Coronavirus Pandemic: A Review of a New-fangled Risk to Public Health

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1 Introduction

The present pandemic of COVID-19 is due to the recurrence of the coronavirus (CoV), wherein a new-fangled virus was recognized and primarily entitled as nCoV. Its name was further changed to Severe Acute Respiratory Syndrome Coronavirus 2 (SARS CoV-2) and the related ailments were termed as COVID-19 [1]. It originates from the Coronaviridae group and is a positive abandoned RNA virus. As the virus splurged globally (on March 11, 2020), it was legitimately labelled as the epidemic [2].

Way back in 1960, the foremost case of CoV was reported as cold. In 2001, around five hundred patients were diagnosed with a flu-identical syndrome. CoV strain via the polymerase chain reaction led to the infection of 17–18 patients. Until 2002, CoV was known to be a meek non-mortal virus. In 2003, several reports were available with the evidences of the dissemination of CoV to several nations. In 2003, numerous cases of SARS triggered by CoV with 1000 deaths were testified. It was declared as the black year for the microbiologists and subsequently dedicated efforts were made to understand CoV. It was concluded that the pathogenesis of the disease was CoV. Until then, totally 8096 patients were inveterate as infected with CoV and

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S. Bhatia et al. (eds.), *Intelligent Healthcare*, EAI/Springer Innovations in Communication and Computing, https://doi.org/10.1007/978-3-030-67051-1_16

in 2004, it was affirmed as the 'state emergency'. In Hong Kong, about 50 cases of SARS were tested out of which 30 were infested by CoV. Eight years later, Saudi Arabia reported many infected patients and deaths [3–7] which was triggered by the Middle East Respiratory Syndrome CoV (MERS-COV). COVID-19 was the foremost acknowledged virus and isolated from the pneumonia patient in Wuhan (China) [5, 7–9].

CoVs are members of the Coronaviridae group and other Nidovirales wherein α-CoV, β-CoV, γ-CoV and δ-CoV are four classes of the subfamily. α-CoV and β-CoV infect merely animals; however, γ-CoV and δ-CoV contaminate birds. In animals, gastroenteritis is caused by α-coronaviruses and β-coronaviruses. SARS-CoV and MERS-CoV is responsible for the spartan breathing disorder in people. However, the supplementary coronaviruses persuade merely slight upper breathing ailments in immunocompetent masses, while the infants, kids and senior citizens are more vulnerable to these viruses [10].

2 Virion Structure

The shape of CoV virions is spherical with a diameter of approximately 125 nm [11, 12]. A main projecting feature of CoV was the weapon-contour point prognoses stemming on an exterior of the virion and named coronavirus due to its resemblance with the solar corona. CoVs have helically symmetrical nucleocapsid that lies inside the virion envelope. CoV encompasses 4 key essential proteins such as the spike (S), membrane (M), envelope (E) and nucleocapsid (N). The S protein is the strongly N-allied glycosylated. The unique spike assembly on the surface of the virus is due to the homotrimers-fixed S protein [13, 14] which facilitates the connection to the host receptor [15]. The S protein is sliced by a host cell into S1 and S2 wherein S1 builds the huge receptor-binding area, whereas S2 makes up the branch of the spike molecule. The M protein is considered responsible for providing the virion its outline due to its trifling size having 3 transmembrane regions. In the virion, the M protein possesses binary unlike conformations permitting it to endorse the curvature of the membrane and binding to the nucleocapsid. The E protein is present in lesser amounts in the virion which is enormously contrary, possessing a similar structural design. The E protein expedites association and discharge of the virus [16]. The N protein is found in the nucleocapsid. It has two different realms including the N-terminal domain (NTD) and C-terminal domain (CTD) which are the binder for the RNA in vitro, and each adopts diverse methods to bind RNA. The finest RNA binding occurs due to the offerings from both fields [17–19]. The N protein is profoundly phosphorylated [20] and recommends initiating a change in the structure [20, 21]. A genomic wrapping signal binds explicitly to the C-terminal RNA binding area [22]. The N protein impasses nsp^3 [18, 23], a key constituent of the replicas multipart and M protein [24]. The hemagglutinin-esterase (HE) is a subsection of β-CoV which fixes the sialic acids on the shallow glycoproteins and embraces the acetyl-esterase action [25]. This in turn enhances the S protein-

facilitated cell entrance and virus blowout via the mucosa [26]. In addition, the HE boosts the Murine Hepatitis Virus [27] despite its contradictory designation in the tissue culture for unidentified explanations [28, 29].

3 Objective

The primary objective is to overview the available information regarding the virus responsible for COVID-19, its origin, epidemiology, spreading, diagnosis, prevention of the transmission, quarantine and treatment.

4 Methodology of Review

Revisiting the available information in the Google and PUBMED.

5 Epidemiology of COVID-19

An outburst of the pneumonia instigated by n-CoV arose in Wuhan (China) with the enduring threat of a pandemic in December 2019. The epidemic of SARS-CoV-2 became a Public Health Emergency of International Concern on 30 January, 2020. Certainly, SARS-CoV-2 possesses a sturdier transmission capability compared to the SARS-CoV. The rapid escalation in the inveterate cases makes the deterrence and control of COV-19 exceptionally solemn [30].

6 Total Coronavirus Cases

2019-nCoV was less severe, more transferrable, and different from both SARS-CoV and MERS-CoV; nonetheless, they were meticulously related. The illness inception in the people confirmed the rapid transmission of 2019-nCoV from person to person [31, 32] and the first mortality was reported on 11 January 2020.The substantial movement of the Chinese people during the Chinese New Year fired this endemic. Soon after, the cases in other provinces of China and different nations were identified. The spread to the healthcare workers who were treating the patients was first reported on 20 January 2020. The lockdown was imposed in Wuhan till 23 January 2020 and extended to other metropolises. The cases of COVID-19 were reported in people who did not have any travel history to China, thereby confirming the native transmission among people [1, 33]. To prevent further transmission and spread of this lethal virus, the airports introduced the screening, isolation (14 days)

and testing mechanisms for detecting the symptomatic persons travelling in China. Shortly, it was found that the asymptomatic people are also responsible for the transmission of this disease. Thus, all the people returning from China were kept under isolation for 14 days and tested to confirm for the symptoms of COVID-19. Despite all efforts, the confirmed cases of Coronavirus continued to have an exponential growth and the cases kept doubling in every 1.8 days [34]. As of 20 August 2020, over 22.5 million infected cases of COVID-19 with nearly 791 thousand deaths have been affirmed globally. India has reported over 2.8 million cases of confirmed COVID-19 and about 54,000 deaths till date (third place in the world after USA and Brazil) wherein all the contact persons of the CoV cases were put under quarantine. However, these data may not give the exact numbers of the cases owing to the restrictions of scrutiny and testing. Although the SARS-CoV-2 originated from the bats, the intermediate animal through which it got transmitted to the humans still remains ambiguous [35].

7 Transmission

Researches revealed that the population of all ages is susceptible to the Coronavirus infections. Mainly the big droplets produced due to coughing and sneezing by the symptomatic people are responsible for the spread of this infection. However, it can also spread through the asymptomatic people and prior to the start of the symptoms. The virus-related loads are more in the nasal cavity than in the oesophagus. The patients infected from Coronavirus are infectious to others not only for the entire duration of the symptoms but even during the process of the clinical recovery. The infected droplets can spread easily up to 1–2 m and if these gets deposited on the surface then they remain infectious there for several days under suitable ambience. However, these germs can be destroyed within 60 s using common disinfectants. In addition, the infection can also be spread if the virus enters the body through nose, mouth or eyes. It exists in the stool and adulteration of water wherein the growth period differs from 2 to 14 days. Various model studies showed that the expected reproduction rate of this virus can range from 2 to 6.47 [36, 37].

The common clinical features of COV-19 are fever, cough, sore throat, headache, tiredness, myalgia, and breathlessness. Up to 7 days, the disease may lead to pneumonia, breathing failure, and demise which is caused due to the increase in the provocative cytokines including interleukin. The complications may comprise severe tremor, lung and kidney injuries where the reclamation of the patient starts in the second or third week. The high-risk population is the senior citizens and those with low immunity. The fatality rate of the infected persons admitted in the hospital ranges from 4% to 11% [35].

8 Diagnosis

The incubation period for SARS-CoV, MERS-CoV and COVID-19 is 4–10 days, 5–6 days and 3–7 days, respectively [38]. The corresponding death period for the above mentioned diseases is reported to be 20–25 days, 11–13 days and 3–7 days, respectively. The symptoms of COVID-19 are high temperature, cough, dyspnoea, muscle ache, confusion, headache, sore throat, rhinorrhoea, chest pain, diarrhoea, biliousness, vomiting, anosmia and dyspepsia. In the self-limited infection, it is not necessary to diagnose the CoV because it can go away on its own. However, it is essential in the epidemiological studies to detect an etiological mediator and the diagnosis becomes vital in the red zones (places with more COVID-19 patients). The detection of the confirmed cases aids to control the epidemics. Real-time polymerase chain reaction (RT-PCR) technique has been established for the analysis of CoV in human. The multiplex real-time RT-PCR assays can analyse all CoVs [39, 40]. In addition, serologic assays can detect the RNA that is difficult to isolate for epidemiological studies [29, 30]. CoVs can enter into the cell either via the conformist endosomal paths of entry or through the non-endosomal passage or via both. The interferon-inducible transmembrane proteins (IFITM) type of action remains unexplained wherein the cell-to-cell blend assays proposed that it wedges the enclosed virus entry by stopping the synthesis of the viral cover with the plasma membrane, thereby modifying the host membrane fluidity.

9 Prevention of Transmission

So far, no antiviral therapeutics has been developed that precisely mark human coronaviruses and hence the treatments are merely helpful. The interferons (IFNs) are somewhat effective in in vitro in contrast to CoV. The IFNs in combination with the ribavirin have improved action in vitro than the IFNs alone when dealing with a few coronaviruses. The efficiency of this blend in vivo needs additional investigation. The SARS and MERS epidemics have encouraged conducting researches on such viruses, thereby recognizing diverse and apt anti-viral targets. Intensive researches must be carried out for the drugs development targeting such mechanisms, enabling to constrain the viral duplication [41, 42].

10 Quarantine

The International Health Regulations (IHR) is a lawful mechanism that binds all countries on the globe and the Member States of the World Health Organisation (WHO). Its role is to aid the global public to inhibit and answer to the acute public fitness hazards that can be transmitted across the borders and threating to the people.

In harmony with the principles delineated in IHR, the travel advisories were issued on a regular basis during the surge of COVID-19 cases in China. According to the travel advisory, Indian travellers were instructed to desist from travelling to China. In fact, the current visas (even eVisa previously dispensed) were now invalid for any overseas national itinerant from China. The passengers who had travelled to China have to be quarantined on return. Although the intermediate- and protracted-term influence of the travel ban persists to be observed, the model studies recommend that for the short span of time. Thus, it was improbable to have a significant influence on the comprehensive spread of SARS-CoV-2 except that unremitting 90% transportable constraints were employed along with extra 50% decline in native spread. Such prohibitions could solitarily build a powerful armour in order to curtail the current outburst.

China enforced a lockdown on 23 January 2020 in Wuhan to quarantine the intense public health surveillance system combined with swift analytical tests and quarantine whenever essential. In order to control the international epidemics, the teamwork of the government, medical staff and common people remains critical. As an alternative to the forced top-down quarantine approaches, the self-isolation and self-inspection appear an added ecological and implementable strategy in a prolonged epidemic like COVID-19 [43].

11 Treatment

At present, merely few options are available for the prevention of this infection. The vaccines have got only approval, but they cannot be always used because of their inadequate effectiveness. It has been reported that in some cases they were connected in the assortment of the new pathogenic CoVs through the recombination of the mingling worries. Although many potential vaccines have been developed, none of them is approved for SARS-CoV. Therapeutic SARS-CoV counterbalancing antibodies have been produced and could be salvaged. The healthcare providers need to be protected using such antibodies. The development of the vaccine for coronaviruses faced several encounters [44]. The vaccines should either provide better immunity in comparison to the novel virus or it must reduce the disease experienced in the course of a secondary infection. The viruses may become adaptable to the vaccine. Moreover, several approaches have been established for the progress of the vaccine to diminish the possibility of the recombination.

Worldwide, approximately 40 teams have been working for developing the injections against CoV infection. The effort is principally encouraged by the extraordinary achievement and quick growth of the Ebola virus vaccines. There is a possibility that COV injections can be based on the viral RNA. The merits of the RNA and DNA vaccines are that they can quickly be developed with high safety; however, no vaccine based on RNA or therapeutic has got regulatory approval. The research on SARS vaccine for COVID-19 is in progression in The Institute Pasteur in France. Despite intensive studies on coronaviruses during last 20 years

predominantly relating to the SARS-CoV-1 epidemic, no vaccine is accessible for either SARS-CoV-1 or MERS so far. Nevertheless, few probable vaccines have lately been invented for phase I clinical trials [29].

12 Application of Nanotechnology to Combat Against Coronavirus

The nanotechnology and nanomedicine have outstanding prospects when dealing with various serious and challenging health problems. For the treatment or disinfection of viruses, nanobiotechnology plays a vital role.

Diagnosis and Treatment of CoV by Nanomaterials

To detect diverse coronaviruses, silver nanoparticles (Ag NPs), MoS_2 nanosheets, Zirconia NPs (Zr NPs) and gold NPs (Au NPs) have been exploited [45–48]. Meanwhile, the coupling of the nanomaterials with the colorimetric sensing, electrochemiluminescence, immunesensing, photoluminescence and chiroimmunosensing techniques became potential for the coronaviruses detection. In near future, the electrochemical devices will also be used for the detection of the new kind of coronaviruses due to their good capacity to couple with the nanomaterials. The use of nanomaterials in these techniques imparts high sensitiveness and leads to quick analyses. To determine the feasibility of the nanomaterials' inclusion in the development of highly effective vaccine for COVID19, materials including the Au, Ag, silver sulphide, TiO_2 (titania), zirconium, graphene and some biopolymers have been used for diagnostic and therapeutic purposes. The vaccines based on the nanoparticles have shown strong latent to persuade advanced defensive immunity retort compared to conformist antigen-based injections. For the rapid detection of the viral infection at an early stage, nanoassays provide superior specificity and sensitivity compared to the existing state-of-the-art techniques.

Nanomaterials for Facemasks Production

The saggy and disposable device called facemask is used to cover the mouth and nose of a person to protect against the potential contaminants in the surroundings. The respirators have been designed to shield the person from gasping hazardous chemicals and contagious particles wherein these respirators minimize the respiratory exposure to aerial toxins. A facemask comprises a filter made up of nanofibres wherein these nanofibres possess very high surface area per unit mass, leading to an

increase in the filter performance by capturing the naturally occurring nanoparticles like viruses and bacteria. Single-fibre filtration theory can be employed to explain the filtration performance of these filters for the particles with a size of 100 nm. The most penetrating particle sizes range from 30 to 100 nm and may vary depending on the test conditions. However, no indication for thermal recoil effects is found for particles with 4 nm in size. In-depth studies are required to measure the total inward leakage for the respirators protecting against nanoparticles [49].

Nanomaterials for Disinfectants

Generally, the patients are at high risk of infections in the hospitals. Several studies have been carried out to develop medications to restrain the spread of germs from various medical equipment surfaces to the environment of the hospitals. The nanotechnology emerged as an outstanding weapon to fight against such infections. Antimicrobial nanomaterials can regulate the infections and destroy bacteria. Nanoparticles are mostly nontoxic compared to other antibiotics and detergents. On top, these nanomaterials are steady and can be produced using simple methods. So far, such a disinfectant that possesses good effectiveness for a wide variety of pathogens has been deficient wherein each pathogen needs the most suitable disinfectant. The suitability of the disinfectant depends on many issues as well as concentrations, time of activity and the types of the surfaces and microbial. In fact, an improper conservation method may lead to contamination of many detergents, causing the stiffening of polymers and enduring corrosion of the treating materials. In this regard, nanomaterials enable in overpowering all such shortcomings. In the recent past, more research was directed on the expounded antimicrobial coatings where the graphene-based nanomaterials revealed outstanding bactericidal activity. The common surfaces in contact with the patients need effective disinfection [50–52] and thus the deposited thin films of graphene-based nanomaterials on top of such surfaces can be greatly useful. A Pune-based startup (Weinnovate Biosolutions in India) has developed a non-alcoholic aqueous-based colloidal silver solution (using NanoAg) as the hand sanitizer and disinfectant. This solution is non-combustible and devoid of harmful chemicals. Therefore, it can emerge as a potential sanitizer for the prevention of infection transmission.

Anti-COVID-19 Nanocoating

The polymers enclosed with copper nanoparticles (Cu NPs) are painted or sprayed as coating on the surfaces. After the deposition of the coating, the nanoparticles pledge the release of metal ions onto the surface. The Cu ions are formed when electrons were stripped from the atoms of a particular element. The Cu atoms became electrically neutral when the negatively charged electrons balance the

positively charged protons. The ions have a reduced negative charge and thus carry an effective positive charge. The Cu ions display an effective antiviral activity against the influenza, herpes simplex and vaccinia virus, eliminating the viral particles that can cling to the surfaces. The ability of the nanoparticles to slowly release the ions indeed provides the solution for the long-lasting protection against COVID-19, other viruses and bacteria [53]. Thus, the coating can actually be effective in reducing the infectivity of the viruses tenfold for weeks, or even months. Such coatings are free from toxic or heavy metals, and thus safe for humans. In short, it may enable the users to minimize the use of harmful chemicals as cleansing agents.

13 Conclusions

Unquestionably, many lessons can be learnt since the international retort to the SARS-COV-2 danger. Maximum of such retorts appear volatile, with minute preparation for the venture to health schemes, involvement of the public and empowerment. The primary intension of the epidemic, intermediator, its treatment, early diagnosis of the asymptomatic patients all remains elusive. Medical judgements have commenced to recognize the injections and active treatment routines. However, exertions to detect medicine at later stage of COVID19 need to be emphasized more. The role of nanotechnology in different facets towards the inhibition and management of COV is remarkable. This infectious disease threat at present time is long lasting. In order to have lesser scales of harm to human life and economy, there is an urgent necessity for investments in setting up people-centric health systems.

Acknowledgement This work has been reported under Statement of Co-operation between Department of Applied Sciences, The NorthCap University, India, and Universiti Teknologi Malaysia, Malaysia.

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