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Covid-19 Pandemic and Human Behavioral Response

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Abstract

The global human population is perhaps at the face of an unprecedented challenge due to the most devastative infection of a new virus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). In addition to the discovery of vaccines against the target virus, important research findings have been published. The present paper attempts to explain the reasons behind the deadly nature of Covid-19, its evolutionary history, pathogenic damage to humans and even death. Since the first report of Covid-19 in the 1960s, the emergence of the current pandemic requires more investigations. The use of host cell machinery by the virus for its propagation through respiratory droplets of infected people and frequent alterations of its structure, virulence, and interactions with the human cell are yet to be detailed. The history of pandemics since 430 BC as well as the sudden disappearance of SARS-CoV-1 are important to enhance our preparedness to combat such pandemics in the future. Adoption of some measures could ensure our win in the battle against Covid-19, such as bringing behavioral change among us at an individual level, a societal level, and in relation to governance and policy.

Keywords: *Covid-19, History of pandemics, Behavioral response, human coronavirus, governance, policy, cytokine storm*

1. Introduction

The coronavirus SARS-CoV-2 identified in the year 2019 as responsible for a pandemic of respiratory illness is called Covid-19. The 2019 coronavirus bears a resemblance to the Severe Acute Respiratory Syndrome (SARS) and has been named SARS-CoV-2. We do not know many aspects of Covid-19. However, the transmission rate of SARS-CoV-2 is faster than that of the SARS-CoV-1 of 2003. Individuals with health conditions, like diabetes, severe asthma, obesity, and respiratory diseases are more severely affected. Diseases of the heart and liver or older age, and HIV infection appears to be the risk factor in Covid-19 which is easily transmitted from person to person; even from asymptomatic virus carriers. The global spread of an epidemic called the pandemic is not new to our species. Disease causing agents, or pathogens, existed on the earth before the appearance of our species. The review has been prepared based on the papers obtained from platforms like PubMed Center, Google Scholar, and other reliable internet sources with restrictions on time basis from 1965-2021 to provide an account of the nature of Covid-19, our learning from past pandemics, along with a note on human behavioral response to Covid-19.

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2. Covid-19 and Its Nature of Devastation

There are approximately 10 nonillion (1031) individual viruses exist on the earth (Editorial, 2011). Viruses drift through the atmosphere, see the in marine water (Katherine, 2019), and lurk in tiny specks of soil (Emerson, 2019). Generally regarded as non-living entities (Nigel and David, 2016), viruses only replicate in a host. With a diameter of below 200 nm, the virus lacks a ribosome (Wessner, 2010). Our species thrived in the virus-filled world. The extraordinary preference for the cells of the virus that it infects perhaps set a balance for the survival of both the virus and our species. A very small fraction of viruses poses a threat to humans. Some viruses mutate more often. Others are capable of jumping from one host to another host species.

Our ancestors faced infectious diseases while they were hunter-gatherers. Before 10,000 years ago, the Agrarian lifestyle enhanced the incidence of epidemics with tuberculosis, malaria, leprosy, and influenza (History.com Editors, 2021a). About 25,000 years ago, a coronavirus infected the people living in modern-day East Asia. Several viral epidemics have wreaked havoc in the last two decades, including SARS-CoV-1 in 2002-2003, H1N1 influenza in 2009, and the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) in 2012. Covid-19 (SARS-CoV-2) with low respiratory infection was first detected and reported to the WHO country office in China on December 31, 2019, as pneumonia of unknown etiology (Katherine, 2020).

Following WHO definition of zoonosis, “as any infection naturally transmissible from vertebrate animals to humans," the Covid -19 is stand as zoonotic disease. However, due to lack of confirmed animal reservoirs this consideration stands premature. Many scientists consider Covid-19 as an “Emerging Infectious Disease” (EID) of probable animal origin. SARS-CoV has been recorded in several animals including dogs, cats, and ferrets. The list also includes deer, lions, tigers, captive-managed mink, and mice. The pathogen transmission from a natural (animal) host to a novel host causing infection of the latter is called the chance event, or spill-over as happens in HIV and Ebola. In such an event, key genomic changes in pathogen makes the pathogen capable to invade the new host. Invasion of Covid-19 in new hosts creates secondary epidemiological cycling to conspecifics, or dead-end, or transmission of zoo anthroponotic nature. The Covid-19 as an EID allows for possible spillover from an animal reservoir but does not allow misrepresenting it as a zoonotic disease (Haider *et al.*, 2020).

Tyrrell and Bynoe (1966) found and named coronavirus B814. Almeida and Tyrrell (1967) studied B814 patients and found particles was found in infectious bronchitis virus of chickens. The pathogens varied between 80 and 150 nm in size, membrane-coated, pleomorphic with a surface bearing club-shaped projection. Corona virus produced adult colds in about 15% (McIntoshe *et al.*, 1970) people. Three of the six previously identified coronavirus strains were only distantly related to OC43 or 229E (McIntosh *et al.*, 1969). Respiratory coronavirus caused various respiratory illnesses with low pathogenicity (Bradburne *et al.*, 1967), the predominant illness, being the infection in the upper respiratory system with occasional pneumonia in young adults and infants (McIntosh *et al.*, 1974). Asthma exacerbations in children, chronic bronchitis in adults, and the elderly were also reported (Falsey *et al.*, 1997). Based on their genetic makeup and antigenic nature, animal and human coronavirus was categorized into three broad groups. Group I consisted of 229E and other viruses, group II consisted of OC43 and group III consisted of avian infectious bronchitis virus and some related to avian viruses (Lai and Holmes, 2001).

Since 2003, human coronaviruses, including SARS, have been known. In the past few years, coronavirology has advanced remarkably. Covid-19 is the seventh member of the coronavirus family to infect humans (Wu *et al.*, 2020) and caused fifth pandemic after the 1918 flu pandemic. The International Committee on Taxonomy of Viruses named the virus as SARS-CoV-2 (ICTV, 2020). The human coronavirus (HCoV) strains like HCoV-NL63, HCoV-229E, HCoV-HKU1, and HCoV-OC43 usually cause mild, self-limiting upper respiratory tract infections, like the common cold (Yin and Wunderink, 2018). SARS-CoV, MERS-CoV, and SARS-CoV-2 can cause life-threatening severe acute respiratory syndrome (Zaki *et al.*, 2012; and Reusken *et al.*, 2013).

Mutations occur during replication of RNA viruses due to the low proofreading ability of their RdRP. Such mutation is beneficial for an emerging virus to adapt to new hosts. Mutation rates could vary in RNA viruses (Hanada *et al.*, 2004) and the synonymous substitution rate for coronaviruses stands at about 1 x 10~3/synonymous site/year, which is lower than some other RNA viruses. Viral exoribonuclease nsp14 governs mutation rate during coronavirus replication partially (Denison *et al.*, 2011). SARS-CoV-2 is evolving in different human groups worldwide who are susceptible to other HCoV. Recombination between SARS-CoV-2 and old HCoV like HCoV-229E, NL63, OC43, and HKU1 has not yet

been found. Now three genetic types of the virus spread globally (Forster *et al.*, 2020) correlating to the geographic locations (Mavian *et al.*, 2020).

3. What We Have Learned from the History of Pandemics

The earliest record of a pandemic in 430 BC during the Peloponnesian War (History.com Editors, 2021b) killed two-thirds of the population. The Antonine Plague began in 165 AD, continued up to 180 AD. The Cyprian plague is believed to have originated in Ethiopia in 250 AD, spread into Rome, and eventually into Egypt and northward. It hit Britain in 444 AD. The Justinian Plague first appeared in Egypt in 541 AD, spread through (History.com Editors, 2021c) Palestine, the Byzantine Empire (History.com Editors, 2021d), and the Mediterranean, and killed about 50 million people, more than one-fourth of the world population in the next two centuries. In the 11th century, leprosy developed into a pandemic in Europe. The Black Death outbreak of 1350 killed about one-third of the world's population. Measles, bubonic plague, and smallpox altogether killed nine-tenths of the indigenous people of the Caribbean due to the sudden entry of the Spanish in the year 1492, which is called the Columbian Exchange. The destruction of the Aztec Empire in 1520 was due to smallpox. The bubonic plague killed one-fifth of London's population in 1665. Cholera was a pandemic that spread in 1817. The plague pandemic began for the third time in China in the year 1855, spread to Hong Kong and India, and killed 15 million people by 1960. About one-third of the population of Fiji died due to measles in 1875. With a start from Kazakhstan and Siberia, the Russian Flu invaded Moscow, Finland, Poland, and the rest of Europe, causing 360,000 deaths until 1890. The Spanish Flu pandemic was responsible for 50 million deaths globally in 1918. In 1957, Asian flu began in Hong Kong, spread to China, the US, and became prevalent in England with a second wave at the beginning of 1958, causing the deaths of about 1.1 million people globally. Since its discovery in 1981, HIV/AIDS has claimed the lives of 35 million people worldwide. ARS spread to cats and humans in China with the deaths of 774 people and is believed to have begun with bats in 2003 (Saplakoglu, 2021).

Covid-19 arising from Wuhan, China in December 2019 is becoming a highly infectious disease and a serious threat to humanity. The name coronavirus signifies its crown-like surface appearance. The rapid human-to-human and air borne transmission are causing unprecedented infectivity and human death now in some countries like India. Covid-19 is not a stable virus but has evolved virulence during the last one-year or so. Coronaviruses (CoV) include a-CoV, and P-CoV, which infects mammals while y- and S-CoV, infects birds. SARS-CoV-2 is a P-coronavirus. This takes entry into humans using Angiotensin-Converting Enzyme2 (ACE2), the same receptor of SARS-CoV. It is a non-segmented positive-sense RNA virus and enveloped (Zhou *et al.*, 2020). The alveolar epithelial cells of lungs and enterocytes of the small intestine contain high amounts of ACE2. The genome sequence of SARS-CoV-2 bears 96.2% similarity to a bat CoV that transmits SARS- CoV-2 via unknown intermediate hosts to humans. The RNA of Covid-19 is the largest viral RNA coding for a large polyprotein (Gayatri Devi and Seethu, 2018). A helical capsid of nucleocapsid protein (N) contains the Covid-19 genome.

Three structural proteins (S) surround the capsid. The spike on the surface of the virus forms a large portion and aids in virus entry (Kahn and McIntosh, 2005). A membrane protein (M) and the envelope protein (E) aid in virus assembly. At the time of entry, spike protein is attached to the host cell. The protease present in the host cell cleaves and activates the receptor, which remains attached to the spike protein. The virus gains entry into the human cell through a process called endocytosis, or direct fusion of the viral envelopes (Fehr and Perlman, 2015). Subsequently, the virus gets uncoated, and its genome takes the opportunity to enter into the cytoplasm of the human cell. The RNA molecules of Covid-19 possess a 3' polyadenylated tail and 5' methylated caps. The ribosome of the human cell directly translates (Shaffer, 2009) mRNA into protein and releases many accessory proteins (Li, 2016). The S, E, and M (structural proteins) move into the Golgi intermediate compartment. The M proteins govern mostly the protein-protein interactions for the assembly of viruses following their attachment to the nucleocapsid. The human cell expels relative virus area units through exocytosis, which are infective. Respiratory droplets and secretions, and direct contact with infected individuals spread Covid-19 (Li *et al*, 2020). This virus is also transmitted through faecal swabs and blood (Zhang *et al.*, 2020). The incubation period of the virus ranges between 1 and 14 days (Ganesh *et al.*, 2020).

4. Why Covid-19 is so Deadly?

On the day of symptom development, Covid-19 manifests a very high viral load, which then decreases overall. Rapid viral proliferation continues from 0 to 6 days before the manifestation of symptoms. Thus, the risk of Covid-19 transmission is dangerously high due to vast viral load in the early stages of symptoms and preclinical period. However, virus can rapidly increase in 5 days before showing symptoms and a high viral load can found 5 days before to 10 days after

manifestation of symptoms. At this time, the virus possesses high transmission ability. Covid-19 has a high viral load before the appearance of symptoms. It is judicious to expand the epidemiological investigations at this time. A high viral load can be maintained for a long time in patients who were administered with corticosteroids. Many Covid-19 patients were retested after discharge, confirmed repositivity, and requarantined in Korea (Jang *et al.*, 2021). In the majority of cases, respiratory insufficiency was the most frequent cause of death. Bacterial, or fungal pathogens were found in the majority of cases. Sepsis caused by purulent lung infection was the significant factor of death. In some cases, deadly respiratory insufficiency due to diffuse lethal alveolar damage was the cause of death. SARS-CoV-2 infection could directly cause lung damage and bacterial infections may contribute to the excessive cytokine release, which is called cytokine storm. High frequencies of fatal pulmonary thromboembolism have also been observed in died patients. Peripheral micro thrombosis in multiple organ systems may cause severe organ damage in patients that survive Covid-19. Comorbidities with arterial hypertension, chronic kidney or heart disease, and chronic pulmonary disease affect the cardiovascular and respiratory system as found in the majority of deceased patients. However, immediate causes of death were directly linked to lung damage initiated by SARS-CoV-2 infection (Elezkurtaj *et al.*, 2021).

Human contact with an infected animal cause infection in human. The virus must find a route of entry, immune system evasion mechanism, entry into host cells, replicating in sufficient numbers and finding a route of transmission to the next host. Generally, specificity of a particular parasite to a particular vertebrate host limits transfer of pathogen between distant species. Influenza A is the well-studied virus that often jumps from animals to humans. A number of mutations occur during such event that enhance infectivity including substitutions in the hemagglutinin protein receptor binding sites to enable the virus to exploit sialylated glycan receptors on respiratory cells of other species. Although the detailed mechanism is yet to be revealed but mutation is a notable cause (Rosenberg, 2015).

5. Abrupt Disappearance of SARS-CoV-1

One of the most recent viruses to vanish was SARS. At the beginning of the epidemic, the mode of emergence of SARS was clear (Rosenthal, 2003). Sophisticated contact tracing and the quirks of the virus itself have driven it to extinction. The virus had infected at least 8,096 people (CDC, 2016), of which 774 died. As a close relative of Covid-19, SARS was an RNA virus, with capability to evolve rapidly. SARS are known to spread through respiratory droplets that produce the same level of crisis like the HIV crisis, or flu pandemic of 1918, which killed 50 million people. SARS infected individuals were easy to identify, and quarantine but it caused one death in five patients (Fung and Yu, 2003). Relatively long incubation period gave extra time to find an infected one before further transmission to the healthy individual. Other than SARS, two other viruses—smallpox and rinderpest—have been driven to extinction by using vaccines, which set ground to eliminate polio. Vaccinations help prime our immune system to fight off viruses, making their spread difficult. Some viruses may not be extinct, because they have multiple hosts. For example, as long as there are bats, Ebola may always be with us. The only very difficult way to drive the virus to extinction is to eliminate it in the wild. MERS infected humans after being transferred from camels and infected people on numerous separate occasions (Dudas *et al.*, 2018). The same stands true for Covid-19, which perhaps jumped to humans through pangolins. The reservoir for Covid-19 is now our species. If it is spread from humans to wildlife, in a kind of reverse spillover, this would make it harder to eliminate it (Franklin and Bevins, 2020). There is also a positive aspect for us. Human Flu virus that existed about 120 years ago is now extinct. Of two main types of flu virus, influenza A infects animals like ducks, geese and the Giant Petrel and humans (de Souza Petersen *et al.*, 2017) and has remained with us in one form or another causing majority of cases of seasonal flu (Newsouthletter medicalnewstoday, 2020) and pandemics. Influenza B only invades seals and humans, and does not cause pandemics. Human flu virus that was in existence before 120 years is now extinct (Carter and Sanford, 2012).

Rapid artificial viral evolution with drugs could bring some benefits. The genetic material of RNA viruses like HIV, the flu, coronaviruses, and Ebola are made of RNA and they hijack their host's machinery to replicate themselves. They have no "proofreading" step for checking mistakes. This is usually considered to be harmful for humans. Mutations create vast genetic diversity among RNA viruses to allow them to evolve quickly. Thus, drugs, or vaccines targeted to combat them become obsolete quickly. Flu strains as we think as a unitary sequence are a whole swarm of various genetic sequences. In the short term, this quirk makes it difficult to eradicate the flu. As among this swarm might be viruses that our immune systems fail to recognize and are therefore able to escape from our immune system. Such astonishing mutation rate acts as a double-edged sword as above a certain rate, mutations become harmful and creates viral strains containing genetic faults that hinder their spread and even cause their extinction. Artificial rapid viral evolution with drugs that encourage them to mutate at an even higher rate than usual could bring some benefits. First,

it might weaken the virus enough to reduce the amount circulating within individual patients. This could make it easier to treat in those with severe illness. There is already some evidence that this can work—clinical trials in the US and Japan have found that the mutation-inducing drug (Baranovich *et al*., 2013) favipiravir is effective against the flu strain H1N1 (Furuta *et al*., 2013) and this make the flu virus less infectious. Covid-19 now already has at least six strains (ScienceDaily, 2020). Covid-19 would bring a new scientific revolution and the concept of catching several colds or flu each year will become normal (Gorvett, 2020). Aberrantly activated monocytes/macrophages produce IL-1β, inflammation-induced impairment of alveolar epithelial regeneration, and expansion of pathological fibroblasts that promote fibrosis and may impair regeneration in Covid-19. Lack of appropriate T-cell responses likely contribute to fatal outcomes in Covid-19. Rapid development of pulmonary fibrosis is likely relevant for patients who survive severe Covid-19, and may inform our understanding of long-term complications seen in these individuals. Important study on host responses to SARS-CoV-2, understanding on potential long-term pulmonary sequelae resulting from Covid-19 provides a basis for therapeutic development for the disease (Melms *et al*., 2021).

6. Our Behavioral Response Towards Covid-19

Outbreaks of pandemics bring changes in human behavior and policy responses since societies face acute constraints and uncertainties. Changes in individual behavior, social behavior, and governance through policy decisions are mention-worthy. Pandemics cause death and impact the lives of people by inducing fear, suffering, and uncertainty, which seriously affect the health and well-being of community people. Covid-19 is primarily a medical problem, specifically an immunological problem, pulmonary problem, cardiac problem, and neurological problem. Covid-19 affected individuals face various health problems, from mild to severe. The health departments of the government and private sectors deal with health problems. The chief roles, however, go to the medical practitioners, nurses, health workers, and management of the government and non-government sectors, as well as policymakers. All the stakeholders have to work in a concerted way and in a timely manner with the highest precautions. In fact, in such cases feelings of anxiety, stress, discomfort, or inconvenience are common in both patients and their relatives, and friends.

7. Individual Behavioral Response

In the beginning of infections, infected people try to hide their infections and alter their behavior to avoid discrimination. Awareness about the disease is expected which may reduce the spread of the disease. Due to asymptomatic cases and incubation period of varying duration, Covid- 19 is not totally avoidable in the early days of infection. Thus, infected people spread infection to family members and others unknowingly. Once people come to know of their disease, he/she isolate him/her. Some individuals do not comply with this due to fear of discrimination. Some individuals underestimate the severity of the disease, which results in inadequate preparedness for dealing with the outbreak. Some individuals did not adapt measures to protect themselves effectively with a false belief that they are naturally immune to the disease. In Public media, people sometimes prescribe a chief way of gaining a natural immunity. Relatively low availability of doctors, or indifference of the individuals to consult a doctor may be a reason behind such behavior. Herding behavior models of Banerjee (1992) and Bikhchandani *et al.* (1992) are useful in explaining such behavior like miracle cure. Whenever people observe other people in believing in such a cure, an individual might follow the herd. Endogenous timing and strategic delay (Gul and Lundholm,1995; Chamley and Gale,1994) study interpret people's belief in miracle cures. To examine the effectiveness of a cure amidst fear of a pandemic is costly and avoiding such cost lead to herding.

8. Social Behavioral Response

Patients and their families may feel judged by others due to perceived stigma (Sotgiu and Dobler, 2020). Similarly, sometimes-infected people may be isolated and discriminated against by their own family members, or community members, a phenomenon known as "experienced stigma." The unaffected community, or less affected community, fails to perceive, or perceives variously, the danger of the Covid-19 pandemic, and thus human social behavior varies markedly region-wise. Altruistic behaviors like providing food are common, but selfish behavior, or self-interest like giving priority to earn money unethically with oxygen cylinders, medicines, or taking high costs to afford medical facilities are apparently more evident. In fact, behavioral economics has identified motives, altruism, and moral motives in explaining kind and helping behavior. Such models imply that the narrow lens of strategic behavior, or reputation models, cannot capture behavior solely based on the warm glow of giving or repeated interactions (Charness and

Dufwenberg, 2006; Fehr and Fischbacher, 2005).Perhaps, as psychologist Michael Tomasello and his coauthors have argued, cooperation, rather than competition, is our basic instinct (Hamann *et al*., 2011; Tomasello, 2009).

9. Governance and Policy Related Behaviors

The responses of the governments and concerned government departments as well as private health sectors to Covid-19 are different in different countries, as social factors, economic factors, and the responses of the policymakers vary country-wise and region-wise. However, the denial in the early stages of the outbreak was common around the world. It took more than six months for the London authorities to respond. Italy initially imposed a lockdown only in certain sections and in selected parts of the country. When it became imperative, Italy declared a national lockdown. Even when a lockdown is imposed, some governments blame others rather than take the responsibility for late or insufficient actions. Due to unprecedented uncertainty, the decision-making was not perfect in Covid-19. Health-related uncertainty leads to unprecedented fear in an individual as well as in the community. Fear of lockdown originates from economic uncertainty. It is difficult to conduct a cost-benefit analysis amidst such uncertainties. The heuristic and biases program of Kahneman *et al.* (1982) (Gilovich *et al.*, 2002; Tversky and Kahneman., 1974) are all in line that when it comes to deal with the uncertainty, decision-makers often succumb to various fallacies and biases rely on cognitive heuristics that may produce suboptimal decisions in some cases (Dasgupta *et al.*, 2021).

10. Conclusion

Covid -19 is becoming a serious threat due to its incubation period in humans as well as the existence of asymptomatic carriers in the population. The disease burden could be reduced to a significant extent if we could identify and treat such individuals and patients. I believe it is important to communicate that Covid-19 does not adhere to any rules in terms of immune invasion mechanisms, incubation period, or pathogenic nature. It is very difficult to formulate an effective management strategy. Thus, training medical practitioners, health workers, and nurses, and the procurement of necessary equipment will definitely help, at least to reduce the disease burden. Communication of misinformation regarding prevention and treatment of Covid-19 should be strictly regulated.

Although we have shown our mastery over almost all the life forms on earth, history has recorded our helplessness during the events of 16 pandemics in a span of about 1850 years. The history of our species has witnessed extreme financial crises, natural catastrophes, world wars, and several pandemics. However, pandemics are significantly different from other global crises. In a pandemic, economic activity will not continue in full form unless there is a cure, or communities are naturally immune. Through judicial intervention, a natural disaster lasts for a brief period of time and normalcy resumes almost immediately. Poverty does not affect the global population like a pandemic. In a pandemic, the risk to life is not location specific. Human behavior, medical facilities, governance, and policy for the spread of the disease and social interactions influence the propagation of the pathogen. A pandemic affects global economic activity and people suffer its consequences together, so solutions must take social behavior into account (Dasgupta *et al.*, 2021). With the advancement of our civilization, along with science and technology, we have modified the natural environment enormously, disrupting natural ecosystem services with dramatic changes in transport, trade, and commerce. All such modifications help in preventing the spread of emerging and re-emerging infectious diseases.

As Covid-19 is a global problem effective intervention to reduce, or stop the spread of the disease requires policy at the international level. Different countries are differently equipped to struggle with the disease following which national-level strategy must be formulated to safeguard the life of its people as per the mandate formulated at the international level. We must keep it in mind that the Covid -19 problem needs global cooperation and so we should not hesitate to take help and support from other countries as well as to extend our support to other countries. However, the denial of the seriousness of the Covid-19 problem at the beginning of the pandemics is a part of our misperception as reflected in case of global climate change mitigation, biodiversity loss, depletion of ground water, indiscriminate use of pesticide and many other cases. The possibility of Covid-19 to be a zoonotic disease although needs strong support but if becomes true ban in wildlife trade, restriction to avoid human contact with the wildlife appears to be immediate judicious measures to be implemented. As I have mentioned earlier, the efforts taken by scientists, doctors have made it successful to discover vaccine within a short period. However, policy issues regarding distribution of vaccines, procurement of vaccines and essential drugs as well as to expand the treatment facilities for providing treatment

facilities to increasing number of Covid patients requires interventions of the concerned Government departments. Unlawful money earning in the banner of Covid-19 treatment must be stopped. Strict monitoring of the Covid-19 care system will definitely safeguard the lives of Covid-19 affected people.

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