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Extensive Review On Covid-19

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Abstract:-Global health has been significantly impacted by the COVID-19 pandemic, which was brought on by the new corona virus SARS-CoV-2. The virus's impact on the heart is one area of worry, particularly for those who already have cardiac conditions. According to studies, COVID-19 people who have cardiac issues are more likely to become really unwell, require intensive care unit treatment, and die.

In December 2019, the first reports of COVID-19 were made in Wuhan, China. It most likely transferred from bats to people via an unidentified animal host. The virus spreads mainly through respiratory droplets from coughing, sneezing, or even talking. The time between exposure and showing symptoms (called the incubation period) ranges from 2 to 14days. Common symptoms include fever, cough, sore throat, fatigue, and difficulty breathing. Most people experience mild symptoms or may not show any symptoms at all. However, elderly individuals or those with underlying conditions may develop serious complications such as pneumonia, acute respiratory distress syndrome (ARDS), or even organ failure.

The death rate from COVID-19 is predictable to be between 2–3%, which is lower than previous corona virus outbreaks like SARS or MERS. However, COVID-19 spreads more quickly, making it harder to control. Diagnosis is mainly done using a test called RT-PCR, which detects the virus's genetic material from nasal or throat swabs. This test is considered the standard method but can sometimes give incorrect results if sample is taken too early, too late, or if it is not collected properly.

Index Terms: - SARS-CoV-2, COVID-19, RT-PCR, Pneumonia, serologic test, antigen test.

I. INTRODUCTION:-

Since the start of COVID-19 pandemic, caused by virus SARS-CoV-2, the world has taken several major steps to deal with the crisis. These include increasing the construction of personal protective equipment (PPE), promoting social distancing and mask use, and allowing emergency use of treatments like remdesivir, antibody therapies, and the steroid dexamethasone. Still, the virus continues to spread and has led to serious impacts on health, daily routine life, and the global economy. Because of this, safe & effective vaccines are crucial to help control the pandemic & bring life back to normal. In response, vaccine development for COVID-19 has happened at an extraordinary pace.

However, creating a vaccine the traditional way usually takes over 15 years, due to the complexity of designing a safe product that works for people of different ages, ethnicities, and health conditions. Vaccine

trials are often expensive and need to monitor large groups of people over time to confirm both safety and effectiveness.
Despite these challenges, COVID-19 vaccine candidates entered human trials in less than six months& some were accepted for emergency use within just 10 months - an unmatched speed in vaccine history. This fast progress was made possible by quick sharing of the virus's genetic information, use of advanced vaccine technologies, global scientific teamwork, strong funding, and high public demand. Governments, nonprofits, and pharmaceutical companies around the world provided major support for this effort. Importantly, even with this speed, the safety and approval processes followed the same strict standards as with past vaccines.
Many of the COVID-19 vaccines were built on virus's spike (S) protein, which is obtained on the surface of virus & allows it to attach to human cells by binding to ACE2 receptor. This S protein is made up of 1273 amino acids & has two main parts: S1 domain & S2 domain. The S1 region is responsible for attaching to ACE2 on human cells, helping the virus enter and infect the body. Choosing the spike protein as a vaccine target was based on earlier research on SARS & MERS, where vaccines targeting this protein showed promise in blocking the virus from infecting cells. This was also confirmed in studies showing that most antibodies in people who recovered from COVID-19 targeted either the spike protein or its RBD.

II. HISTORY:-

Corona viruses are a group of viruses with a positive-sense RNA genome & a protective outer layer. They appear round in shape, ranging from 60 to 140nanometres in size & have spike-like projections on their surface, which look like a crown under an electron microscope—hence the name "corona" (Latin for crown). Four types of coronaviruses—HKU1, NL63, 229E & OC43
However, in the past two decades, two serious outbreaks occurred due to corona viruses jumping from animals to humans. The first was in 2002–2003, when a new virus from the beta corona virus group, originally found in bats, reached humans through palm civet cats in China's Guangdong province. With a fatality rate of about 11%, this virus, known as SARS-CoV, infected 8,422 persons, primarily in China and Hong Kong& resulted in 916 fatalities.
The second major outbreak was in 2012, when MERS-CoV (Middle East Respiratory Syndrome Corona Virus), also of bat origin, emerged in Saudi Arabia. In this case, camels were the intermediate hosts. MERS infected 2,494 people & led to 858 deaths, showing a much higher death rate of 34%.
The earliest identification of a human corona virus dates back to 1960, when it was associated with the common cold. A Canadian study in 2001 reported around 500 patients with flu-like symptoms &from them 17–18 tested positive for a corona virus strain using polymerase chain reaction (PCR) techniques.
Things changed in 2003 when SARS spread rapidly to countries including the United States, Thailand, Hong Kong, Vietnam, Singapore& Taiwan. That year saw over 8,000 confirmed cases & more than 1,000 deaths. This outbreak marked a turning point for microbiologists, who began to study corona viruses more seriously to understand their transmission and disease-causing mechanisms. By 2004, both the WHO & the U.S. Centres for Disease Control and Prevention (CDC) declared SARS a public health emergency.
Further reports from Hong Kong in 2004 confirmed that out of 50 patients with severe acute respiratory symptoms, 30 were infested with a corona virus. In 2012, new cases in Saudi Arabia once again raised concerns, as MERS began to cause severe illness and deaths.
Then in late 2019, a new strain of corona virus (SARS-CoV-2) was identified in a patient with pneumonia in Wuhan, China. This virus caused the global COVID-19 pandemic. The disease spread rapidly worldwide, overwhelming healthcare systems and leading to major social and economic disruption.
As of mid-2025, while vaccination efforts and improved treatments have greatly reduced severe cases and new variants of virus continue to emerge, requiring ongoing surveillance, booster vaccinations, and public health measures.

III. EPIDEMIOLOGY:-

The virus-laden droplets can travel about 1 to 2 meters & settle on nearby surfaces. When the environment is right, virus can persist on surfaces for a few days. However, it can be quickly destroyed-often within a minute-by common disinfectants like hydrogen peroxide or sodium hypochlorite. Inhaling the droplets or touching contaminated surfaces and subsequently contacting one's face (mouth, nose, or eyes) might infect a person.

There’s also evidence that virus is present in stool. It’s suggested that if sewage water is contaminated, it could lead to transmission through aerosols or the fecal-oral route, though this is still being studied. So far, there is no strong sign of virus being passed from a pregnant woman to her baby before birth, but newborns can become infected after birth through close contact.

The time between being exposed to virus & showing symptoms (incubation period) typically ranges from 2 to 14days. The virus enters into body by assigning to ACE2 receptors, which are found on cells in the respiratory tract. The reproduction number (R_0), which tells us how many people one infected person can pass the virus to, has been estimated between 2 and 6.47 in various studies. For comparison, SARS had an R_0 of around 2, while the H1N1 flu pandemic in 2009 had an R_0 of about 1.3.

IV. PATHOPHYSIOLOGY:-

The corona virus that causes COVID-19, known as SARS-CoV-2, Once inside the body, the virus binds to a specific protein called ACE2 (angiotensin-converting enzyme 2), which is originate on surface of many cells, especially in the lungs, heart, kidneys, and intestines.

After attaching to ACE2 receptors, virus enters the host cell & begins to release its genetic material. This allows it to use the host cell’s machinery to make duplicates of itself. These newly formed viruses then exit the cell, often damaging or killing it in the process, and go on to infect nearby cells.

The initial site of infection is usually the upper respiratory tract, but in severe cases, the virus can move deeper into the lungs, causing inflammation and damage to lung tissue. This can result in pneumonia or ARDS, especially in individuals with weakened immune systems or underlying conditions like diabetes or heart disease.

As the immune system reacts to the virus, it sends out immune cells to attack the infection. In addition to lungs, COVID-19 can affect other organs due to the wide presence of ACE2 receptors. For example: In the heart, the virus can cause inflammation of heart muscle (myocarditis), abnormal heart rhythms, or worsen pre-existing cardiovascular diseases. In the kidneys, the virus may lead to acute kidney injury. In the brain, patients may experience neurological symptoms such as headaches, confusion, or even strokes in severe cases.

The gastrointestinal tract may also be affected, leading to symptoms like diarrhoea or nausea.
Growth Cycle of Corona virus (SARS-CoV-2)

1. Attachment (Binding): The virus begins its cycle by attaching itself to a host cell. The outer S protein of SARS-CoV-2 binds to a specific receptor on human cell surface called ACE2. These receptors are found in many tissues, especially in the lungs.
2. Entry (Penetration): The virus penetrates the host cell after attaching itself to the ACE2 receptor. This occurs either by endocytosis, in which virus is absorbed into the cell as a tiny bubble-like structure, or by direct fusing of viral envelope with the cell membrane.
3. Uncoating: Once within the cell, the virus releases single-stranded RNA, its genetic material, into the cytoplasm of host cell. This is where the replication process begins.
4. Replication and Translation: The viral RNA takes over the host cell's machinery to make viral proteins & more copies of its RNA. The host ribosomes (protein-making structures) are used to produce:

Structural proteins like spike, membrane, envelope& nucleocapsid proteins. Non-structural proteins that help in RNA replication.

5. Assembly: Newly made viral RNA & proteins are collected into new virus particles in a special area of the host cell called endoplasmic reticulum-Golgi intermediate compartment (ERGIC).

6. Maturation: The immature viruses go through changes in structure and become fully developed (mature) viruses as they move through the Golgi apparatus of the host cell.
7. Release (Exocytosis): Lastly, a process known as exocytosis causes the newly developed virus particles to exit the host cell. They are discharged into the extracellular space after leaving the cell in tiny sacs, prepared to infect nearby cells and start the cycle over.

V. SYMPTOMS:-

The common symptoms of COVID-19 are
• Fever.
• Dry cough.
• Fatigue.

• Taste or smell loses.	• Nasal congestion	• Diarrhoea.	• Sore throat.	• Headache.
• Joint/muscle pain.	•Different kinds of skin rash.	• Nausea or vomiting.	•Conjunctivitis (also known as red eyes).	• Chills or dizziness.

Table 01:- COVID-19 symptoms

Severe COVID-19 disease symptoms include:
• Breath shortness.
• Appetite loss.
• Confusion.
• Pressure & persistent pain in the chest.
• Fever (above 38 °C).

VI. CLINICAFEATURES:-

COVID-19 can show a varied range of symptoms. Some people have no symptoms at all, while others may experience serious conditions like severe lung problems or failure of multiple organs. The most commonly reported symptoms include fever (though not everyone gets it), cough, sore throat, headache, tiredness, body aches& difficulty in breathing. In some cases, eye irritation (conjunctivitis) has also been observed. Because these symptoms are like to other respiratory infections, it can be hard to tell them apart.
In certain individuals, the illness can worsen around the end of first week. This may lead to pneumonia, breathing failure, or even death. Such progression is linked to a strong immune response, where the body produces high levels of inflammatory substances (like G-CSF, IL-2, IL-7, MCP-1, MIP-1A,IL-10, IP-10 & TNF-α). On average, people started experiencing shortness of breath by the fifth day, needed hospital care by the seventh day, and developed severe breathing problems (ARDS) by the eighth day. Around 25–30% of patients required admission to severe care units (ICU).
Common problems included serious lung damage, shock, and kidney problems. For those who recovered, improvement usually began in 2^{nd}& 3^{rd}week. The normal hospital visit for healthier patients was about 10days. Older adults & people with existing health conditions (heart disease, diabetes or weakened immune systems) were more likely to have severe outcomes, making up about 50-75% of fatal cases. Among hospitalized adults, the death rate was reported between 4% & 11%, while the total death rate was projected to be between 2% & 3%.
Children, including newborns and infants, generally experienced much milder symptoms than adults. For example, a group of 34 children treated in a Shenzhen hospital between 19 January &7 February included 14 boys & 20 girls, with an average age of nearly 9years. Most of them caught the virus from a family member& 26 had a travel or stay history in Hubei province. About 9% of children had no symptoms, while others had only mild ones. Fever & cough were common signs. All the children recovered with basic treatment, and there were no deaths. Only one child was reported to have a severe infection with organ complication.

VII. DIGNOSIS:-

A person is considered a suspected COVID-19 case if they have symptoms like fever, cough& sore throat, along with a recent travel history to China or other regions where the virus is distributed, or if they've been in contact with someone who has travelled to such areas or has been diagnosed with COVID-19. However, not all cases show symptoms-some people may not even have a fever. A confirmed case means the person tested positive using a molecular test.

The diagnosis is made using molecular tests on samples taken from respiratory system, like throat swabs, nasal swabs, sputum, or fluids from the lungs. In some cases, virus can also be noticed in stool or blood, especially in severe infections. It's important to note that presently available multiplex PCR panels don't detect COVID-19, and commercial testing kits were initially unavailable. In India, samples from suspected cases must be sent to authorize labs, such as those linked to the National Institute of Virology in Pune. Over time, commercial testing options are expected to become more accessible.

The WBC count is usually normal or low, and many patients have a reduced lymphocyte count (less than 1000), which is linked to more severe illness. Platelet levels may be slightly low or normal. Inflammatory markers are usually raised, while procalcitonin remains normal unless there's a bacterial infection. Liver enzymes, kidney markers (creatinine), D-dimer, and muscle enzymes may be elevated in more severe cases.

Chest X-rays often show infections in both lungs, but may look normal in the early stages. CT scans are more accurate and usually reveal lung changes such as ground-glass opacities & patchy areas of merging. CT scans can even show abnormalities in patients without symptoms or signs of lung disease. In some cases, CT findings have helped diagnose COVID-19 in patients who initially tested negative but were later confirmed positive with repeat tests.

VIII. CLINICAL DIAGNOSTICS:-

Diagnosing COVID-19 begins with evaluating symptoms and any known exposure to the virus. This is done while considering the incubation period of SARS-CoV-2, which ranges up to 14days, with most people showing symptoms within 4–5 days. Common symptoms include fever or chills, coughing, trouble breathing, exhaustion, headache, muscular pains, taste or smell lose, runny or congested nose, nausea, sore throat, vomiting & diarrhea, according to the U.S. CDC. Among hospitalized patients, fever & cough are the most frequently stated symptoms. The World Health Organization (WHO) has also pointed out that sudden loss of smell (anosmia) or taste (ageusia) is quite specific to COVID-19. This may be linked to high levels of ACE2 receptors in the nose or mutations like D614G that increase how the virus replicates in the body.

Imaging tools like chest CT scans are also used alongside clinical assessments to help with diagnosis and monitoring. CT scans typically show areas of lung damage, especially in the lower parts of the lungs, and these patterns are similar to those seen in SARS or MERS. One study in Wuhan found that CT scans correctly identified COVID-19 in 97% of patients compared to RT-PCR tests, but the specificity was low, meaning false positives were possible due to overlap with other lung infections. Chest X-rays may also show hazy areas or consolidation, and ultrasound may reveal thickened lung membranes or fluid build up. However, not all patients show abnormalities in imaging, especially early in the disease.

Lab tests can also support diagnosis, although they are not unique to COVID-19. Infected patients often show reduced white blood cells and lymphocytes, increased liver enzymes, and raised points of inflammatory markers like CRP, ESR& ferritin. Severe cases are linked with high D-dimer, high neutrophil-to-lymphocyte ratio,very low lymphocyte count, low albumin, and elevated markers like IL-6, troponin, and serum amyloid A. However, these lab changes can also appear in other infections such as dengue, typhoid, or flu.

Artificial intelligence (AI) has occurred as a helpful device in COVID-19 detection. AI systems analysing CT scans have been able to distinguish COVID-19 pneumonia from other types of lung infections with high accuracy (AUC ~0.87–0.88). AI-based models using chest X-ray images also showed high sensitivity and accuracy. More advanced AI models that combine CT scans with symptoms, lab data, and exposure history have shown improved accuracy, with some models achieving an AUC of 0.92.

New AI approaches are even exploring mobile apps that use cough or breathing sounds to detect the virus early. These apps analyze sound patterns for signs of infection, though real-world testing is needed to confirm their reliability.
AI has also been applied in analysing breath samples for specific chemicals (VOCs) that may indicate COVID-19. These breath tests have shown good sensitivity (82.4–100%), though specificity varies. Factors like food intake or environmental conditions can affect results. Despite current limitations, breath-based AI tools may become fast, low-cost screening methods in the future.

A) IN-VITRODIAGNOSTICS: MOLECULAR TESTING:-

SARS-CoV-2 infection is established by detecting the virus's RNA through Nucleic Acid Amplification Tests (NAATs). The most sensitive and commonly used NAAT method is Reverse Transcription quantitative PCR (RT-qPCR). In order to detect virus, this procedure entails first removing RNA from patient respiratory samples, using reverse transcriptase to transform it into complementary DNA (cDNA)& then amplifying the viral genetic material using qPCR. This standard method takes about 3.5 to 4 hours and needs three different reagent kitsfor RNA extraction, cDNA synthesis& PCR amplificationalong with specialized lab equipment.
During the COVID-19 disease, labs around the world experienced shortages in testing reagents, especially those used for RNA extraction, as well as personal protective equipment (PPE). To overcome these limitations, some researchers tested simplified methods that skip the RNA extraction step by heating the sample directly (e.g., at70°C for 10min or 98–99°C for 5min). These methods have shown similar accuracy to standard procedures, though refining sensitivity across different sample types remains challenging.
Automated systems that perform all steps—from RNA extraction to detection—have been developed to improve efficiency and reduce contamination risks. For instance, Roche's Cobas SARS-CoV-2 systems (6800 and 8800) can process up to 384 and 1,056 samples, respectively, in an 8-hour window with high accuracy (up to 99.6% agreement with traditional RT-PCR). Similarly, Abbott's m2000 system processes 96 samples at once and delivers around 470 test results per day, showing high sensitivity (93%) and perfect specificity (100%) compared to CDC's RT-PCR test.
Other automated testing platforms include Hologic's Panther Fusion & Aptima SARS-CoV-2 assays & the Bio fire Defence COVID-19 test. These systems vary in testing volumes—up to 335, 275, and 72 samples in 8 hours, respectively—and differ slightly in testing techniques. Fusion and Bio-fire use multiplex PCR, while Aptima relies on Transcription-Mediated Amplification (TMA). Despite their differences, all three systems demonstrated strong clinical performance. The Fusion and Bio fire platforms had a positive contract of 98.7%, while Aptima showed 94.7%; all showed 100% negative contract, indicating strong specification.

B) IN-VITRO DIAGNOSTICS: ANTIGEN TESTING:-

Antigen testing is another form of diagnostic tool that shows promise for use at point care. Antigen tests, which usually use samples from nasal or nasopharyngeal swabs, identify certain proteins from the virus in contrast to molecular testing, which identify the genetic material of the virus. One major advantage of this method is its speed results can be obtained in about 15 minutes, much faster than RT-PCR, which can take several hours.
Detecting viral antigens early in infection can be especially helpful in controlling disease spread. Antigen detection relies on methods such as antibody or similar to those already used for diagnosing viruses like HIV and hepatitis B. Among the viral proteins, the nucleocapsid (N) protein is considered a strong goal for diagnostic tests because it is produced in large quantities during infection and shows limited overlap with proteins from other corona viruses, reducing the chance of false positives.
Previous experience with SARS & MERS has shown that N protein is ideal for use in a sandwich immunoassay with monoclonal antibodies. One small study using an ELISA test to detect N protein in blood of COVID-19 patients showed a 76% positivity rate before antibodies became detectable, suggesting it could be valuable for early diagnosis. However, more research is required to approve whether this is due to early bloodstream infection or excess viral protein leaking into the blood from the lungs.

Currently, two main types of antigen test kits are widely used:
Immunochromatographic test (ICT) – Uses gold-conjugated antibodies that show coloured lines if the virus is present.
Fluorescence immunochromatographic assay (FIA) – Uses fluorescent-labelled antibodies and a specialized reader for result interpretation.

IX. TREATMENT:-

The first & most vital step is proper isolation of the infected person to avoid the spread of virus to others, including family members, other patients, and healthcare workers.
Non-invasive ventilation, high-flow nasal cannulas (HFNC), face masks, or nasal prongs can all be used to administer oxygen treatment to patients with low oxygen levels. In more severe situations, extracorporeal membrane oxygenation (ECMO) or even mechanical breathing can be necessary. Some patients may also need kidney support through dialysis (renal replacement therapy). If bacterial or fungal infections are suspected, antibiotics or antifungal medications are used.
The use of steroids remains controversial. While global health bodies like the WHO do not recommend corticosteroids for COVID-19, Chinese guidelines support short-term, low to moderate doses in patients with severe lung complications (ARDS). The WHO has also issued specific recommendations for managing critically ill COVID-19 patient 75% received anti-viral such as oseltamivir, ganciclovir & lopinavir-ritonavir
The average period of non-invasive ventilation was 9 days, while mechanical ventilation lasted a median of 17 days.
In children, the disease generally remained mild and was managed with basic supportive care without the need for ICU treatment.
In contrast, the benefit of vaccination among children and young adults was marginal, largely due to their lower baseline risk of death from Covid-19. For individuals aged 0 to 19, the number of lives saved was just 0.01%, while life-years saved stood at 0.1%. For those aged 20 to 29, deaths prevented amounted to 0.07%, with 0.3% life-years gained.

X. PREVENTIONS:-

1) Effective prevention & control of COVID-19 rely on a combination of personal, healthcare, and community-level strategies aimed at reducing virus transmission.
2) Isolation of Cases: Individuals who are established or suspected to have COVID-19 should be kept separate from others to avoid further spread.
3) Physical Distancing: Maintaining a safe distance from other people lowers the chance of person-to-person transmission, particularly in busy or public areas.
4) Proper Ventilation: Improving airflow in indoor settings, such as homes and workplaces, helps dilute and remove potentially infectious particles
5) Protection of Healthcare Workers
6) Personal Protective Equipment (PPE): Frontline health workers must use protective gear such as masks, gloves, face shields, and gowns to minimize exposure.
7) N95 Respirators: During procedures that may generate aerosols, such as intubation, properly fitted N95 masks are recommended for maximum protection.
8) Routine Cleaning and Disinfection: Regular decontamination of surfaces, medical tools, and shared spaces is critical to infection control in healthcare settings.
9) Community-Based Safety Practices
10) Avoiding Crowded Places: Reducing time spent in gatherings or congested areas lowers the chance of exposure to the virus.
11) Staying Informed: Keeping up with public health guidelines and updates from reliable sources helps individuals make informed decisions about their safety.
12) Global and Scientific Response

13) Vaccine Research and Development: Continuous efforts are being developed by scientists across the world to grow effective & safe COVID-19 vaccines.
14) International Collaboration: Countries and health organizations are waged together to slow the global spread of the virus & share knowledge, resources, and strategies.

XI. VACCINE PLATFORMS:-

vaccine platform	Advantages	Disadvantages
Whole inactivated virus vaccine	Stronger immune response; Not as dangerous as live attenuated viruses	Possible modification of epitopes through the inactivation process
Live attenuated virus vaccine	Stronger immune response; Inborn antigen protection; imitating a natural infection	Risk of continuing to be virulent, especially for those with weakened immune systems
Viral vector vaccine	Stronger immune response; Protection of inborn antigen; imitating natural infection	More complex manufacturing process; Risk of genomic integration; Response diminished by pre-existing immunity against vector
Subunit vaccine	Safe & well-tolerated	Lesser immunogenicity; Necessity of adjuvant or conjugate to increase immunogenicity
Viral-like particle vaccine	Safe & well-tolerated; mimicking inborn virus conformation	Lesser immunogenicity; More complex manufacturing
DNA vaccine	Safe & well-tolerated; Stable under room temperature; Highly adjustable to new pathogen; Inborn antigen expression	Lesser immunogenicity; Difficult management route; Hazard of genomic integration
RNA vaccine	Safe & well-tolerated; Highly adjustable to new pathogens; Inborn antigen expression	Lesser immunogenicity; Necessity of low temperature storage & transportation; Possible risk of RNA-induced interferon response

Table 02:- Vaccine Platforms and Their Potential Advantages
Corona virus vaccine development: from SARS & MERS to COVID-19

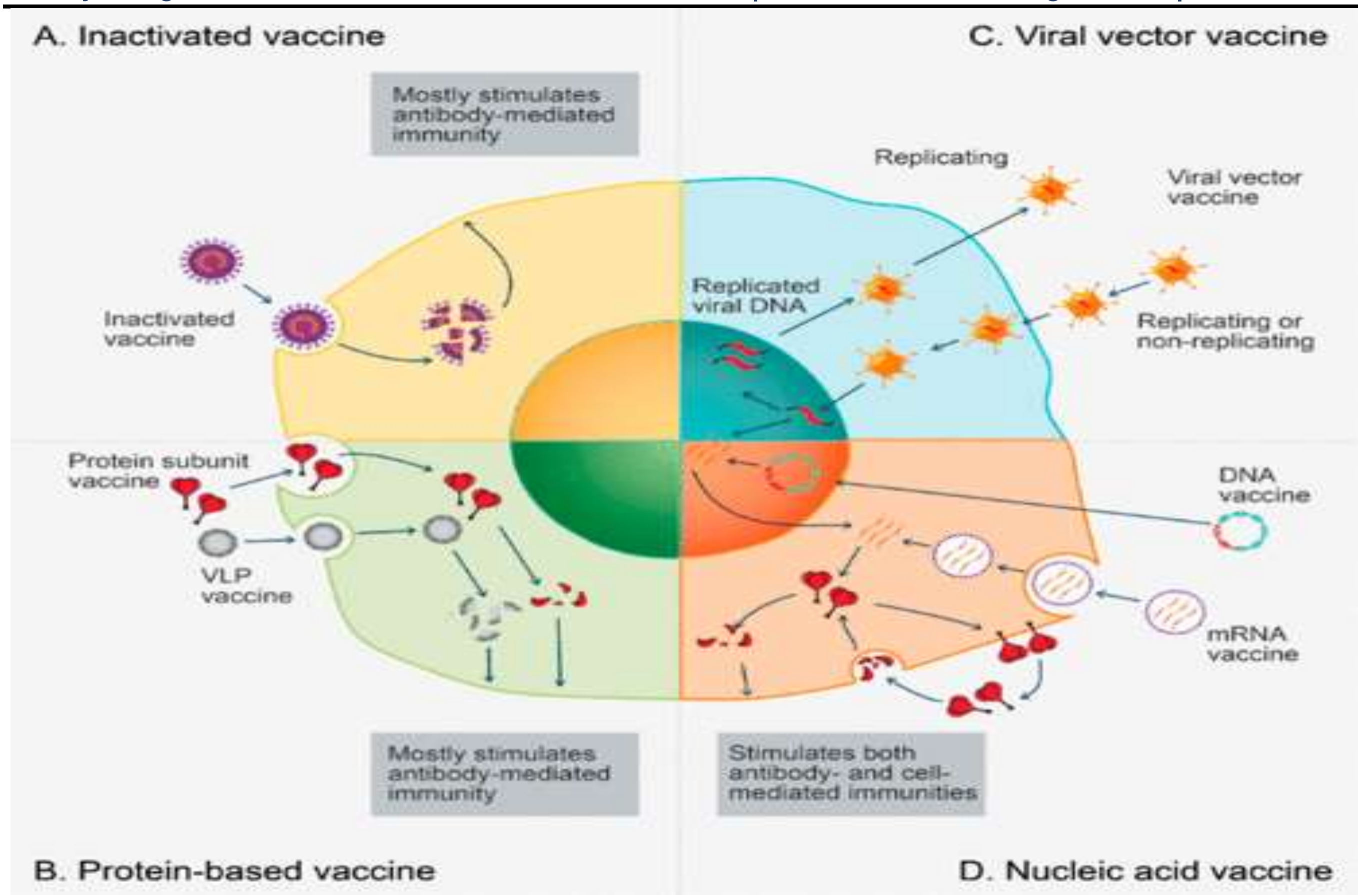

Figure 01:- Vaccine Platforms

Vaccine platforms and how they cause cells to produce immunogen. (A) When an inactivated vaccine is absorbed and digested by cells, it produces a wider range of antigens. (B) When a protein-based vaccination is absorbed by cells and converted into several epitopes, it results in a more tailored reaction to the antigen. (C) The viral vector vaccination boosts immunity and the inflammatory response while delivering DNA encoding antigens to cells. (D) The nucleic acid vaccine penetrates cells & acts as template for transcription and translation of protein antigens.

Recombinant spike protein vaccines for COVID 19 -

1. VAT00002 vaccine – the VAT00002 Sanofi – GSK COVID 19 vaccine created by Sanofi Pasture and GSK it contain SARCoV-2 spike protein that produced in insect cell
2. SCB 2019 vaccine – SCB 2019 is a protein subunit COVID 19 vaccine created by Clover Biopharmaceuticals in China.

XII. FUTURE DIRECTION:-

The accessibility of well-established diagnostic technologies has allowed scientists to quickly adapt tools for detecting COVID-19. Insights gained during the 2002 SARS outbreak played a key role in shaping strategies for identifying SARS-CoV-2. Remarkably, within just three weeks of virus first being seen under an electron microscope, scientists were able to map its genetic sequence—an achievement that took five months with the original SARS virus. This rapid progress highlights both the global scientific community's swift response and significant improvements in diagnostic capabilities between 2002 & 2020, including the widespread use of next-generation sequencing for fast genetic analysis.

Effective epidemic control depends heavily on continuous surveillance and timely sharing of public health data. With Smartphone usage rising globally smart phones have the technical capabilities to assist with real-time data collection, case reporting, and even point-of-care tests. Integrating diagnostic tools with Smartphone technology could help improve disease tracking, reduce transmission, and lower death rates.

At the same time, the safety of laboratory personnel conducting COVID-19 testing is critically important. The risk of lab-acquired infections increases when personal protective equipment (PPE) is in short supply or when proper laboratory procedures and training are lacking—situations more likely during times of crisis. To ensure a safe working environment, efforts to improve lab worker protection should go hand-in-hand with efforts to enhance diagnostic systems.

XIII. CONCLUSION:-

A grouping of clinical valuation& laboratory-based (in vitro) testing techniques are used to diagnose COVID-19. As shown in Figure 3, multiple diagnostic tools are available, and choosing the most suitable one depends on various factors like patient's symptoms, stage of infection, available lab facilities, treatment options, public health goals, and ongoing research needs.

RT-PCR remains the gold standard for confirming COVID-19. However, other methods like clinical evaluation, antibody tests, and antigen detection can support and enhance diagnosis. While antibody tests are mainly used for studying disease spread at the population level due to the delay in antibody development, antigen tests can help quickly detect cases that are currently infectious, potentially helping to reduce transmission.

The number of diagnostic tests continues to grow, with many gaining Emergency Use Authorization (EUA) from regulatory agencies like U.S. FDA. However, all new tests should undergo well-structured validation studies to ensure they perform accurately and reliably, and to support their official approval.

For effective patient care and outbreak control, there is an urgent requirement to progress in diagnostic tests that are fast, easy to use, highly accurate, and scalable for large populations. Priority should be given to affordable point-of-care (PoC) tests that can detect multiple infections simultaneously, especially in settings with limited resources.

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