W, *et al.* A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med 2020; 382(8): 727-33. [http://dx.doi.org/10.1056/NEJMoa2001017] [PMID: 31978945]

[7] Wu A, Peng Y, Huang B, *et al.* Genome composition and divergence of the novel coronavirus (2019-nCoV) originating in China. Cell Host Microbe 2020; 27(3): 325-8. [http://dx.doi.org/10.1016/j.chom.2020.02.001] [PMID: 32035028]

[8] Ren LL, Wang YM, Wu ZQ, *et al.* Identification of a novel coronavirus causing severe pneumonia in human: A descriptive study. Chin Med J (Engl) 2020; 133(9): 1015-24. [http://dx.doi.org/10.1097/CM9.0000000000000722] [PMID: 32004165]

[9] Chan JF, Yuan S, Kok KH, To KK, Chu H, Yang J, *et al.* A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating personto-person transmission: A study of a family cluster. Lancet 2020; 395: 51423. [http://dx.doi.org/10.1016/S0140-6736(20)30154-9]

[10] Park SE. Epidemiology, virology, and clinical features of severe acute respiratory syndrome - coronavirus-2 (SARS-CoV-2; Coronavirus Disease-19). Clin Exp Pediatr 2020; 63(4): 119-24. [http://dx.doi.org/10.3345/cep.2020.00493] [PMID: 32252141]

[11] Eastern Mediterranean Regional Oce. Cairo, Egypt: EMRO 2019.

[12] Coronaviruses, including SARS and MERS.Red Book®: 2018 Report of the Committee on Infectious Diseases. 31st ed. Itasca, IL: American Academy of Pediatrics 2018; pp. 297-301.

[13] Muhammad Adnan Shereen, Suliman Khan, Abeer Kazmi, Nadia Bashir, Rabeea Siddique. COVID-19 infection: Origin, transmission, and characteristics of human coronaviruses. J Adv Res 2020; 24: 91-8. [http://dx.doi.org/10.1016/j.jare.2020.03.005]

[14] Li Q, Guan X, Wu P, *et al.* Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. N Engl J Med 2020; 382(13): 1199-207. [http://dx.doi.org/10.1056/NEJMoa2001316] [PMID: 31995857]

[15] Meselson M. Droplets and aerosols in the transmission of SARS-CoV-2. N Engl J Med 2020; 382(21): 2063. [http://dx.doi.org/10.1056/NEJMc2009324] [PMID: 32294374]

[16] Jin Yuefei, Yang Haiyan, Ji Wangquan, *et al.* Virology, epidemiology, pathogenesis, and control of COVID-19. Viruses 2020; 12(4): 372-0.

[17] Zou L, Ruan F, Huang M, *et al.* SARS-CoV-2 viral load in upper respiratory specimens of infected patients. N Engl J Med 2020; 382(12): 1177-9. [http://dx.doi.org/10.1056/NEJMc2001737] [PMID: 32074444]

[18] El Zowalaty ME, Järhult JD. From SARS to COVID-19: A previously unknown SARS- related coronavirus (SARS-CoV-2) of pandemic potential infecting humans - Call for a one health approach. One Health 2020; 9: 100124. [http://dx.doi.org/10.1016/j.onehlt.2020.100124] [PMID: 32195311]

[19] Abduljalil JM, Abduljalil BM. Epidemiology, genome, and clinical features of the pandemic SARS-CoV-2: A recent view. New Microbes New Infect 2020; 35: 100672.

[http://dx.doi.org/10.1016/j.nmni.2020.100672] [PMID: 32322400]
[20] van Doremalen N, Bushmaker T, Morris DH, *et al.* Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. N Engl J Med 2020; 382(16): 1564-7. [http://dx.doi.org/10.1056/NEJMc2004973] [PMID: 32182409]
[21] Rubens JH, Karakousis PC, Jain SK. Stability and viability of SARS-CoV-2. N Engl J Med 2020; 382(20): 1962-3. [http://dx.doi.org/10.1056/NEJMc2007942] [PMID: 32283575]
[22] Amirian ES. Potential fecal transmission of SARS-CoV-2: Current evidence and implications for public health. Int J Infect Dis 2020; 95: 363-70. [http://dx.doi.org/10.1016/j.ijid.2020.04.057] [PMID: 32335340]
[23] Cubillos J, Querney J, Rankin A, Moore J, Armstrong K. A multipurpose portable negative air flow isolation chamber for aerosol-generating procedures during the COVID-19 pandemic. Br J Anaesth 2020; 125(1): e179-81. [http://dx.doi.org/10.1016/j.bja.2020.04.059] [PMID: 32386834]
[24] Srivastava Nishant. Prevention and control strategies for SARS-CoV-2 infection. Coronavirus Disease 2019 (COVID-19) 2020; 127-40.
[25] Spagnuolo Gianrico, De Vito Danila, Rengo Sandro, Tatullo Marco. COVID-19 outbreak: An overview on dentistry. International Journal of Environmental Research and Public Health 2020; 17(6): 2094.
[26] Meng L, Hua F, Bian Z. Coronavirus disease 2019 (COVID-19): Emerging and future challenges for dental and oral medicine. J Dent Res 2020; 99(5): 481-7. [http://dx.doi.org/10.1177/0022034520914246] [PMID: 32162995]
[27] Huang L, Zhang X, Zhang X, *et al.* Rapid asymptomatic transmission of COVID-19 during the incubation period demonstrating strong infectivity in a cluster of youngsters aged 16-23 years outside Wuhan and characteristics of young patients with COVID-19: A prospective contact-tracing study. J Infect 2020 Apr 10; S0163-4453(20): 30117-1. [http://dx.doi.org/10.1016/j.jinf.2020.03.006] [PMID: 32283156]
[28] Docea AO, Tsatsakis A, Albulescu D, *et al.* A new threat from an old enemy: Reemergence of coronavirus (Review). Int J Mol Med 2020; 45(6): 1631-43. [http://dx.doi.org/10.3892/ijmm.2020.4555] [PMID: 32236624]
[29] Tang X, Wu C, Li X. On the origin and continuing evolution of SARS-CoV-2. Nat Sci Rev 2020; 36.
[30] Kaul D. An overview of coronaviruses including the SARS-2 coronavirus–Molecular biology, epidemiology and clinical implications. Current Medicine Research and Practice 2020. [http://dx.doi.org/10.1016/j.cmrp.2020.04.001]
[31] Siordia JA Jr. Epidemiology and clinical features of COVID-19: A review of current literature. J Clin Virol 2020; 127: 104357. [http://dx.doi.org/10.1016/j.jcv.2020.104357] [PMID: 32305884]
[32] Young BE, Ong SWX, Kalimuddin S, *et al.* Epidemiologic features and clinical course of patients infected with SARS-CoV-2 in Singapore. JAMA 2020; 323(15): 1488-94. Epub [http://dx.doi.org/10.1001/jama.2020.3204] [PMID: 32125362]
[33] Liu Y, Gayle AA, Wilder-Smith A, Rocklöv J. The reproductive number of COVID-19 is higher compared to SARS coronavirus. J Travel Med 2020; 27(2): taaa021. [http://dx.doi.org/10.1093/jtm/taaa021] [PMID: 32052846]
[34] Bai Y, Yao L, Wei T, *et al.* Presumed asymptomatic carrier transmission of COVID-19. JAMA 2020; 323(14): 1406-7. Epub [http://dx.doi.org/10.1001/jama.2020.2565] [PMID: 32083643]
[35] Su Eun Park. Epidemiology, Virology, and Clinical features of severe acute respiratory syndrome coronavirus 2 SARS-CoV-2; Corona-virus Disease-19. Epidemiology, Virology, and Clinical Features of Severe Acute Respiratory Syndrome Coronavirus 2 SARS-CoV-2; Coronavirus Disease-19 2020; 27(1): 1.
[36] Mungroo Mohammad Ridwane, Khan Naveed Ahmed, Siddiqui Ruqaiyyah. Novel coronavirus: Current understanding of clinical features, diagnosis, pathogenesis, and treatment options. Pathogens 2020; 9(4): 297.
[37] Nadeem Muhammad Shahid, Zamzami Mazin A, Choudhry Choudhry, Murtaza Bibi Nazia, Kazmi Imran. Origin, potential therapeutic targets and treatment for coronavirus disease (COVID-19). Pathogens 2020; 9(4): 307.
[38] Chawla Onam, Saxena Shailendra K. Preparing for the perpetual challenges of pandemics of coronavirus infections with special focus on SARS-CoV-2. Coronavirus Disease 2019 (COVID-19) 2020; 165-86.
[39] Kakodkar P, Kaka N, Baig MN. A comprehensive literature review on the clinical presentation, and management of the pandemic coronavirus disease 2019 (COVID-19). Cureus 2020; 12(4): e7560. [http://dx.doi.org/10.7759/cureus.7560] [PMID: 32269893]
[40] Nicola M, O'Neill N, Sohrabi C, Khan M, Agha M, Agha R. Evidence based management guideline for the COVID-19 pandemic - Review article. Int J Surg 2020; 77: 206-16. [http://dx.doi.org/10.1016/j.ijsu.2020.04.001] [PMID: 32289472]
[41] Gabutti G, d'Anchera E, Sandri F, Savio M, Stefanati A. Coronavirus: Update related to the current outbreak of COVID-19. Infect Dis Ther 2020; 1-13. [http://dx.doi.org/10.1007/s40121-020-00295-5] [PMID: 32292686]
[42] Cevik M, Bamford C, Ho A. COVID-19 pandemic - A focused review for clinicians. Clin Microbiol Infect 2020; S1198-743X(20): 30231-7. [http://dx.doi.org/10.1016/j.cmi.2020.04.023] [PMID: 32344166]
[43] Wu F, Wang A, Liu M, *et al.* Neutralizing antibody responses to SARS-CoV-2 in a COVID-19 recovered patient cohort and their implications. medRxiv 2020; 2020: 7365.
[44] Ju B, Zhang Q, Ge X, *et al.* Potent human neutralizing antibodies elicited by SARS-CoV-2 infection. Biorxiv 2020; 2020: 990770.
[45] Spencer JC, Ganguly R, Waldman RH. Nonspecific protection of mice against influenza virus infection by local or systemic immunization with Bacille Calmette-Guérin. J Infect Dis 1977; 136(2): 171-5. [http://dx.doi.org/10.1093/infdis/136.2.171] [PMID: 894076]
[46] Starr SE, Visintine AM, Tomeh MO, Nahmias AJ. Effects of immunostimulants on resistance of newborn mice to herpes simplex type 2 infection. Proc Soc Exp Biol Med 1976; 152(1): 57-60. [http://dx.doi.org/10.3181/00379727-152-39327] [PMID: 177992]
[47] Moorlag SJCFM, Arts RJW, van Crevel R, Netea MG. Non-specific effects of BCG vaccine on viral infections. Clin Microbiol Infect 2019; 25(12): 1473-8. [http://dx.doi.org/10.1016/j.cmi.2019.04.020] [PMID: 31055165]
[48] Fidel PL Jr, Noverr MC. Could an unrelated live attenuated vaccine serve as a preventive measure to dampen septic inflammation associated with COVID-19 infection? MBio 2020; 11(3): e00907-20. [http://dx.doi.org/10.1128/mBio.00907-20] [PMID: 32561657]
[49] Ye G, Lin H, Chen S, *et al.* Environmental contamination of SARS-CoV-2 in healthcare premises. J Infect 2020; S0163-4453(20): 30260-7.
[50] Greenhalgh T, Schmid MB, Czypionka T, Bassler D, Gruer L. Face masks for the public during the covid-19 crisis. BMJ 2020; 369: m1435. [http://dx.doi.org/10.1136/bmj.m1435] [PMID: 32273267]
[51] Eikenberry SE, Mancuso M, Iboi E, *et al.* To mask or not to mask: Modeling the potential for face mask use by the general public to curtail the COVID-19 pandemic. Infect Dis Model 2020; 5: 293-308. [http://dx.doi.org/10.1016/j.idm.2020.04.001] [PMID: 32355904]
[52] Mazumder A, Arora M, Bharadiya V, *et al.* SARS-CoV-2 epidemic in India: Epidemiological features and *in silico* analysis of the effect of interventions. F1000 Res 2020; 9: 315. [http://dx.doi.org/10.12688/f1000research.23496.1] [PMID: 32528664]
[53] Ambikapathy Bakiya, Kamalanand Krishnamurthy. Mathematical modelling to assess the impact of lockdown on COVID-19 transmission in india: model development and validation. JMIR Public Health and Surveillance 2020; 6(2): e19368..
[54] Singh Kirti, Bali Jatinder, Singh Arshi, Sharma Nandini. COVID 19: Understanding the disease to implement containment strategies. MAMC J Med Sci 2020; 6(1): 7.
[55] Indian Council of Medical Research. List of COVID-19 testing https://www.icmr.gov.in/pdf/covid/labs/COVID_Testing_Labs_23072020.pdf
[56] Indian Council of Medical Research. https://www.icmr.gov.in/pdf/press_realease_files/ICMR_PR%20_IgG_Elisa_30052020.pdf
[57] Central TB. http:// www.tbcindia.nic.in