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Current Various Tests in Practice for The Detection of COVID-19

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ABSTRACT

The COVID-19 has spread all over the world and has produced a pandemic situation which has directly affected on public health, hence it has been declared as public health crisis. This novel coronavirus have 14 days incubation period and these infectious virus have not shown any symptoms at the early phase. This review paper aims to give information about diagnostic tests for the detection of corona. This infection can be detected and diagnosed by various tests like antigen test, PCR test and antibody test. These tests give information whether the person is infected or not. These tests also provide information regarding treatment of that particular patient. Above three tests can effectively detect and diagnose the virus but among these tests, the PCR is quite reliable, standard and rapid and it also diagnoses the small fragments of DNA with different strains pathogens. In this review paper, we have tried to give an information about the detection tests for COVID-19 and their applications.

INTRODUCTION[1, 2, 3]:

Coronavirus was first found in Wuhan, China in December 2019 and further was spread worldwide. This virus produces pneumonia with unknown cytology, it also shows stimulatory and produces lots of sticky cough in lungs which leads to cause disturbance in breathing and further decrease in oxygen level in blood. Coronavirus named as COVID-19 means "Corona Virus Disease found in 2019". The novel coronavirus has created this pandemic situation which has been also declared by the World Health Organization as a "Pandemic". It is a viral infection which directly attacks on the respiratory system and produces atypical pneumonia. This infectious disease gets spread from one person to another person if the proper distance is not maintained. Hence due to public health issue, COVID-19 is being classified as public health crisis by international communities on January 30,2020. This novel coronavirus has is pretty long incubation period which is up to 14 days hence, in early days of infection, the symptoms are not seen clearly. Virus has shown symptoms after 5 to 6 days of infection so early stage detection seems to be quite hard. In early phase of the infection, the diagnosis of infection can be done by mainly 3 tests which are Antigen test, Molecular/PCR test and Antibody test. These tests are much more effective to detect or diagnose the infection. In above tests molecular/PCR test is quite best and effective to detect specific pathogen because some time antigen and antibody test fails to detect virus due to their different mutated molecular strains. These mutated strains can easily be detected by PCR technique. Due to these tests, not only early detection of COVID-19 infection can be possible, but also helps in selection of appropriate treatment, hence the current review article focusses on the available tests for detection of presence of COVID-19 infection.

The Detection Tests

A. Molecular/PCR TEST [4, 5, 6]:

Meaning:

This PCR technique was initially was discovered by Kary Mullis in 1983. Polymerase Chain Reaction test is a novel effective and popular technique which is based on molecular biology. This test performs directly assay on genomic DNA. In which enzymatically replication of DNA takes place without using any living microorganism like E. coli or yeast. This technique is based on the principle of amplification, in which the small amount of DNA is amplified and replicated. The PCR replicates small fragments of DNA up to 10kb base pair. So, this

technique is used for detection of infectious diseases and for discrimination of pathogenic strains of various viruses.

This nose swab PCR test is also called as “Gold Standard Test” because of accurate, effective and reliable detection of COVID-19 virus. This test also detects the DNA fragments even if anyone is infected for short time.

Procedure:

This PCR test is based on three steps which are sample collection, extraction and PCR.

1. Sample collection:

The sample collection is done by using cotton swab. The sample is collected from respiratory material which is found in nose. There are different types of nasal swabs in which sample is collected from nostrils and nasopharyngeal area. After sample collection, it is sealed in tube and sent to laboratory.

2. Extraction:

Once the swab sample is received, the extraction is done. Which means, the genetic material of virus is isolated from this swab sample. Further, these extracted genetic materials go tfor PCR processing.

3. PCR:

In this step, the special chemical and special machinery is being used which is called as thermal cycler. In this thermal cycler, extracted genetic material undergo chemical reaction and make millions of copies of small DNA fragments of COVID-19 virus. If any virus’s genetic material traces are present in the sample then the fluorescence light is produced due to chemical reaction. This produced fluorescence light is then detected by PCR machine and by a special software and the result is produced.

Inference:

If this fluorescence light shows positive result, then it is the indication that the sample tested person has been infected with COVID-19 virus.

This PCR test needs1 to 2 days to produce the result after sample collection.

Advantages of this test:

1. Accurate

2. Effective

3. Sensitivity up to 95-100%

4. Reliable

5. Sensitive for short duration infection

6. Detects various strains pathogens

7. Detects small genetic material

B. Rapid Antigen test [7, 8, 9, 10]:

The Rapid antigen test (RAT) is a quick diagnostic test which is appropriate for the purpose of concern testing which directly identifies the absence or presence of an antigen. An antigen is the segment of a pathogen which provokes an immune response. From the viral surface, antigen tests observe for antigen proteins. In the instance of coronavirus, these are generally proteins from the surface spikes.

The antigen tests are mostly used for detection of respiratory pathogens. For the identification of SARS-CoV-2, the antigen tests have been granted by the U.S.Food and Drug Administration (FDA) as emergency use authorization (EUA). Antigen tests are immunoassays, which identify the existence of a particular virus-related antigen that indicates presence of viral infection. Antigen tests are comparatively low-cost and largely can be utilised at the point of attention. For identifying the existence of viral nucleic acid, Antigen tests for SARS-CoV-2 are usually less sensitive than other nucleic acid amplification tests (NAATs) and the real-time reverse transcription polymerase chain reaction (RT-PCR). This rapid antigen test should be used in the early stage of the disease, i.e., 5-7 days after the symptoms like fever, cough, problem in breathing has been occurred.

Principle:

For the recognition of SARS-CoV-2 Antigens in person's nasopharyngeal swab sample, the antigen test is used which is a qualitative membrane, based immunoassay. SARS-CoV-2 antibody is layered in the region of the test line. When an isolated swab sample is employed,

that reacts with SARS-CoV-2 antibody-layered particles in the case. The mixture is then transferred uphill on the membrane by capillary activity and responds with the SARS-CoV-2 antibody in region of test.

Procedure:

This test needs the nasopharyngeal swab or other respiratory samples.

1.A sterile swab is put into the nostril.

2.The swab is taken from the exterior of the posterior nasopharynx.

3. The inserted sterile swab is removed from the nasal cavity.

4. Into an extraction buffer tube, the swab is introduced, while crushing the buffer tube, the swab is mixed above 5 times.

5.The swab is then eliminated while crushing the sides of the tube to isolate the liquid from the swab.

6. Force The nozzle cap is forced strongly onto the tube.

7. Three drops of isolated sample are put to the sample well of the case.

8. The test result can be read in 15-30 minutes.

Inference:

1.When two different coloured lines are observed then the antigen test is positive which indicates that the person is infected by SARS-CoV-2 i.e., One coloured line is seen in the control region (C) and another coloured line is seen in the test region (T).

2. When only one coloured line is seen in the control region (C) and no coloured line seen in the test line region (T) then the antigen test is negative.

3. When no line is seen in the control region (C) then the antigen test is invalid.

Advantages of the test:

1. Economical

2. Results can be obtained in 30 minutes.

3. Simple

4. Fast process

C. Antibody Test [11, 12, 13]:

Antibody test, which is also known as serology test. This is the quantitative test for detection of COVID- 19 with the help of IgG antibody. This antibody test shows the positive result after 8 to 13 days of infection of COVID-19.

After the recovery from COVID-19, antibody test provides an information about antibodies in our body so, it determines that whether the patient is eligible for plasma donation or not.

The time required for antibody test is up to 24 hours.

Meaning:

Antibodies are produced as an immune response to the COVID-19 antigen. Antibodies can act as a protective and as evidence to the exposure of SARS CoV-2 (COVID-19).

Antibodies that are produced late in the first or second week (7-10 days), IgM reaches peak at the end of 2nd week (14 days) and IgG antibody usually becomes positive after 8 - 13 days of infection and peaks around 21 days.

Longevity of IgG is not established. Therefore, retesting with IgG testing is advisable after every 3 months.

Procedure:

1. A lab technician or a physician will take a blood sample through a finger prick or by inserting a needle into a vein in the arm.

2. The blood sample of an individual is examined to identify one or more types of antibodies such as:

IgM Antibody: These antibodies take place early in an infection.

IgG Antibody: These antibodies seem later.

IgM is the first antibody present in the blood on infection where IgG antibody come across in abundance in our blood.

3. If any IgG antibody presents in body, then test is considered to positive. If not then it is considered to be negative in result.

When an antibody test is performed:

1. Between 0 to 7 days:

In this phase, only PCR and Antigen test done and detect the virus at early phase.

2. Between 7 to 14 days:

In this phase, the viral load starts decreasing and rising in the level of antibodies.

3. After 14 days:

In this phase, IgG antibodies level is high in the body even if the patient recovers from COVID-19 infection. So, antibody test gets positive.

Difference between coronavirus test and antibody test:

The Coronavirus test is also called as diagnostic test. It is performed when there are signs of active virus. Coronavirus testing is quite simple and one can get faster results than antibody testing. These tests only say about the presence or absence of virus in the body.

Antibody test is helpful in detection of past disease condition.

Drawbacks:

● Take more time for detection.

● Antibody test detects COVID-19 virus after 8 to 13 days of infection.

● The ICMR is not recommend this test for COVID-19 detection.

● This test is only performed for serosurveillance.

● An IgG antibody not having long life so this test so, this test performed after every 3 months.

Table No. 1: The various COVID-19 detection tests.[14, 15]:

Sr. no.	Parameters	RT-PCR test	Antigen test	Antibody test
1.	Detection	Detect the genetic material of COVID-19 virus that is RNA.	Detect proteins or antigen which present in virus.	Detect the antibodies which produced due to COVID-19 infection. Detection done by biological response of body towards virus.
2.	Report time	1 to 2 days	Upto 30 minutes.	Upto 24 hrs.
3.	Detection phase	Detection COVID-19 infection in early phase. (0 to 7 days of infection)	Detection COVID-19 infection in early to moderate phase. (7 to 14 days of infection)	Detection COVID-19 infection in late phase. (After 14 days of infection)
4.	Purpose	Detect the active infection.	Detect the active infection.	Detect the past infection.
5.	Accuracy	Very accurate	Accurate but further conformation needed.	Used for serosurveillance and further health planning.
6.	Cost	Much expensive	Less expensive	Less expensive
7.	Requirements	Doctor's prescription needed. Trained doctor also required.	Doctor's prescription needed. Trained doctor also required.	Doctor's prescription needed. Trained doctor also required.
8.	Advantages	Effective in individual testing.	Mass testing effective.	Use in mass screening.
9.	Sample collection	Naso or oropharyngeal swab.	Nasopharyngeal swab.	Blood sample
10.	Sensitivity	Highly sensitivity	Moderately sensitive	Use in surveillance not for diagnosis purpose.

CONCLUSION:

This review represents detailed study about diagnostic tests and provide information about their effectiveness, reliability and sensitivity. The above COVID-19 detection tests are based on the detection and diagnosis purpose. These tests are developed for the primary diagnosis and provide information about strain of pathogen. These tests also give an idea about the presence of coronavirus with immediate result (even though for some, it requires a span of day or two) and then help in selection of the treatment.

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