A Review on Coronavirus Disease a New Threat to Public Health and Strategies for Rational Use of Personal Protective Equipment (PPE)

Dimisulu Priyanka[*1]

*1 M.Tech Biotechnology,

Dept. of Chemical Engineering, AUCE(A),

Andhra University, Visakhapatnam,

Andhra Pradesh, India

dimisulupriyanka@gmail.com

Veluru Sri Devi[2]

Professor,

Dept. of Chemical Engineering, AUCE(A),

Andhra Pradesh University, Visakhapatnam,

Andhra Pradesh, India

R. Srikanth[3]

Professor,

ANITS College of Engineering, Visakhapatnam

Andhra Pradesh, India

Venkat Rao Poiba[4]

Assistant Professor

Dept. of Chemical Engineering, AUCE(A),

Andhra Pradesh University, Visakhapatnam,

Andhra Pradesh, India

Abstract

Coronavirus disease-2019 (COVID-19) is an infectious condition caused by the SARS CoV. The condition was seen in 2019 in Wuhan, China, and has spread globally, resulting in a pandemic. The deaths per number of diagnosed cases are estimated at between 1% and 5%, but varies by age and other health conditions. The infection is spread from one person to others via respiratory droplets, often produced during coughing and sneezing. It takes 2–14 days to develop the signs from the day of exposure. Reverse transcription-PCR from a nasopharyngeal swab or oropharyngeal swab is the standard method of diagnosis. Its adviced that mask should be used by the people who feel they are affected from the virus and to their caregivers, but not the general public. As the coronavirus 2019 (COVID-19) began spreading globally with no clear treatment in vision, preventing became a major role of controlling the condition and its effects. COVID-19 spreads from the sprayer of an infected individual whether they are showing any symptoms or not. Therefore, it becomes nearly unfeasible to point exactly where the patient is. This is where personal protective equipment (PPE) and individual protective equipment comes in. The discussions include the paper recommends decontamination and reuse of PPE and proper disposal of PPE.

Keywords: ***COVID-19, Pandemic, Infectious diseases, Personal protective equipment (PPE), Public health.***

I. INTRODUCTION

Coronaviruse belongs to the Coronaviridae family in the Nidovirales order. Corona represents crown-like spikes on the outer surface of the virus; thus, it was named as coronavirus. Coronaviruse are minute in size (65-126 nm in diameter) and contain a single-stranded RNA as nucleic material, with a size ranging from 26 to 32 kilobases (kb) in length. The subgroups of the coronavirus family are alpha (α), beta (β),gamma (γ), and delta (δ) [1][2]. In late December 2019 following the severe acute respiratory syndrome coronavirus (SARS-Cov-1) outbreak in 2002 and the Middle East respiratory syndrome coronavirus (MERS-CoV) outbreak in 2012, SARSCoV-2 disease has become the third coronavirus to emerge in the past two decades [3]. At the time of writing this article, total number of confirmed positive cases of coronavirus disease 2019 (COVID-19) was 3,677,165 worldwide [4]. Millions of people have been put under lockdown across the globe in order to reduce the transmission of virus [5].In retaliation to coronavirus pandemic, countries have instituted economic recovery programs to alleviate unemployment. Whilst it is understandably difficult to examine other adverse results in the midst of this pandemic, it is vital to remember that there is another major challenge that threatens human prosperity-climate change. The COVID-19 recovery programs to simultaneously facilitate the climate agenda presents a strategic opportunity to transition towards a more sustainable post-COVID-19 world [6]. The pandemic has caused vital environmental challenges including municipal solid waste (MSW) and hazardous biomedical waste management. Solid waste association of North America (SWANA) has disclosed the potential changes in the volume and source of solid waste generated due to enforcement of lockdown by the authorities to contain the disease outbreak [7]. China, is from where the COVID-19 infection started and the government has recorded the relevant

data on this issue. According to the 11 march press releases of the State Council's joint prevention and control mechanism in China, the amount of MSW in large and medium sized cities was reduced by 30.00% during the disease outbreak. However, the generation of medical waste increased sharply (+370.00%) in Hubei Province [8]. World health organization (WHO) has formulated guidelines for the disposal of infectious and non-infectious healthcare waste during COVID-19 outbreak. The proportion of non-infectious waste, which is more than 80.00% of the total quantity of healthcare waste generated, needs to be collected and disposed as municipal waste [9].

A. Origin

In December 2019, adults in Wuhan, capital city of Hubei region and a major transportation hub of China started presenting to local hospitals with severe pneumonia of unknown cause. Many of the initial cases had a common exposure to the Huanan seafood market that also traded live animals. The surveillance system was activated and respiratory samples of patients were sent to reference labs for etiologic investigations. On December 31st 201 9, China notified the outbreak to the World Health Organization and on 1st January the Huanan sea food market was closed. The virus was recognized as a coronavirus that had >95% homology with the bat coronavirus and >70% similarity with the SARS CoV. Environmental samples from the Huanan sea food market also tested positive, signifying that the virus originated from there [10].The WHO recommends collecting samples from both the upper and lower respiratory tracts. This can be carried out through expectorated sputum, bronchoalveolar lavage, or endotracheal aspirate. These samples are then assessed for viral RNA using polymerase chain reaction (PCR). If a positive test result is achieved then it is recommended to repeat the test for re-verification purposes. A negative test with a strong clinical suspicion also warrants repeat testing.[11]. The below figure is a graphical representation of ultrastructural morphology of coronavirus.

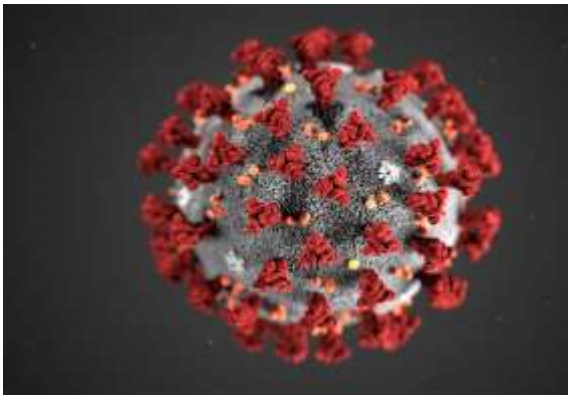

Fig.1.A graphical representation of the ultrastructural morphology of coronavirus (SARS-CoV-2). Source: Centers for Disease Control and Prevention—Public Health Image Library. Credit: Alissa Eckert, MS, Dan Higgins, MAM *(Public Domain).*

II. TRANSMISSION

The initial cases were likely linked to direct exposure to infected animals (animal to human transmission) at a seafood market in Wuhan, China. The clinical cases with diversity in disclosure history have emerged. This can further intricate that human to human transmission

of the virus is also possible. The human-to-human transmission is considered the main form of transmission.

Individuals who remain asymptomatic could also transmit the virus [12].However, the most common source of infection is symptomatic people. Transmission occurs from the spread of respiratory droplets through coughing or sneezing[13]. The below figure shows about the transmission of Coronavirus. Data also suggest that close contact between individuals can also result in transmission.[14] This also indicates possible transmission in closed spaces due to elevated aerosol concentration. SARS-CoV-2 has a basic reproduction number of 2.2[12]. This suggests that a patient can transmit the infection to two other individuals.Current data suggest that the virus has an incubation period of three to seven days[15].These findings are based on initial cases. Therefore, further studies are needed to address transmission dynamics and incubation time.

Fig.2.Transmission of Coronavirus

III. CORONAVIRUS LIFECYLCE

All coronaviruses contain specific genes in ORF1 downstream regions that encode proteins for viral replication, nucleocapsid and spikes formation [16].The below figure indicates the entire mechanism of pathogenicity of SARS-CoV-2.The glycoprotein spikes on the outer surface of coronaviruses are responsible for the attachment and entry of the virus to host cells (fig:3). The receptor-binding domain (RBD) is loosely attached among virus, therefore, the virus may infect multiple hosts [17], [18].Other coronaviruses mostly recognize aminopeptidases or carbohydrates as a key receptor for entry to human cells while SARS-CoV and MERS-CoV recognize exopeptidases [19] The entry mechanism of a coronavirus depends upon cellular proteases which include, human airway trypsin-like protease (HAT), cathepsins and transmembrane protease serine 2 (TMPRSS2) that split the spike protein and establish further penetration changes [20],[21].MERS-coronavirus employs dipeptidyl peptidase 4 (DPP4), while HCoV-NL63 and SARS-coronavirus require angiotensin-converting enzyme 2 (ACE2) as a key receptor [19], [17].SARS-CoV-2 holds the typical coronavirus structure with spike protein and also expressed other polyproteins, nucleoproteins, and membrane proteins, such as RNA polymerase, 3-chymotrypsin-like protease, papain-like protease, helicase, glycoprotein, and accessory proteins [22], [23].The spike protein of SARS-CoV-2 contains a 3-D structure in the RBD region to maintain the van der Waals forces [24]. The 394-glutamine residue in the RBD region of SARS-CoV-2 is recognized by the critical lysine 31 residue on the human ACE2 receptor [25].

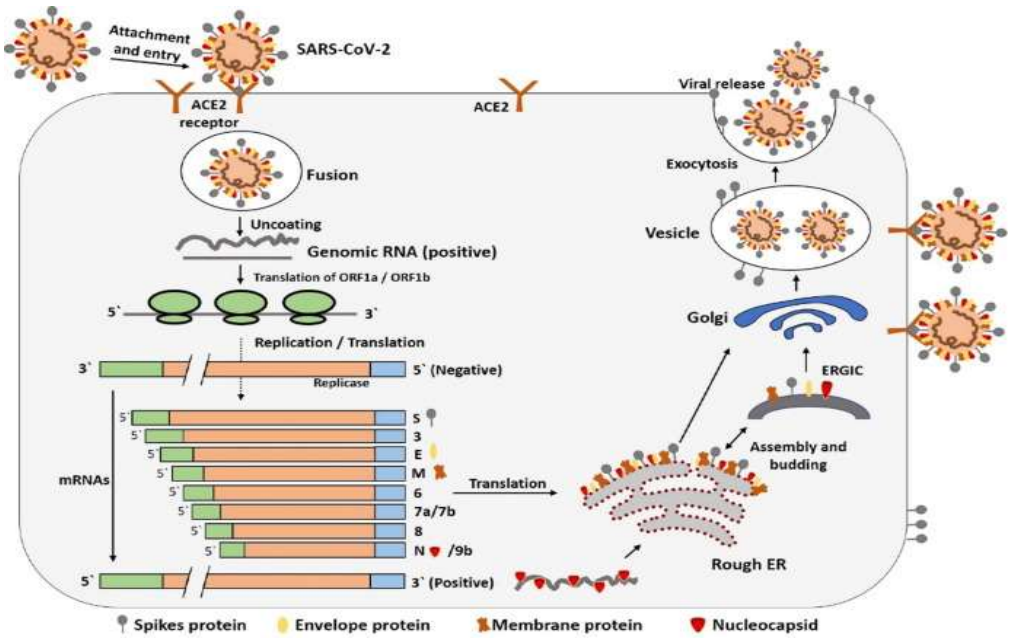

*Fig.3.*The entire mechanism of pathogenicity of SARS-CoV-2, from attachment to replication is well mentioned in the figure below:

IV. EPIDEMIOLOGY

In December 2019, Wuhan City, Province of China, became the center of an outbreak of novel contagious coronavirus disease (COVID-19) of unknown etiology [26],[27]. Efforts are underway to continue to better understand more about transmittable, severity, and other features associated with COVID -19 [28]. It appears that an infected animal may have first transmitted the virus to humans at a sea food market [29],[30]. Soon, a secondary source of infection was found to be human-to-human transmission of the COVID-1 9 virus. It became clear that the COVID-19 infection occurs among close contacts and exposure to the virus [29]. Recent studies showed that people aged ≥ 60 years and the population with poor immune function such as diabetes, cardiovascular disease, chronic respiratory disease, cancer, renal, and hepatic dysfunction are at higher risk for severe COVID-19 than children who might be less likely to become infected or, if so, may show milder symptoms or even asymptomatic infection [31]. Coronavirus disease 2019 (COVID-19) is spreading very quickly across China and is being exported to a number of countries, some of which have seen onward transmission. According to WHO, COVID-19 continues to emerge and represents a serious problem to public health. On 2 March 2020, more than three million confirmed cases of COVID-19 has been reported by the World Health Organization. Of these, more than 240 000 have been fatal.

About 83,959 cases were confirmed in China, and 4637deaths.

V. DIAGNOSIS

Diagnosis of corona virus and acquiescence with any of the underlying, could be diagnosed as critical COVID-1 9 patient [32],[33]

A. Respiratory anguish

In which the rate of respiration is equal or more than 30 breathes per minute.

B*. *Pulse oximetry oxygen saturation at rest

Should be equal to or less than 93%.

C. ***Oxygenation index (Pao2/Fio2*)**

Should be equal to or less than 300mm/HG

D. If imaging test of lungs were done and shows significant progression i.e. more than 50% in lesion that too within 24 – 48 hours.

E. If patient had undergone respiratory failure and there is need for mechanical ventilation.

F. If patient has underwent shock, along with above discussed features along with failures of other organs.

G. Laboratory Diagnosis

Certain biochemical and haematological parameters can be used to signal critical disease and high risk of fatality. The PaO2/FiO2 may be ≤300, 200, or 100 mmHg in mild, moderate, or severe ARDS, respectively. During the initial stage of the disease, the total white cell count may be normal or reduced along with lymphopenia, which in itself indicates a grim prognosis. Destruction of the T lymphocyte leads to a bad clinical outcome. The white cell parameters
are altered as a result of cytokine release syndrome. As the severity increases, more lymphopenia occurs with a continuous reduction in its absolute values. Enzymes of liver and skeletal muscle, lactate dehydrogenase, and C-reactive protein levels are elevated. Procalcitonin levels help in differentiating COVID-19 from sepsis in which the levels are increased, whereas in COVID-19, the levels remain normal. Features of multiorgan dysfunction including raised amylase level and deranged coagulation markers, especially raised D-dimer at admission, are associated with increased mortality. Manifestation of coagulopathy in COVID-19 is indicated by increased levels of fibrinogen and D-dimer, while there is mild alteration in the prothrombin/activated partial thromboplastin times and platelet counts, especially during the initial stages of the infection. In a study on 191 patients, it was found that increased mortality has been associated with D-dimer values >1.0 μg/mL at admission, increased prothrombin time, elevated IL-6 and other markers of inflammation, and increased troponin level besides any other associated comorbidity [34] .Increasing IL-6 levels and fibrinogen levels correlate well with each other. Increased D dimer levels are a marker of disease severity and also used to monitor the prognosis of the treatment outcome. MuLBSTA score system is a marker of mortality rate in viral pneumonia and comprises six indices – multilobular infiltration, lymphopenia, bacterial co-infection, smoking, hypertension, and age [35]. Combined nasopharyngeal and oropharyngeal swabs are the most recommended samples. Swabs collected from both thenostrils and oropharynx are placed and transported in the same tube containing viral transport medium. [36]. Nasopharyngeal wash in ambulatory patients and lower respiratory tract specimens such as sputum, endotracheal aspirate,

broncho-alveolar lavage in patients with respiratory distress can be collected. Some of the test methods continuous reduction in its absolute values. Enzymes of liver and skeletal muscle, lactate dehydrogenase, and C-reactive protein levels are elevated. Procalcitonin levels help in differentiating COVID-19 from sepsis in which the levels are increased, whereas in COVID-19, the levels remain normal.

H. Molecular testing

The laboratory confirmation of COVID-19 is based on detection of unique sequences of SARS-CoV-2 RNA by nucleic acid amplification test (NAAT) using real-time RT-PCR. RNA can be extracted using any standard extraction protocols. A variety of RNA gene targets are used by different manufacturers targeting one or more of the envelope, nucleocapsid, spike, RNA-dependent RNA polymerase (RdRp), and ORF1 genes. The recommended protocols are usually based on the detection of at least two targets in the virus genome: detection of E gene as a screening tool followed by confirmation of E gene-positive samples by detection of at least one more gene such as RdRp/Orf/N gene/S gene. The Essay is specific for all SARS-CoV-related coronaviruses (i.e., SARS-CoV, COVID-19 virus, and related bat viruses).The screening E gene PCR has higher sensitivity.[36] .Molecular detection using well-designed protocols is usually very specific; thus, a positive result confirms the detection of viral RNA but may not necessarily indicate the presence of viable virus.[37].The National Institutes of Health (NIH) suggest that several groups of people have the highest risk of developing complications due 2 COVID-19:

These groups include:

- Young children
- People aged 65 years or older
- Women who are pregnant

The WHO recommends collecting samples from both the upper and lower respiratory tracts. This can be achieved through expectorated sputum, bronchoalveolar lavage, or endotracheal aspirate[38].These samples are then assessed for viral RNA using polymerase chain reaction (PCR). If a positive test result is achieved, it is recommended to repeat the test for re-verification purposes. A negative test with a strong clinical suspicion also warrants repeat testing.

VI. SYMPTOMS

The Emergency Committee of WHO asserted this epidemic as a worldwide health emergency on 30, Jan of 2020 [38] dependent on developing case warning rates in Chinese and universal areas. The case discovery rate is changing hourly and day by day. About 20% of cases are serious, and mortality is around 3% [39]. After the 2-14 days presented to coronavirus, the side effect and sigh/symptom may be seeming and can include: [40]. Fever, Cough, Shortness of breath, Pneumonia in both lungs, Headache, Muscle soreness, Fatigue.

VII. TREATMENT AND PREVENTION

Scientists cannot easily cultivate human coronavirus in the laboratory unlike the rhinovirus, which is another cause of the common cold. This makes it difficult to gauge the impact of the coronavirus on national economies and public health [41]. There is no cure for this disease so treatments include self-care and over-the-counter medication. People can take several steps including:

- Resting and avoiding overexertion
- Drinking enough water
- avoiding smoking and smoky areas
- Taking acetaminophen, ibuprofen, or naproxen for pain and fever
- Using a clean humidifier or cool mist vaporizer
- Doctor can diagnose the virus responsible by taking the sample of respiratory fluids such as mucus from the nose or blood.
- Standard recommendations to prevent infection spread. It includes regular hand washing, covering mouth and nose when coughing and sneezing, thoroughly cooking meat and eggs. Avoid close contact with anyone showing symptoms such as coughing and sneezing.

VIII. IS WEARING PPE IMPORTANT?

The primary mode of transmission of coronavirus is known to be droplet or contact based. Infected individuals are prone to spread the virus while coughing, sneezing, or speaking. This micro virus, when ejected, can travel up to a distance of six feet. Wearing a face mask, along with other precautionary measures like hand hygiene and self-isolation, limits the transmission of infectious agents [42],[43]. Initially, the usage of masks among the public was highly controversial. Experts discouraged healthy people from wearing masks due to the scarce supply. This equipment was reserved for those in direct contact with infected patients [44]. However, the rapid rise in the degree of local transmission has caused many countries to allow their citizens to wear non-medical/cloth masks, along with practicing social distancing [43],[44] Evidence-based studies reveal that the concomitant use of household (non-medical) face masks, as well as using a proper handwashing regimen, reduces the probability of local transmission, thereby decreasing the death toll [45]. It should be noted that according to the World Health Organization (WHO) guidelines, medical masks and respirators should only be reserved for healthcare workers [44].

IX. DECONTAMINATION AND REUSE OF PPE

According to standard Infection Prevention and Control (IPC) guidelines, PPE is a single-use, disposable item. However, due to the current shortage of PPE, health care providers are challenged to rationally use 4 of 8 limited supplies by decontaminating and reprocessing them. It should be noted that there is no proven effectiveness of these practices and priority is given to the rapid manufacture of protective items [46]. Improper or inadequate decontamination of equipment before reuse is unsafe and can pose serious threats [47]. When disinfecting PPE, it is important to keep in mind the efficacy of the method used, check for any residual toxicity, and make sure that the functional integrity of the material is maintained. General strategies include following the manufacturer’s guideline to disinfect and reprocess the PPE.

Routine inspection of protective material should be carried out, along with the replacement of the equipment if the integrity is not maintained or it is damaged.

A. Respirators and Medical Masks

1) Usually cleaning prior to disinfection is required. Respirators and Medical masks they lose their protective property when they undergo cleaning.
2) Considering the current conditions, these items can be worn by a single HCW for multiple shifts. Factors, such as humidity and shelf-life, limit their use.

3) Medical masks can be reprocessed using the Environment Protection Agency (EPA)-registered disinfectants.
4) Filtering face piece respirators can be decontaminated using vaporous hydrogen peroxide, moist heat, and bleach solution.
5) Remember to replace these respirators if breathing is hindered.

B. Gowns

1) Submerge in hot water and detergent, then thoroughly scrub the gown.
2) Afterward, soak in 0.05% chlorine solution for about 30 minutes.
3) Rinse in clean water and ideally allow drying in the sun.
4) Gowns having small holes and tears could be mended whereas worn out gowns should be discarded.

C. Disposable Face Shields

1) Clean first the inside and then the outside surface of the visor using a detergent-soaked clean cloth.
2) Clean the outside of the visor with a clean cloth saturated with disinfectant.
3) Wipe the outside of the visor with clean water.
4) Use towels or dry air to completely dry the visor.

D. Reusable Goggles and Face Shields

1) Immerse in warm water and neutral detergent solution.
2) Rinse with clean water.
3) Wipe with disinfectant and then again rinse with clean water.
4) Dry completely using towels or dry air.

X. PROPER DISPOSAL OF PPE

Potentially infectious medical waste (PIMW), such as COVID 19 testing kits and PPE, have a serious risk of coming in contact with infectious bodily fluids. These materials should be kept safely on site (hospitals, testing centers) in the secure containers.

They should then transferred to storage facilities, where they are disinfected and disposed of off to landfill sites [48]. Individuals are responsible for waste management should take caution and should wear appropriate gear. It is extremely critical to properly decontaminate and dispose of any waste material that could infect people who come in contact with it.

XI. LIMIT THE NEED FOR PPE

The need for PPE can be minimized by the following interventions [49]:

- Limit patient contact and use alternate tools, such as telemedicine, for non-emergency cases.
- Make sure that no personnel who is not immediately needed for the patients' care should enter the premise of the COVID-19 ward that should be a separated and isolated area. The visitors should either not be allowed at all or should have minimal contact with the patients.
- All non-urgent procedures/appointments should be postponed.
- PPE should be reused with proper decontamination guidelines.
- PPE should be used beyond their shelf life making sure they are not worn out or damaged.
- In the case of the absolute absence of PPE, alternate methods for barrier control (e.g., glass shields) should be employed. These practices do not guarantee the absolute safety of healthcare professionals, and their effectiveness is questionable. However, under the present circumstances, these crisis strategies given by the CDC should be duly addressed.

XII. GLOBAL PRATICES IN MSW MANAGEMENT DURNING COVID-19 PANDEMIC

The British government has published COVID-19 regulatory position statements for local authorities and waste collectors. These statements focus on waste stream prioritization, expansion in the temporary waste storage capacity, waste segregation, adaptation of MSW incinerator to process COVID-19 infectious waste, and communication with residents[50].

XIII. CONCLUSION

Coronavirus was spreading human to human transmission by close contact via airborne droplets generating by coughing and sneezing. So avoid these activities with infected people. Coronavirus may transmit through pet animals such as dog, cat, pig, cow, turkeys. So avoid contact and separate them if observed any infection activities like diarrhoea, cold, fever.

As per WHO and ECDC guideline avoid the contact with sick person and also avoid the market or public place as per possible.

Elderly and immunocompromised patients are at the greatest risk of fatality. The rapid spread of disease permits intense surveillance and isolation protocols to prevent further transmission. This new virus outbreak has challenged the economic of medical and public health infrastructure of China and to some extent of other countries. Therefore, it is highly critical that PPE’s should be used in all clinical and non-clinical settings. Citizens should use a cloth barrier while stepping out of the house and public gatherings should be strictly avoided. The proper protocol should be followed when the healthcare professionals consider reusing PPE.

REFERENCES

[1] Wang Chen, W.Horby Peter, G. Hayden Frederick, F.Gao George. "A novel coronavirus outbreak of global health concern". The Lancet. 2020;395(10223):470–473.

[2] Zi-Wei Ye, Shuofeng Yuan, Kit-San Yuen, Sin-Yee Fung, Chi-Ping Chan, and Dong-Yan Jin·Several coronaviruses can infect humans, like the globally endemic human coronavirus HCoV-229E, HCoV-NL63, HCoV-HKU1, and HCoVOC43 that tend to cause mild respiratory disease, and the zoonotic Middle East respiratory syndrome coronavirus (MERS-CoV) and severe acute respiratory syndrome coronavirus (SARS-CoV) that have a higher case fatality rate

[3] Coronavirus Outbreak. Available at: https://www.worldometers.info/coronavirus/. Accessed 23 Feb

[4] Wang J. Wang, J. Shen, D. Ye, X. Yan, Y. Zhang, W. Yang, X. Li, J. Wang, L. Zhang, L. Pan Disinfection technology of hospital wastes and wastewater: suggestions for disinfection strategy during coronavirus disease 2019 (COVID-19) pandemic in China "Environ. Pollut"., 262 (2020), Article 114665, 10.1016/j.envpol.2020.114665

[5] Johns Hopkins University Coronavirus Resource Centre, 2020. COVID-19 dashboard by the Centre for Systems Science and Engineering. https://coronavirus.jhu.edu/map.html (accessed 05 May 2020).

[6] S. Saadat, D. Rawtani, C.M. Hussain Environmental perspective of COVID-19 Sci. "Total Environ"., 728 (2020), Article 138870, 10.1016/j.scitotenv.2020.138870

[7] Rosenbloom market 2020 D. Rosenbloom, J. Markard. A COVID-19 recovery for climate Science, 368 (6490) (2020), p. 447, 10.1126/science.abc4887

[8] SWANA - Solid Waste Association of North America article, 2020. SWANA reminds all state and local governments that solid waste management is an essential public service. https://swana.org/news/swana-news/article/2020/03/19/swana-reminds-all-state-and-localgovernments-that-solid-waste-management-is-an-essential-public-service (accessed 05 May 2020).

[9] Klemes et.al.2020 J.J. Klemes, Y.V. Fan, R.R. Tan, P. Jiang "Minimising the present and future plastic waste, energy and environmental footprints related to COVID-19 Renew". Sust. Energ. Rev., 127 (2020), Article 109883, 10.1016/j.rser.2020.109883

[10] WHO -World Health Organization Water, Sanitation, Hygiene, and Waste Management for the COVID-19 Virus: Interim Guidance(2020) (accessed 01 May 2020)

[11] C.C. Lim, C. S. Tan, M. Kaushik, H. K. Tan. Initiating acute dialysis at earlier Acute Kidney Injury Network stage in critically ill patients without traditional in-dications does not improve outcome: a prospective cohort study. Nephrology.2015;20:148-54. Google Scholar (https://scholar.google.co.in/scholar?hl=en&q=Initiating acute dialysis at earlier Acute Kidney Injury Network stage in critically ill patients without traditional in-dications does not improve outcome: a prospective cohort study

[12] Singhal Tanu A Review of Coronavirus Disease-2019 (COVID-19). "The Indian Journal of Pediatrics".2020;87(4):281-286. Google Scholar (https://scholar.google.co.in/scholar?hl=en&q=A Review of Coronavirus Disease-2019 (COVID-19)

[13] M. Cascella, M. Rajnik, A. Cuomo, SC. Dulebohn, RD. Napoli: Features, Evaluation and Treatment Coronavirus (COVID19)(https://www.ncbi.nlm.nih.gov/books/NBK554776/). StatPearls Publishing, Treasure Island, FL; 2020

[14] I. Ghinai, TD. McPherson, JC. Hunter, et al.: First known person-to-person transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in the USA [Epub ahead of print] (https://dx.doi.org/10.1016/S0140-6736(20)30607-3).Lancet. 2020, Accessed: March 21, 2020: 10.1016/S0140-6736(20)30607-3(https://dx.doi.org/10.1016/S0140-6736(20)30607-3).

[15] Q. Li, X. Guan, P. Wu, et al.: Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia [Epub ahead of print] (https://dx.doi.org/10.1056/NEJMoa2001316). N Engl J Med. 2020,10.1056/NEJMoa2001316 (https://dx.doi.org/10.1056/NEJMoa2001316).

[16] S. van Boheemen, M. de Graaf, C. Lauber, T.M. Bestebroer, V.S. Raj, A.M. Zaki, et al.Genomic characterization of a newly discovered coronavirus associated with acute respiratory distress syndrome in humans MBio, 3 (6) (2012), pp. e00473-e512

[17] V.S. Raj, H. Mou, S.L. Smits, D.H. Dekkers, M.A. Müller, R. Dijkman, et al.Dipeptidyl peptidase 4 is a functional receptor for the emerging human coronavirus-EMC Nature, 495 (7440) (2013), pp. 251-254,

[18] S. Perlman, J. Netland Coronaviruses post-SARS: update on replication and pathogenesis Nat Rev Microbiol, 7 (6) (2009), pp. 439-450.

[19] N. Wang, X. Shi, L. Jiang, S. Zhang, D. Wang, P. Tong, et al.Structure of MERS-CoV spike receptor-binding domain complexed with human receptor DPP4 Cell Res, 23 (8) (2013), p. 986

[20] I. Glowacka, S. Bertram, M.A. Müller, P. Allen, E. Soilleux, S. Pfefferle, et al.Evidence that TMPRSS2 activates the severe acute respiratory syndrome coronavirus spike protein for membrane fusion and reduces viral control by the humoral immune response J Virol, 85 (9) (2011), pp. 4122-4134,

[21] S. Bertram, I. Glowacka, M.A. Müller, H. Lavender, K. Gnirss, I. Nehlmeier, et al. Cleavage and activation of the severe acute respiratory syndrome coronavirus spike protein by human airway trypsin-like protease J Virol, 85 (24) (2011), pp. 13363-13372

[22] F. Wu, S. Zhao, B. Yu, Y.-M. Chen, W. Wang, Z.-G. Song, et al.A new coronavirus associated with human respiratory disease in China Nature, 1–5 (2020),

[23] P. Zhou, X. Yang, X. Wang, B. Hu, L. Zhang, W. Zhang, et al.A pneumonia outbreak associated with a new coronavirus of probable bat origin Nature [Internet]., Feb (2020), p. 3.

[24] X. Xu, P. Chen, J. Wang, J. Feng, H. Zhou, X. Li, et al.Evolution of the novel coronavirus from the ongoing Wuhan outbreak and modeling of its spike protein for risk of human transmission Science China Life Sciences, 63 (3) (2020), pp. 457-460

[25] Y. Wan, J. Shang, R. Graham, R.S. Baric, F. Li Receptor recognition by novel coronavirus from Wuhan: an analysis based on decade-long structural studies of SARS J Virol (2020).

[26] C.Huang,Y. Wang, X. Li et al., "Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China," The Lancet, vol. 395, no. 10223, pp. 497–506, 2020.,

[27] F. Wu, S. Zhao, B. Yu et al., "A new coronavirus associated with human respiratory disease in China," Nature, vol. 579,no. 7798, pp. 265–269, 2020

[28] S. P. Adhikari, S. Meng, Y. J. Wu et al., "Epidemiology, causes, clinical manifestation and diagnosis, prevention and control of coronavirus disease (COVID-19) during the early outbreak period: a scoping review," Infectious Diseases of Poverty,vol. 9, no. 1, p. 29, 2020

[29] Q. Li, X. Guan, P. Wu et al., "Early transmission dynamics in Wuhan, China, of novel coronavirus infected pneumonia,"New England Journal of Medicine, vol. 382, no. 13, pp. 1199–1207, 2020.

[30] P. Zhou, X. L. Yang, X. G. Wang et al., "Discovery of a novel coronavirus associated with the recent pneumonia outbreak in humans and its potential bat origin," BioRxiv, 2020**.**

[31] T. P. Velavan and C. G. Meyer, "The COVID-19 epidemic,"Tropical Medicine & International Health, vol. 25, no. 3,pp. 278–280, 2020

[32] Xia Jianhua, Tong Jianping, Liu Mengyun, Shen Ye, Guo Dongyu .Evaluation of coronavirus in tears and conjunctival secretions of patients with SARS-CoV-2 infection"Journal of Medical Virology".2020;92(6):589-594. Google Scholar (https://scholar.google.co.in/scholar?hl=en&q=Evaluation of coronavirus in tears and conjunctival secretions of patients with SARS-CoV-2 infection.

[33] Use of convalescent plasma therapy in SARS patients in Hong Kong Cheng Y., WongR., Soo Y. O. Y., Wong W. S., Lee C. K., Ng M. H. L., Chan P., Wong K. C., Leung C. B.,Cheng G. European Journal of Clinical Microbiology & Infectious Diseases.2005;24(1):44-46. Google Scholar (https://scholar.google.co.in/scholar?hl=en&q=Use of convalescent plasma therapy in SARS patients in Hong Kong)

[34] F. Zhou, T. Yu, R. Du, G. Fan, Y. Liu, Z. Liu, et al. "Clinical course an risk factors for mortality of adult in patients with COVID-19 in Wuhan", China: A retrospective cohort study. Lancet 2020;395:1054-62.

[35] L. Guo, D.Wei, X. Zhang, Y. Wu, Q. Li, M. Zhou, et al. "Clinical features predicting mortality risk in patients with viral pneumonia": The MuLBSTA Score. Front Microbiol 2019;10:2752.

[36] World Health Organization. Laboratory Testing for Coronavirus Disease 2019 (COVID-19) in Suspected Human Cases: Interim Guidance. WHO/COVID-19/laboratory/2020.5. Geneva: WHO; 2020. Available from:https://www.who.int/publications-detail/laboratory-testing-for-2019-novel-coronavirus-in-suspectedhuman- cases-20200117.

[37] P. Zhang, Q. Gao, T. Wang, Y. Ke, F. Mo, R. Jia, et al. "Evaluation of recombinant nucleocapsid and spice protein serological diagnosis of novel coronavirus disease 2019 (COVID-19)". Medxriv [Internet]. 2020; Available from:https://www.medrxiv.org/content/10.1101/2020.03.17.20036954v1

[38] Peiris, J. S. M., S. Lai. T, L. Poon. et. al. "Coronavirus as a possible cause of severe acute respiratory syndrome". The Lancet,2003; 361(9366): 1319-1325

[39] C. Wang, PW. Horby, FG. Hayden, GF. Gao (2020). A novel coronavirus outbreak of global health concern. The Lancet

[40] W. Wang, J. Tang, F. Wei (2020). Updated understanding of the outbreak of 2019 novel coronavirus (2019â€nCoV) in Wuhan, China. "Journal of Medical Virology".

[41] National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases https://www.cdc.gov/coronavirus/2019-ncov/about/prevention-treatment.html.

[42] European Centre for Disease Prevention and Control data.Geographical distribution of 2019- nCov cases. Available online:(https://www.ecdc.europa.eu/en/geographicaldistribution-2019-ncov-cases) (accessed on 05 February 2020.

[43] S. Feng, C. Shen, N. Xia, W. Song, M. Fan, Cowling BJ: Rational use of face masks in the COVID-19 pandemic .Lancet Respir Med. 2020, 8:434-36. 10.1016/S2213-2600(20)30134-X

[44] Social Distancing. Keep Your Distance to Slow the Spread . (2020). Accessed: May 3, 2020: http://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/social-distancing.html.

[45] Advice on the Use of Masks in the Context of COVID-19 . (2020). Accessed: May 3, 2020:http://www.who.int/publications-detail/advice-on-the-use-of-masks-in-the-community-during-homecare-and-in-healthcare

[46] CDC Recommends People Wear Cloth Masks to Block the Spread of COVID-19. Surgical Masks and N95 Respirators Should be Reserved for Health Care Workers. (2020). Accessed: May 3, 2020:http://www.theverge.com/platform/amp/2020/4/3/21206044/masks-cloth-coronavirus-cdcrecommendation-guidelines-wear-spr.....

[47] J. Howard, A. Huang, Z. Li, et al.: Face masks against COVID- 19: an evidence review [PREPRINT] . Preprints.2020, 2020040203. 10.20944/preprints202004.0203.v1

[48] Operational Considerations for Personal Protective Equipment in the Context of Global Supply Shortages for Coronavirus Disease 2019 (COVID-19) Pandemic: Non-US Healthcare Settings. (2020). Accessed: May 3,2020: http://www.cdc.gov/coronavirus/2019-ncov/hcp/non-us-settings/emergency-considerationsppe.html

[49] Rational Use of Personal Protective Equipment (PPE) for Coronavirus Disease (COVID-19): Interim Guidance, 19 March 2020. (2020). Accessed:May3,2020:http://apps.who.int/iris/handle/10665/331498.

[50] Water, Sanitation, Hygiene and Waste Management for COVID-19 . (2020). Accessed: May 3, 2020 :http://www.who.int/publications-detail/water-sanitation-hygiene-and-waste-management-for-covid-19.

[51] E. Livingston, A. Desai, M. Berkwits: Sourcing personal protective equipment during the COVID-19 pandemic. JAMA. 2020, 323:1912-14. 10.1001/jama.2020.5317:

[52] DEFRA Department for Environment Food & Rural Affairs, Government of UK, 2020a. Guidance on prioritizing waste collection services during coronavirus (COVID-19) pandemic.https://www.gov.uk/government/publications/coronavirus-covid-19-advice-to-localauthorities-on-prioritising-waste-collections/guidance-on-prioritising-waste-collectionservices-during-coronavirus-covid-19-pandemic (accessed 06 May 2020).