Chapter 12
Trends and Innovations in Biosensors for COVID-19 Detection in Air

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Abstract  Pandemic is not a word to use lightly or carelessly. It is a word that, if misused, can reason difficult fear, or unwarranted acceptance that the fight is over, foremost to needless suffering and fatality. Coronavirus disease of 2019 (COVID-19) has become a deadly disease shaking the whole world. All the countries are facing a crisis in disposing of fast diagnostics of the syndrome, able to be organized to a wide number of persons. To control the spread of this virus harmful results of coronavirus have given rise to the growth of analysis tools. In this urgent situation, many researchers and scientists are working on finding a solution to control the deadly virus. In this chapter, we focused on researching biosensors that could detect the virus in the air. People breathe about 11,000 L of polluted air that is invisible. The major purpose of this sensor is, it could be used as another method and more significant to calculate the concentration of virus in the air, but it won’t be the replacement for laboratory tests. Advanced technology, time-consuming and low-cost equipment for this disease spreading virus is in need to control the pandemic at the earliest. This biosensor is prevalent and can detect even minute amounts of viruses present in the air and surroundings.

Keywords  SARS-Cov-2 · Virus disease · Air · Biosensors · Types of biosensors and its role · Detection of virus in air · Precautions

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12.1 Introduction

The first plague pandemic, the Justinian plague has occurred between the sixth and eighth centuries AD during the period of the great Roman Empire. During the fourteenth century, Black Death in the pre-modern era was the worldwide second pandemic. The post-industrial age in nineteenth century middle and the beginning of twentieth century that occurred was considered to be the third pandemic all over the country.

The primary root cause of plague disease is mainly rodents. By nature, humans can never infect one another, but it is exceptional for rare pneumonic spread. Rat colonies thrived during this spread of plague on coastal ships, and mainly the affected rats were transported from one part of the place to another place to affect humans all over the world. Later the bubonic plague became a crawl disease in the widespread animal population (epizootic), growing fast as the lying beneath rat population increase. In the early twentieth century, after landing by ship to the Indian hinterland the epidemic started to grow as quickly as it can, being carried rapidly with their complement of infected rats with the grain movements through railways [1]. Later it is, however, reversed to the middle age crawl epizootic to one side from railway links.

Cholera was the first and foremost modern pandemic in the world, during the nineteenth century it traveled Europe from Asia ensuing the colonial railway link. Why this cholera hasn’t spread in Europe at the beginning through the Indian Ocean trade route? Still, it stays as a big mystery. Was it is because the cholera pathogen cannot able to survive long outside its warm weather in tropical areas?

There was a mortality decline followed by the public health revolution. In the nineteenth century, not only in Europe, the mortality count started to increase in India, despite there was an improvement in food security, developmental works in modern techs like all roads, railways, and canals that was also the main cause to the rapid growth of this malarial fevers, the population was decreasing till 1921.

The presence of virus and spread always gives a grave threat to entire globalization. There are several viruses which are mostly infectious but relatively do not spread, results in less death ration such as seasonal flu, and on the other side some viruses are not virulent but highly dangerous, some are Ebola, SAR Syndrome, MER Syndrome, and COVID [2]. Still, there will be also a hope, the perfect disaster will occur often, a strain both non-infectious and high dangerous to live with the potential of causing death on an overwhelming scale. The life of human worth has changed in a certain period, but half-million mortality from COVID-19 to date is not so far to be a perfect disaster for humans. Hardly 40–50 million people globally claimed the Spanish flu a century ago [3]. During the first two plagues around thirty to fifty and two hundred million lives claimed, respectively, and 10–12 million in China as well as in India alone during the third pandemic. In the nineteenth century, it was over 40 million perished from cholera.
12.2 Corona Virus Disease-19 (COVID-19)

Recently from the last of December 2019, a whole world person has been getting infected by coronavirus disease 2019 (COVID-19), to be precise, it’s the fifth pandemic after the flu pandemic occurred in the year 1918. The first and the earliest date of symptoms were started on December 1, 2019. The identification of these patients, were quite common which includes fever, dry cough, and body pain, and later it was identified as viral pneumonia [4]. In the beginning, by the member of the press and media, it was named as “Wuhan pneumonia” based on the virus symptoms and also its origin place. The whole set of chromosome sequencing pointed to this disease-causing pathogen is a new type of coronavirus. Hence, this disease-causing virus comes in the seventh row of the coronavirus background to affect humans. On January 12, 2020, the WHO for the time being termed this new virus as 2019 novel coronavirus disease (2019-nCoV) and then on of February 12, 2020 in a formal and public way they named this disease-causing infection as COVID-19 (coronavirus disease 2019). WHO on the 11th of March in closing announced the gauging the highly dangerous COVID-19 can be delineated as a widespread along with the globe, after the 1918 Spanish flu (H1N1) estimated around 50 million human deaths, 1957 Asian flu (H2N2) death rate was nearly 1.5 million, 1968 Hong Kong flu (H3N2) the mortality count was one million, and in 2009 Pandemic flu (H1N1) which is 300,000 human deaths, respectively.

COVID-19 also spreads like other coronaviruses do, mainly through one person to another contact. Purely the infection depends on the person’s body condition and it may be either for some mild or for some deadly. Severe acute respiratory syndrome coronavirus disease-2 belongs to the family of seven types of coronavirus; it includes the deadly virus that causes severe diseases like MERS disease and SARS disease. Seven types of coronavirus are shown in Table 12.1 with their causes. It won’t be a serious threat to healthy people like the other coronaviruses affect most of us with the colds during the year.

As we all know it is usual for a virus to change, or affect, to infect people. A study has been carried out by the 103 Chinese people with COVID-19 cases; the results tell that the virus spread has just done its part. During the process, they found 2 strains, and then they named it as L and S type of strains. We can all know that this S strain is very old, and the L strain is the one that is more common in the early stages of the pandemic.

Vaccines are a while off yet, so routine testing is vitally important at this stage of the pandemic to cure the deadly disease. Even when the vaccine is available, people will still need to be tested, and it is one of the most significant solutions at the moment in the fight against the coronavirus. One issue with current testing methods is that they produce a high number of false-negative and false-positive results [5]. Not ideal in the best of times, never mind when public health professionals and health systems are stretched beyond their standard capacity. So, while we currently have routine tests to diagnose if a person has/has had the coronavirus, new and more effective (i.e., more
Table 12.1  Seven types of Corona Virus and their causes source from [72–74]

| Breed                                                      | Year of origin | Genera-Lineage | Pathogen   | Intermediate pathogen | Symptom | Reference |
|------------------------------------------------------------|----------------|----------------|------------|------------------------|---------|-----------|
| Human coronavirus 229E                                     | 1966           | α              | Bats       | Camelids               | Light   | [72]      |
| Human coronavirus OC43                                     | 1967           | β-A            | Rodents    | Cattle                 | Light   | [72]      |
| Severe acute respiratory syndrome-coronavirus              | 2003           | β-B            | Bats       | Civets                 | High    | [72]      |
| Human coronavirus NL63                                     | 2004           | α              | Bats       | Unknown                | Light   | [73]      |
| Human coronavirus HKU1                                     | 2005           | β-A            | Rodents    | Unknown                | Light   | [73]      |
| Middle East respiratory syndrome—coronavirus               | 2012           | β-C            | Bats       | Camels                 | High    | [74]      |

accurate) diagnostics are being sought after [6, 7]. There are several researchers and doctors in both academia and industry that are answering the call to control this.

12.3  Biosensors and Its Types

It is an analytical device, which can be used as a chemical substance detection that combines the physicochemical detector with a biological component. The delicate biological elements such as tissues, micro organisms, antibodies, nucleic acids, etc., are biological-based materials that tie up or identify the analysis in the process of study. This sensitive biological element is mostly available in the markets and it is generally produced by biological engineers. The transmitting or the detecting element present in the sensor, which sends one signal to another one [8], which is works in a physicochemical way like electrochemiluminescence which results in easily measure and quantify the combination of the analyte with the biological element.

Biosensors classification is given below:

A. Electrochemical biosensor
B. Optical biosensor
C. Thermal biosensor
D. Electronic biosensor
E. Piezoelectric biosensor
F. Gravimetric biosensor
12.3.1 **Optical Biosensor**

The optical measurement principle is used in the optical biosensor devices. They also use optical fiber as well as optoelectronic transducers for its process. The word optrode which represents the compression of two terms optical and electrode [9, 10]. The main purpose of this sensor is involving in transuding elements like antibodies and enzymes. This biosensor allows us to secure non-electrical inaccessible sensing equipment. One of the extra benefits of this sensor is it doesn’t require/need reference sensors frequently like other sensors. The optical biosensors are broadly divided into two categories such as direct and labeled optical detection biosensors.

12.3.2 **Thermometric Biosensor**

In our daily life, huge number of biological reactions takes place those are mainly interconnected with heat, and this makes the base for the invention/formation of thermometric biosensors. Usually, these kinds of sensors that deal with heat are referred to as thermal (heat) biosensors. To measure/estimate/calculate the serum cholesterol this thermometric-biosensor is used in a wide range [11]. It is also used for the known glucose value, to find the amount of urea, and penicillin G can be done with these biosensors.

There are many numerous applications of biosensors available according to the need. The need for a biosensor in our daily activities is tremendous broadly used in the biological area and commercial applications like identifying the target molecules, recognition of biological elements, and the tendency of the disposable portable detection system in some situations [12, 13]. Diabetes patients to monitor the glucose levels, targets related to medical health departments, general applications like detection of pesticides for farmers in agriculture and water contaminants (river, lake) and some of the metal ion compounds, sensing remotely for the airborne virus in Bioware activities, checking water quality in coastal waters by explaining clam ethnology in groups bivalves around the world in online, pathogens detection, toxic substances determination for bioremediation before and after and organophosphate detection, folic acid, pantothenic acid routine analytical measurement as an alternate for microbiological assay, drug residues in food determination (antibiotics and promoting the growth of the viruses, mainly the flesh of an animal and honey), biological activity and the origin of new devices, and toxic detection metabolites like mycotoxins [14].

12.3.3 **Progress of SARS-Corona Virus Disease**

All human coronaviruses are basically from animal origins, termed as, natural hosts. Particularly bats are one of the Human coronavirus 229E, SARS-Corona Virus,
Human coronavirus NL63, and MERS-Corona Virus which is a natural host. Further, rodents are the main cause of HCoV-OC43 and HKU1. The less sustaining ability of the RNA-dependent RNA polymerase (RdRP) generates mutations mainly due to the replication of RNA viruses. The variation in the genome gives rise by viral RdRP, it would be helpful for the existing organism to stick [15]. The mutation rates are varying in RNA viruses based on the new hosts are shown in earlier studies. When we look at the same interchange ratio for coronaviruses it may be nearly around \(1 \times 10^{-3}/\text{synonymous/year}\), which is very low when compared with some other RNA viruses. Viral exoribonuclease nsp14 is used partially to control the mutation rate during coronavirus replication. If not, SARS-COVID 19 has been entering continuously to various groups globally during the widespread [16].

From the database of GISAID submitted in January 2020, the data of nCoV-19 sequences, the virus was earlier identified in the last December 2019 from China, Wuhan. Though, there is so much variation while comparing the old sequence database with the currently submitted sequences gathered from North America in early 2020. These viral sequences are changing continuously; phylogenetic network construction is very hard to find the growth of the microorganism in distinct populations and surroundings. Though the microorganism continuously spreading inside the person to person or other human coronaviruses, join together between COVID and past coronaviruses, such as Human coronavirus 229E, OC43, and HCoV HKU1, still haven’t found. The research shows that three types of genetic viruses have been spreading/passing worldwide [17]. The studies also demonstrate that the pathogens may also relate to the environmental location, size of the sample and different analyzing studies are still being an argument in the research field. Though there is various research and arguments are going on, it is still not clear that the virus is affected by replication environments like immunological and genetic restrictions with the evolution of SARS-COVID, in varying person populations. The selection process of SARS-COVID mutations with evolutionary pressure is on the process. The examination of the variation in patterns of COVID will provide a detailed database for a different population about vaccine development [18].

12.4 Analysis and Survey

12.4.1 Survey Report

There are 2 types of rapid Point of Care method that can able to find the COVID-19 virus, first one is nucleic acid and antibody (Ab) tests. This AB test is generally carried out by finding the presence of the microorganism in infected human Sputum or through snot i.e., nose or mouth. Finding the growth of the microorganism at the beginning phase of infection or before the start of the symptoms appears these kinds of tests are acting well, and it will be accurate [19]. If we see on the other side, the IgG/IgM test—antibody test is carried out by getting an infected person
blood sample which contains the virus against antibodies. Thevarajan et al. (2020) says that the basic finding report says that five days or about after the early infection stage, the virus usually activates the immune response that stimulates the building of both Immunoglobulin G and Immunoglobulin M in the blood which is fighting against the virus. This body’s immune system could be found in the infected person plasma, serum, or blood [20]. The present Point of Care biosensors and the available devices in the market for coronavirus 2 are tabulated in Table 12.1. While, compared to the clinical sensitivity and relatively unique, which are 79–97 which is higher than already available POC biosensors commercially, quantitative real-time polymerase chain reaction (qRT-PCR), COVID-19 gold standard. The 86.43–93.75 and 90.63–100%, Immunoglobulin G/Immunoglobulin M lateral flow test strip, respectively.

12.5 Role of Biosensor in COVID-19

12.5.1 Possible Origins of Virus

Any tiny/small organism, which includes viruses/bacteria, can become airborne. Contamination in the material can be aerosolized by various methods/ways; it depends on air to person and animal doing things like coughing, daily activity, sleeping, its breed, etc. [21]. If an infectious particle is clear and proper, it can stay as an airborne, there are so many to come into proximity neither with animal nor person and possibly form a disease. The statistical ratio of an airborne tiny organism—microorganism causing a spread based on its spreading nature and its capability to withstand the stress of aerosolization [22]. The latest Chinese health statement suggested that this new coronavirus may spread quickly than what we thought, through an “airborne route.” This microorganism is now called severe acute respiratory syndrome coronavirus 2, disease (SARS-CoV-2), and the infection it creates are now titled as COVID-19 [23, 24].

This virus can quickly spread over in an open/dirty environment because it tends to grow larger and larger by joining with the airborne particles when compared with the particles in a clean/controlled environment. After all, in clean space, the virus is more likely to remain small and it’s hard to inhale by animals and humans. The main spread/cause of this disease is mainly due to sneezing, coughing, talking, hugging each other at that we sneeze, or spread the particles in a large size. The CDCP of china almost right away changed the announcement, nothing Corona virus-2 was not considered to be an airborne virus [25, 26].

Wet/sticky droplets greater than 5–10 millionths of a meter or micrometer which is bigger easily have the nature of falling to the land within minutes/fraction of time or stay on a different surface. These sultry droplets are considered to be the travel risky largest routes for the coronavirus 2 [27]. But tiny organisms haven’t been involved in the process of CovidVirus-2. Tiny particles tend to evaporate quickly in the air so it won’t create high-risk factors (i.e., less than 1/10 of a second is not wet air).
They will leave some gelatin-like particles which consist of proteins, salts including viruses and these leftovers are generally named as “droplet nuclei” and it is easily inhalable. They may remain for hours or for a long time it depends on the virus, travel, or pass through the air currents via clinics, theatres, shopping malls, colleges, schools, temples, and working place. This is how usually this type of airborne disease spread in animals and humans [28].

There is more number of ways to spread airborne microorganisms. To affect the humans/animals, the droplet nuclei must contain infectious pathogen and the virus can enter the mucous membranes—our ears, nose, eyelids, mouth, and digestive paths, and this virus can enter our cells and reproduce to infect/affect [29]. The center in china confirmed that this virus appears to pass through droplets, direct contact with person to person, and by creating contact with contaminated/affected surfaces, persons, and objects.

Once the infected person leaves the room measles virus can stay or withstand in a room for nearly 30 min, there are more chances to infect quickly. Same way, the MERS coronavirus has been recorded in the infectious state from clinical air samples and found to be dangerous. Other viruses that may infect or spread through an airborne way include the main causes of rhinoviruses, the common cold and flu viruses [30].

Habitual respiratory viruses which develop through airborne particles means it won’t be a surprise to detect coronavirus 2 and this ability. The spreading of this virus is through airborne means the virus could travel faster and furthermore. It can also spread via contaminated air, highly crowded places and reach humans additionally from the affected person, despite them not in their straight line of sight [31].

Anderson and his collaborators concluding this based on sequencing genomic analysis that is potential beginning for coronavirus 19-2 will be through one of the two possible attempts. On one hand, the virus use the nonhuman host i.e., particles, substances, or objects as a medium to jump on the humans. Likewise, the previous first coronavirus spread has emerged and caused the infection, with persons catching the virus after direct exposure to civets (coronavirus 1) and camels. The scientists of this group suggested that bats are the main transmitter for SARS-CoV-2 as it is the same as a bat coronavirus [32]. Still, now there is no reported case of straight transmission of person to bats, anyhow, proposing that a median host was involved between humans and bats.

Second case, the distinctive features of coronavirus 2 and spike protein shows the similar RBD portion that binding in the cleavage site and cells that open the microorganism up it would have evolved to their present condition earlier to human entry [33]. The ongoing epidemic would probably have spread vastly as earlier as persons were getting infected, as the virus would have already progressed the condition to develop it as a pathogenic and can increase among the humans.

The research work report says that the virus of a non-pathogenic version can jump from humans into animal hosts and then progress to its present pathogenic condition inside the human population. From the findings, some coronaviruses from pangolins, from Asia and Africa found mammals like an armadillo, which have an RBD structure very same to that of Corona virus-2. A spread from pangolin might
be passed on to humans, civets or ferrets used maybe pass straight or through some medium of the host [34, 35].

Another prominent method to know the spike protein nature of COVID-2-19, within the human host the cleavage site could have evolved, maybe through limited undetected circulation before the start of the epidemic in the human population. The researchers also research and found that the corona virus-2 cleavage site resembles the same to the strains of bird flu cleavage sites, it can be easily transmitted among one human to another human. Corona virus-2 could have evolved such a deadly cleavage site in human cells and soon it will vanish the ongoing epidemic, as the coronavirus could have become far more capable of spreading between humans [36].

12.5.2 Detection of Coronavirus in Air

RT-PCR a molecular method is mainly used for most of the laboratories or laboratory works, to find how the virus spreads in respiratory organs? It is a most familiar method and used to find even micro count presence of viruses and apart from this, this method consumes more time, easily detectable, and no error-prone [37, 38]. Jing Wang and his group from Materials Science and Technology, the Swiss Federal Laboratory had developed another testing methodology in the new kind of biosensor, where two different effects connected to find the tiny virus in a short time safely and more accurately: i.e., through an optical and thermal biosensor technique [39].

The researchers explained that this sensor consists of a glass substrate with a very small structure of gold, basically named as gold nanoislands. On elaborating they produced artificial receptors of DNA that coincides exactly with the sequences of the COVID-2 RNA which is mounted on the nanoislands. Alternatively, this COVID is also known as RNA virus: Generally, this coronavirus has not to consist of a double-strand DNA genome as in surviving organisms, but of an RNA single strand genome as in living organisms. According to the researchers, the receptors on the sensor acting as a unique RNA sequence are therefore the complementary sequences to the microorganism, which can find the virus in less time [40, 41].

The technology used by the researchers for the detection purpose is termed to be localized surface plasmon resonance (LSPR). This is based on the principle of optical biosensor principle that takes place in nanostructures made by metallic: Suppose if the virus starts to react, it activates the striking light in a particular range of wavelength and forms a plasmonic near-field on all sides of the nanostructure. The molecules present in the exciting plasmonic near-field changes, the local refractive index bind over the surface they noticed. An optical sensor situated at the backside of the device could be helpful to calculate the change and it could find/say neither the sample contains the RNA strands nor not [42, 43].

SARS-Corona virus and SARS-COVID2, the two deadly viruses vary only a bit in their RNA strand apart from that there is no difference. “Tests showed that the sensor can clearly distinguish between the very similar RNA sequences of the two viruses.” By using this biosensor we have no need to wait for a long time to get
the results, and they will be available in a fraction of time. However, this sensor is still not available to calculate the concentration of the coronavirus in the air by this time of need. The research is focused mainly in the developmental methods to make this possible for instance, the pathogen that spreads in the environment/air, reduces/removes the aerosols in the air and the RNA is releasing from the viruses it takes some more time to use this product [44].

While the biosensor is not an alternative to clinical diagnostics, the scientists see the system potentially operating in crowded environments. For ease of use, the integrated system will be a portable device that can be used for rapid detection in public areas, such as train stations and hospitals [45, 46]. To find the virus on time and accurately, the sensor combines two different effects: optical and thermal.

Because the coronavirus genome is a single RNA strand, the sensor features a false DNA receptor that matches with the specified RNA sequences of the COVID-19. The receptors are usually mounted on the sensor’s gold “nanoisland,” which are placed on a glass substrate. The biosensor is based on an optical process termed as localized surface plasmon resonance, or LSPR. The nanostructures made of metallic, while moving, modulate the particular light in a correct wavelength range and form a plasmonic near-field region near the nanostructure [47]. The confined refractive index in the exciting near-field plasmonic region modifies its position when molecules attach to the surface [48]. The thermal aspect of the sensor offers secondary confirmation of detection. To maintain a constant high temperature to eliminate nonspecific bindings, a laser is applied to the sensor during the whole detection process [49]. The plasmonic photothermal (PPT) effect produces localized heat and raises the ambient temperature, allowing only the RNA strands of the virus to join with the nanoisland receptors [50, 51].

To demonstrate the sensor’s accuracy, the researcher tested their sensor’s ability to detect SARS-CoV, a closely connected virus. In 2003, pandemic broke out the SARS-Corona virus, which triggered the SARS pandemic, and its RNA only differs slightly. From the result, the sensor could differentiate between the exact RNA sequences of the two different viruses [52, 53].

Our proposed dual-functional plasmonic technology can accurately discriminate against the viral sequence and perform quantitative detection. Therefore, we hope that it can be applied to study the transmission of airborne viruses and assess the virus threat in the air. To achieve this aim, it requires a fully integrated system [54]. This system will contain several important subunits including the air sampling unit and these developed biosensors. For ease of use, the integrated system will be a portable device that can be used for rapid detection in public areas, such as train stations and hospitals.

We need to further integrate the air sampling unit and biological processing unit into the final system. These two subunits can facilitate the online fast detection of airborne virus by collecting the airborne virus and extracting the viral sequence. We are currently working on these developmental works in parallel [55, 56]. At present, this new type of optical sensor has demonstrated its practical potential. We hope that more efforts can participate in the development of similar novel technologies. Although some of these emerging technologies cannot be put into use in the short
term, more participation in scientific research will speed up their development. As of now the work is not completely faded out: first the virus started to develop in China and then globally even before the COVID-19, at the beginning of January 2020, the usage of this sensor is not advisable and so to improve the process of the device/sensor in a more effective to find a particular virus accurately [57, 58]. The main ultimate motto of this sensor is not replacing the already available laboratory methods, but it can work as other test methods for medical purpose and assist in the diagnosis process, and more conspicuous to calculate the virus aggregation in the environment/air in day to day life: For instance, in busy places like bus stations or colleges, public gatherings [59]. New test methods are in urge for the finding of the coronavirus to normal and the pandemic under control as earlier as possible with fast test results and accuracy.

Some of the latest technology growth for coronavirus fast detection and their different specification by researchers are shown in Table 12.2. In Table 12.3 the considerable biomarkers for sensing are tabulated. The ideal demonstrative test has both high affectability and particularity (genuine negative rate). The affectability is accounted for along with the limit of detection (LoD). The LoD sets the most reduced grouping of SARS-CoV-2 RNA that can be identified by the RT-PCR test, which is controlled by distinguishing the nearness of the viral RNA in at any rate 95% of the cases. For coronavirus examines, the LoD can arrive at levels lower than 10 genome

| S. no | Technology used for sensing | Analyte | Detection limit | Answer time of the sample | Care point? | Reference |
|-------|-----------------------------|---------|-----------------|---------------------------|------------|-----------|
| 1     | qRT-PCR                     | N-gene  | 3.2 copies/μL   | >2 h                      | No         | [77]      |
| 2     | qRT-PCR                     | ORF1ab, N gene, S gene, MS2 | 10 copies/μL | >2 h | No | [77] |
| 3     | qRT-PCR                     | ORF1a   | 9 copies/μL     | >2 h                      | No         | [77]      |
| 4     | qRT-PCR                     | ORF1ab, N Gene | 0.025 copies/μL | >2 h | No | [77] |
| 5     | Lateral-flow assay          | Nucleocapsid protein | 80% sensitivity | ~15 min | Yes, SOFIA system | [77] |
| 6     | CRISPR-based lateral-flow assays | E-gene, N-gene | 70–300 copies/μL | ~30 min | Yes | [77] |
| 7     | Surface plasmon resonance DNA | 0.22 pM to 50 μM | – | – | [75] |
| 8     | Field effect transistor Protein | 1.6*10^1 pfu/mL to 1.6*10^4 pfu/mL | 4 h | – | [76] |
Table 12.3  List of considerable biomarkers for coronavirus disease, source from [78–80]

| S. no | Biomarker                  | Normal patient | Affected patient     | Biological samples | Reference |
|-------|----------------------------|----------------|---------------------|--------------------|-----------|
| 1     | Serum ferritin (ng/mL)     | 15.0–150.0     | 800.4 (452.9–1451.6)| Serum              | [78]      |
| 2     | C-reactive protein (mg/L)  | 0–1            | 57.9 (20.9–103.2)   | Plasma             | [78]      |
| 3     | Interleukin-2R (U/mL)      | 223.0–710.0    | 757.0 (528.5–1136.3)| Serum              | [79]      |
| 4     | IL-6 (pg/mL)               | 0–7            | 7–9                 | Blood              | [79]      |
| 5     | Serum amyloid A (SAA) (mg/L)| 0–10           | 108.4               | Saliva             | [80]      |

duplicates per response (0.5 cp/μL). However, the affectability differs relying upon the picked packs and PCR instrument.

12.6 Preventive Measures

Though we have tremendous development in technology most of the highly developed countries and developing countries haven’t find the vaccine for this coronavirus disease-19, and still there is no confirmation of medications for this coronavirus, so we need to protect and take of our self and our family members [60]. Some of the precautions to be taken to avoid this virus are listed below:

1. Limit close contact between infectious people and others. Ensure a social distance of nearly around one meter from another person. In areas where COVID-19 is circulating and the distance cannot assure us, so better wear a mask [61].

2. Find the infected people quickly and isolate them as much as soon and care for and all of their close contacts can be quarantined in appropriate facilities.

3. Clean hands, and during cough and sneezing cover with a cloth or tissue or bent elbow at all times.

4. Avoid public gatherings, close-contact meetings, and restricted and enclosed spaces with poor ventilation.

5. Indoor settings must be ensuring good ventilation, including homes and offices.

6. Stay home if feeling unwell and call your medical provider as soon as possible to determine whether medical care is needed [62].

7. In countries or areas where COVID-19 is circulating, health workers should use medical masks continuously in their daily activities in clinical areas in health care facilities [81].
Health workers must use additional personal protective equipment and safety measures must be taken care when helping/treating for coronavirus infected person. More details for medical professionals are available here and here [63]. Workplaces should have in place protective measures, details here. During the cleaning process, it is mandatory to wear disposable gloves and gowns and needs to change it often, if not there is a huge chance to get infected quickly. So it requires loads of advanced protective equipment [64, 65]. On a regular basis, all floors, counters, bathrooms, housekeeping surfaces should be cleaned, or when some third person entered in. Hot water, Dettol, or any kind of detergent can be used as a disinfectant [66, 67]. There is more number of ways of diluted disinfectant mixtures to get contaminated with resistant pathogens. So it is compulsory to discard the remaining mixtures and clean the container with detergents [68, 69]. To avoid cleaning solution contamination, it should be reduced. Two buckets can be used for the wetting of mop. Suppose if you are using a single bucket, the detergent must be changed often [70]. Outside walls, gates, windows, and door curtains should be cleaned when it gets contaminated or if you see dust particles [71]. This corona virus has taken over our lives, filling everything with a deafening silence and a distressing void that stops everything as it passes by; “we feel it in the air/surrounding/environment. We find ourselves afraid and lost.” “Healing people, not saving (money) to help the economy (is important), healing people, who are more important than the economy. People are temples of the Holy Spirit, the economy is not.” We all fight together and against this deadly virus.

12.7 Conclusion

Current evidence suggests that COVID-19 spreads between people through direct, indirect such as spread via contaminated objects or surfaces, or close contact with infected people via mouth and nose secretions. These include sputum, secretions, or death rattles. Usually, these are secreted from the open pores like mouth and nose when an affected person sneezes, coughs, talks, or kisses, for example. People who are in direct contact within the range of one meter with an affected person can catch COVID-19 when those infectious droplets get into their throat, nose, or eyelids.

To avoid contact with these wet particles, it is must/compulsory to stay away at least one meter away from the infected person, wash your hands often in running water, and cover the lips and jaws with a tissue or mask or hand key while sneezing or coughing; it will reduce the spread. When standing one meter or more away is not possible, wearing a fabric mask is an important measure to protect others. Cleaning hands frequently is also critical. Shortly, if we find an airborne route, it does not consider being the major transmission of the virus. This sensor can be used as another method and more precisely to know the virus aggregation in the
surrounding/air in day to day life, but it won’t be the replacement for laboratory tests. Advanced technology, time-consuming and low-cost equipment for the current coronavirus is in need to bring the pandemic under control at possible earliest. This biosensor is well defined, advanced, and can detect even very small amounts of viruses present in the air and environment.

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