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Covid-19 Vaccines: The Need of the Hour

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ABSTRACT

Coronavirus has invaded the whole world despite all necessary precautions. Several strategies and restrictions have been imposed to overcome the disease since the outbreak of covid19. To tackle this epidemic, getting vaccinated is the only effective way. Several vaccine types have been tested for covid19, including nucleic acid-based, protein-based, and whole virus-based vaccines. The clinical trial phase of several vaccines is underway, however; twenty vaccines have been used on a wide scale throughout the world, out of which six vaccines are granted in India. The current article is mainly focused on vaccines approved for use, their trials, and efficacy, and how they have been used during the pandemic to shed light on disease control.

Keywords: Vaccines, Covid19, SARS Cov2, Pandemic, Antigen, Efficacy, Immunity.

INTRODUCTION

Human beings have developed various breakthroughs and technologically advanced facilities for their comfort and healthy life. With this came a slew of new difficulties for humanity. Medical research has been effective in the previous few decades in overcoming several life infectious diseases, which were life-threatening such as plague, dengue, malaria, polio, hepatitis, chickenpox, etc. The global team of researchers, scientists, policymakers, and health care providers devised drugs and vaccines for eradicating these diseases (Delany *et al.*, 2014).

Pathogens are responsible for causing disease. They can be anything such as fungus, bacteria, parasites, or viruses (Punt *et al.*, 2019). They can cause disease by direct or indirect exposure. However, the defense mechanism of the body plays an important role to protect us against pathogens. The passage of pathogens in the body is prevented by

physical barriers such as skin layer, mucus, etc. Innate immunity forms the first line of defense. The primary exposure to pathogens activates the immune system, which destroys these pathogens and normalizes the body.

Antigens are parts of pathogens or the pathogen itself. Antigenic exposure activates the immune system and produces antibodies which, in turn, destroy antigens. A primary response occurs when the body encounters the pathogen for the first time and produces antibodies. Memory cells (T cells and B cells) are also produced during this process of the primary response, which persists in the body even after the antigen is destroyed (UNICEF, 2021). If the body comes into contact with the same antigen shortly, these memory cells will recognize it instantly and eliminate it without delay (Shah, 2021). In the secondary response, antibodies are formed faster than in the primary response and with significantly more antibodies than those made in the primary response.

At times, the body's immune system fails to destroy the antigen, necessitating the use of external supplements to boost immune response or get rid of pathogenic effects. These supplements can be in the form of medications, therapies, Vaccines, etc. Medications are the drugs used to cure the diseased condition. They are in the form of antibiotics, pain relievers, antidepressants, etc. Other strategies to encounter antigens are plasma therapy and vaccines. In Plasma therapy blood from people who have already encountered immunogen and recovered from the disease, is used to treat patients with the same antigenic disease. The plasma from the donor is collected and processed to inject into the patient suffering from the infection (ClinicalTrials.gov, 2020). Certain diseases are treated using plasma therapies such as Hemophilia, Leukemia, Autoimmune diseases, etc. However, this plasma therapy may have some risks like allergic reactions, lung damage, and infections like hepatitis B, HIV, etc.

Vaccines are the part or modified form of pathogen that stimulates the production of antibodies against the infection without causing disease (Prevention, 2021). Vaccines are made such that it produces the same response that the original virus produces when it infects the body. Vaccines are either made from the inactivated antigen or the part of antigen without actually infecting individuals but stimulating the antibody production. Vaccination is a considerable achievement in contemporary medical science (Bralić, 2018).

Composition of Vaccines:

Vaccines are composed of various ingredients apart from the fragment of a disease-causing agent or its blueprint (Fig-1). All the ingredients added for making vaccines have a specific purpose. However, the safety and effectiveness of the components are tested during each step of vaccine manufacturing. Components required for vaccine making are nearly similar and have been used for a long back (WHO, 2020).

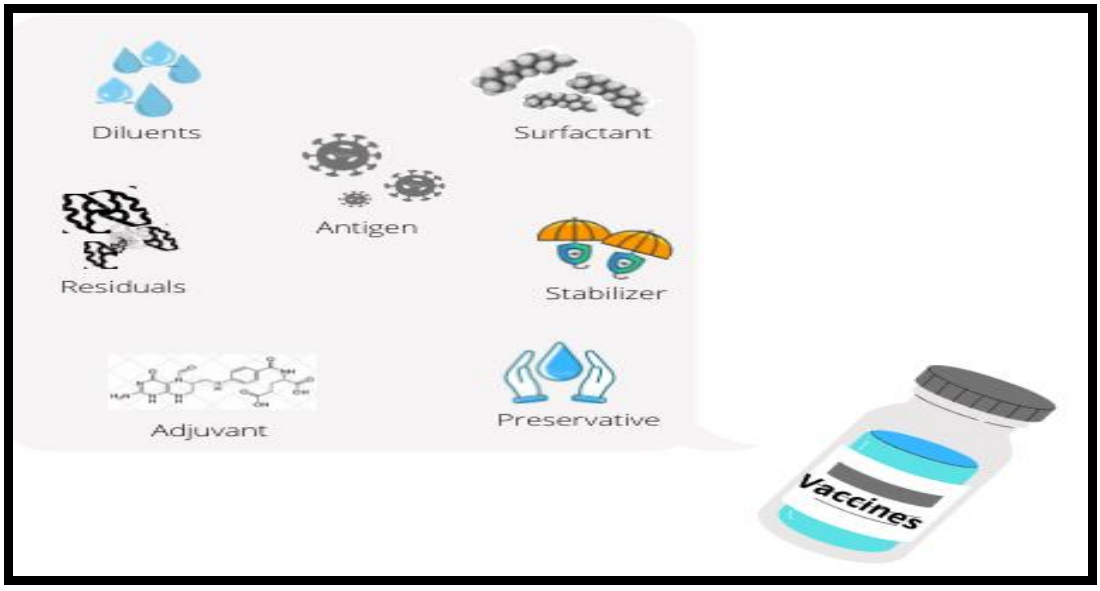

Figure 1: Components of Vaccines.

1. Antigen: Antigen is the basic component required for making any kind of vaccine. This can be the inactivated form of the disease-causing agent or any part of antigens such as nucleic acid, sugar, or protein responsible for the elicitation of an immune response.
2. Stabilizers: Stabilizers provide stability within the mixture by not allowing other components to react with each other or get stuck to the walls of the vials. It maintains the integrity of all the active components used in the vaccines. Stabilizers can be anything such as sugars, proteins, amino acids, gelatin, etc.
3. Preservatives: Preservatives are added so that no contamination could occur in the mixture once the vial is opened for use. Some vaccines may not have preservatives as they are intended for single-use which is discarded after a single shot. 2-phenoxyethanol proves to be the best choice as a preservative and is used widely in most vaccines (WHO, 2020). Preservatives are chosen such that they should not hamper the quality of the vaccine.
4. Surfactants: Surfactants prevent the settling of the components of the vaccines by reducing the surface tension of the liquid. Clumping of any of the components is blocked and is blended (Ascarateil & Dupuis, 2006).
5. Residuals: Residues are inactive components that are used in extremely tiny amounts which are counted in ppm or ppb (WHO, 2020). They are not necessarily added to all the vaccines. The addition of residuals depends on the requirement of the manufacturing process.
6. Adjuvants: Adjuvants are used to form stronger immune responses along with antigens. They form the mimic of antigen and boost the activity by producing an immune response. Salts of Aluminum are the choice for adjuvants (CDC, 2020).
7. Diluents: Sterile water is the most common type of diluent used. Diluents are added to make up the proper concentration of the vaccine before use if needed.

Ideal Vaccines have some important characteristics (Levine & Sztein, 2004).

1. Vaccines should not have any side effects on the target
2. Vaccine administered should have the desired effect
3. It should have high efficacy
4. Vaccines should have a long-term effect
5. Vaccines should be easily administrable (like non-invasive or oral)
6. It should be cost-effective.

These properties are ensured by making vaccines undergo several testing phases by the International Federation of Pharmaceutical Manufacturers & Associations, 2014. Vaccines are manufactured in different phases (Fig-2).

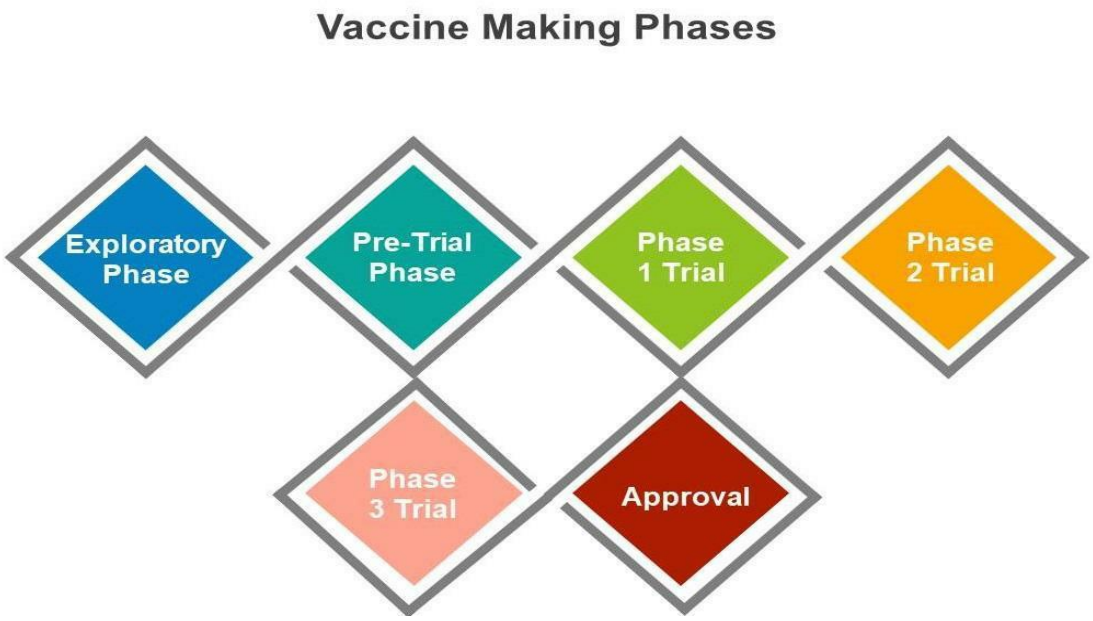

Figure 2 : Vaccine manufacturing process

1. Exploratory phase: This is also called the preclinical phase. In this phase of vaccine development, screening and evaluation are done of which antigen evokes the immune response. The arrangement of requirements is more focused in this phase.
2. Pretrial: This is the initial testing phase. In this phase, a test of the vaccine is done on animal models such as rats and monkeys to understand whether the vaccine is producing any kind of response and how long it shows its effect. In this phase, the safety level of the vaccine is also investigated. If the vaccine succeeds in producing an immune response, then it is taken for trials on human beings in three phases.
3. Phase 1 trial: In this phase of the vaccine trial, the vaccine is given to a small group of people (about100 or less) to check if it generates an immune response. The efficacy of the vaccine is a focused variable in this phase. Assessment of safety is also done. Healthy, adult and young volunteers are the choice of group.
4. Phase 2 trials: Once the phase 1 trial shows a desirable effect, the phase 2 trial is conducted. In this, a relatively larger group of volunteers are tested (hundreds to thousands of people). Effects of vaccine over sex, age, and other parameters are considered. The control group without being vaccinated is compared to the test group. The safety and effectiveness of the dose are studied thoroughly.
5. Phase 3 trial: Vaccines are given to thousands of people. In this phase also control and test groups are studied. The effectiveness of the vaccine is the main concern in this phase. In both the 2nd and 3rd phases of the study, the researcher conducts a blind study where the experimenter is not aware which group is given the vaccine and the non-vaccinated group.
6. Approval for public use: Once the phase three trial is successful, the Application of approval is submitted to the national authority that will review and approve the license. This approval is granted by the organizations such as the Centre for Disease Control (CDC), the World Health Organization (WHO), the Food and Drug Administration (FDA), etc.

The world is witnessing a pandemic, which was first reported in Wuhan, China in 2019. This pandemic is termed 'COVID19' by WHO. This virus responsible for the disease belongs to the family of Coronaviridae which causes respiratory disease (Thanh Le *et al*., 2020). The World Health Organization declared this outbreak of coronavirus as a 'Global Pandemic' on the 11th of March 2020 which is among the deadliest in history. More than 4.4 million people died due to covid19 worldwide (Worldometer, 2021; WHO, 2021).

At first, the possible medicines used against covid19 were

1. Remdesivir: It is a class of Medications belonging to a class of antivirals prescribed for the age group of 12 and above with people having an average weight greater than 40kg. Remdesivir is taken intravenously. It is a nucleotide prodrug analogous to adenosine which attaches to the RdRp (RNA-Dependent RNA Polymerase). Remdesivir inhibits viral replication (MedlinePlus, 2021). This drug causes severe reactions during and after administration of injection such as nausea, hypersensitivity reactions, elevated transaminase levels, etc.
2. Anticoagulation drugs: It is also called blood thinners. This includes certain drugs such as heparin or enoxaparin. These are given to patients hospitalized to prevent blood clots. For people who have already developed blood clots, full doses of anticoagulants are given but this causes a risk of bleeding (Rico-Mesa *et al*., 2020).
3. Dexamethasone: It is used for its anti-inflammatory and Immunosuppressive effects worldwide. It is often used in association with other corticosteroids like methylprednisolone and prednisone. It is more beneficial for patients who have severe forms of the disease (WHO, 2020). Long-term use of these drugs may lead to side effects such as cataracts, hypertension, osteoporosis, etc.

Plasma therapy was one of the options for treating Covid19 initially. In the meantime, plasma therapy and prescribed medicines proved ineffective in curbing this diseased condition (Indian Council of Medical, 2020).

Prevention and control involved seeking medical attention to symptomatic patients. Other than these other tasks involved monitoring of asymptomatic infections, regular follow-ups, close contact tracking, high-risk population inspections, monitoring of patients after cure and discharge, and disinfection of the epidemic source. But the only way for the effective

control of COVID-19 infections is by vaccination (Blankestijn & Meijvis, 2020).

The vaccine for covid19 is the fastest made vaccine in the history of medical science in less than 1 year (Fauci, 2021). The first launch of the vaccine by the UK was done in December 2020 after the disease outbreak in Nov 2019.

Forms of vaccine:

Vaccines are made by using different methods. The following shows various forms of vaccines (Services, 2021).

1. Whole virus vaccine: -

In this form of the vaccine, the whole virus is used as a stimulant to trigger an immune response. This type of vaccine produces the best response. This can be done by weakening the ability of viruses to infect but can produce the desired response (World Health Organization, 2021). This is called a live attenuated form of the vaccine. Weakening of virus or bacteria potency is achieved by genetic modification or by heat killing (traditional method). However, these vaccines can be ineffective in certain situations where the person is unable to produce an immune response due to low immunity or having underlying diseased conditions.

Another method of whole virus vaccine includes inactivation of the genetic material of virus or bacteria so that they could not replicate and make copies but can produce an immune response.

2. Protein subunit vaccines: -

These types of vaccines do not use the whole pathogen instead use a small part of the pathogen that can be used to generate an immune response. The advantage of this type of vaccine is that it produces antibody smaller antigenic parts which are highly specific (World Health Organization, 2021). Although the disadvantage, when compared with the whole virus vaccine, is that it produces a weak and short-lived response and so it requires adjuvants to increase the immune response.

Recombinant protein vaccine:

These are Vaccines prepared by using bacterial or yeast cells. A small piece of Genetic material is taken which is then inserted in bacteria or yeast, on replication this makes protein from pathogen as well which is further isolated and used as an active constituent in the vaccine.

Toxoid vaccines:

Certain pathogens release toxins after entering the host. These toxins produce the same effect which is produced by the whole virus or part of it. These toxins are used in some vaccines which produce strong immune responses. These toxins are inactivated before using it in vaccines which will not harm. This inactivated form is called 'Toxoid'

Conjugate vaccines:

Polysaccharides are attached to the stronger proteins in conjugate vaccines. The proteins act as carriers for these polysaccharides. An immune response is formed against these polysaccharides which form the protective outer covering of pathogens. These polysaccharides are recognized as foreign material and antibodies are generated.

3. Nucleic acid vaccines: -

These vaccines are easy to develop. Genetic material from pathogens is used in nucleic acid vaccines instead of the whole pathogen or part of it. This genetic material after entering the cell utilizes the cell's natural protein-making mechanism and produces protein. This protein is the same as that of pathogens. Genetic material can be either DNA or RNA depending on the type of pathogen (World Health Organization, 2021).

RNA vaccine:

mRNA enclosed in the lipid membrane is used for RNA types of vaccines. This lipid membrane provides stability and also facilitates entry into the cell. These types of vaccines are less compatible as they are not capable of combining with human genetic code.

DNA Vaccines:

DNA is comparatively much more stable than RNA so enclosing it into a lipid membrane is not required. Pathogenic DNA is incorporated into the host by the process called electroporation. Once it enters the Host cell, DNA is transcribed to mRNA before being translated into the pathogenic protein.

4. Viral vector: -

Viral vector vaccines use harmless vectors as carriers for antigens in the body. Once entered the body produces an immune response against the antigen.

These types of vaccines are easy to make and relatively cheaper compared to other types of vaccines (World Health Organization, 2021).

Replicating vector vaccines:

Replicating vectors tend to make copies of pathogens other than acting as vectors. The edge of using replicating vectors is that it provides an antigenic source for a longer duration which results in an extended immune response.

Non-Replicating Vector vaccines:

Non-replicating vectors cannot make copies. This is done by modifying the vector so that it could not make copies. The advantage of using this kind of vector is that the adverse effects associated with the viral vectors are minimized or eliminated. However, the effect shown by this type of vaccine remains as far as the effect of the initial dose remains. To be effective there is always a need for taking a dose after some time.

Vaccine origin and type

A diverse group of vaccines came into the market for Covid 19, vaccine candidates, vaccine forms, vaccine developers, and the country where they originated (Table -1).

Comparison of Different Vaccines

Comparison of the amount of dose, number of doses needed, the preventive ability of the vaccine, the recommended age group for vaccination, and the severity of any side effects were represented in table - 2.

Table 1 Shows different vaccines, types, developers, and countries of origin of vaccines against Covid-19.

Name	Vaccine Type	Primary Developers	Country of Origin
Comirnaty (BNT162b2)	mRNA-based vaccine	Pfizer, BioNTech; Fosun Pharma	Multinational
Moderna COVID-19 Vaccine (mRNA-1273)	mRNA-based vaccine	Moderna, BARDA, NIAID	US
COVID-19 Vaccine AstraZeneca (AZD1222); aka Vaxzevria and Covishield	Adenovirus vaccine	BARDA, OWS	UK
Sputnik V	Recombinant adenovirus vaccine (rAd26 and rAd5)	Gamaleya Research Institute, Acellena Contract Drug Research, Pfizer that approve development	Russia
Sputnik Light	Recombinant adenovirus vaccine (rAd26)	Gamaleya Research Institute, Acellena Contract Drug Research, Pfizer that approve development	Russia
COVID-19 Vaccine Janssen (JNJ-78436735; Ad26.COV2. S)	Non-replicating viral vector	Janssen Vaccines (Johnson & Johnson)	The Netherlands, US
BBIBP-CorV	Inactivated vaccine	Beijing Institute of Biological Products; China National Pharmaceutical Group (Sinopharm)	China
Epi Vac Corona	Peptide vaccine	Federal Budgetary Research Institution State Research Center of Virology and Biotechnology	Russia
Covaxin (BBV152)	Inactivated vaccine	Bharat Biotech, ICMR; Ocugen	India
Convidicea (PakVac, Ad5-nCoV)	Recombinant vaccine (adenovirus type 5 vector)	CanSino Biologics	China
WIBP-CorV	Inactivated vaccine	Wuhan Institute of Biological Products; China National Pharmaceutical Group (Sinopharm)	China
CoviVac	Inactivated vaccine	Chumakov Federal Scientific Centre for Research and Development of Immune and Biological Products	Russia

Table 2 Continued…

Name	Vaccine Type	Primary Developers	Country of Origin
ZF2001	Recombinant vaccine	Anhui Zhifei Longcom Biopharmaceutical, Institute of Microbiology of the Chinese Academy of Sciences	China, Uzbekistan
QazVac (QazCovid-in)	Inactivated vaccine	Research Institute for Biological Safety Problems	Kazakhstan
SARS-CoV-2 Vaccine, Inactivated (Vero Cell)	Inactivated vaccine	IMBCAMS, China	China
Sinovac: CoronaVac	Inactivated vaccine	Sinovac Life Sciences Co, Ltd	China
NOVAVAX (NVX-CoV2373/Covovax)	Recombinant type	Novavax, Inc	US
SANOFI (CoV2 preS dTM-AS03 vaccine)	Recombinant type	Sanofi Pasteur	France
SCB-2019	Recombinant type	Clover Biopharmaceuticals	China
CvnCoV (CV07050101)	mRNA based	The German Federal Ministry of Education and Research (BMBF) or Coalition for Epidemic Preparedness Innovations (CEPI)	Germany

Source: RAPS -Regulatory Affairs Professionals Society's COVID-19 vaccine tracker and Status of COVID-19 Vaccines within WHO EUL/PQ evaluation process

Table 3 Showing dose, schedule, efficacy, recommended age group, and side effects of different vaccines

Name	Amount of Dose	Number of dose and time interval	Recommended Age group	Severe side effects
Comirnaty (BNT162b2)	0.3 ml/dose	2 Doses (Min 21 days apart)	12 years and above	Severe allergic reactions (Who, 2021)
Moderna COVID-19 Vaccine (mRNA-1273)	0.5 ml/dose	2 Doses (Min 28 days apart)	18 years and older	Severe Hypersensitivity Reaction to a Drug (Who, 2021)
COVID-19 Vaccine AstraZeneca (AZD1222) aka Vaxzevria and Covishield	0.5 ml/dose	2 Doses (Min 84 days apart)	18 years and older	No severe side effects (Who, 2021)
Sputnik V	0.5ml/dose	2 Doses (Min 21 days apart)	Effective for all age groups	Severe allergic reactions (Dr.Reddy's, 2021) (On hold for further assessment)
Sputnik Light	0.5-0.8 ml	1 Dose	18 years and older	No severe side effects (Bhardwaj, 2021) (On hold for further assessment)
COVID-19 Vaccine Janssen (JNJ-78436735; Ad26.COV2.S)	0.5 ml/dose	1 Dose	18 years and older	No severe side effects (Vaccine & S, 2021)
BBIBP-CorV	0.5ml/dose	2 Dose (Min 28 days apart)	18 years and above	Serious nausea, Acute disseminated encephalomyelitis, Thrombosis (Who, 2021)
EpiVacCorona	0.5ml/dose	2 Dose (Min 21 days apart)	18 and above	No severe side effects

Table 4 Continued…

Name	Amount of Dose	Number of dose and time interval	Claimed Efficacy	Recommended Age group	Severe side effects
Covaxin (BBV152)	0.5 ml/dose	2 Doses (Min 28 days apart)	77.80%	18 and above	No severe side effects
Convidicea (PakVac, Ad5-nCoV)	0.5ml	1 Dose (Min 21 days apart)	90.07%	18 and above	No severe side effects (Ongoing assessment)
WIBP-CorV	0.5ml/dose	2 Doses	72.80%	18 and above	Serious nausea and Inflammatory Demyelination Syndrome
CoviVac	0.5 ml/dose	2 Doses (Min 28 days apart)	80%	18 and above	No severe side effects
ZF2001	0.5 ml/dose	2-3 Doses	Under clinical trial	18 and above	No severe side effects
QazVac (QazCovid-in)	0.5ml/dose	2 Doses (Min 21 days apart)	96%	18 and above	No severe side effects
SARS-CoV-2 Vaccine, Inactivated (Vero Cell)	0.5ml/dose	2 Doses (Min 21- 28 days apart)	Under clinical trial	18 and above	No severe side effects
Sinovac: CoronaVac	0.5ml/dose	2 Doses (Min 21- 28 days apart)	51% against symptomatic and 100% for preventing hospitalization	18 and above	No severe side effects
NOVAVAX (NVX-CoV2373/Covovax)	0.6ml/dose	2 Doses (Min 21days apart)	Under assessment	18 and above	No severe side effects
SANOFI (CoV2 preS dTM-AS03 vaccine)	0.5ml/ dose	2 Doses (Min 21days apart)	Under assessment	18 and above	No severe side effects
SCB-2019	0.5ml/ dose	2 Doses (Min 21days apart)	Under assessment	18 and above	No severe side effects
CvnCoV (CV07050101)	0.5ml/ dose	2 Doses (Min 21days apart)	Under assessment	18 and above	No severe side effects

Source-NIH(https://clinicaltrials.gov/), RAPS(https://www.raps.org/news-and-articles/news-articles/2020/3/covid-19-vaccine-tracker), FDA(https://www.fda.gov/emergency-preparedness-and-response/coronavirus-disease-2019-covid-19/covid-19-vaccines)

Vaccines in India

India has ventured on the largest vaccine drive in the world. Before COVID 19 vaccine drive, India has successfully administered the Polio vaccine reaching across the length and breadth of the country. Smallpox was the first infectious disease to be eradicated through vaccination.

Vaccination for Covid19 in India was strategized using a systematic and scientific approach. The vaccine was prioritized first for more vulnerable groups. The vulnerable groups included healthcare workers or those who work at the frontline during this Covid19 pandemic, old age people, people with certain diseases, etc. (Ministry of health and family welfare, 2021). The vaccination drive was initiated in different phases (Fig-3).

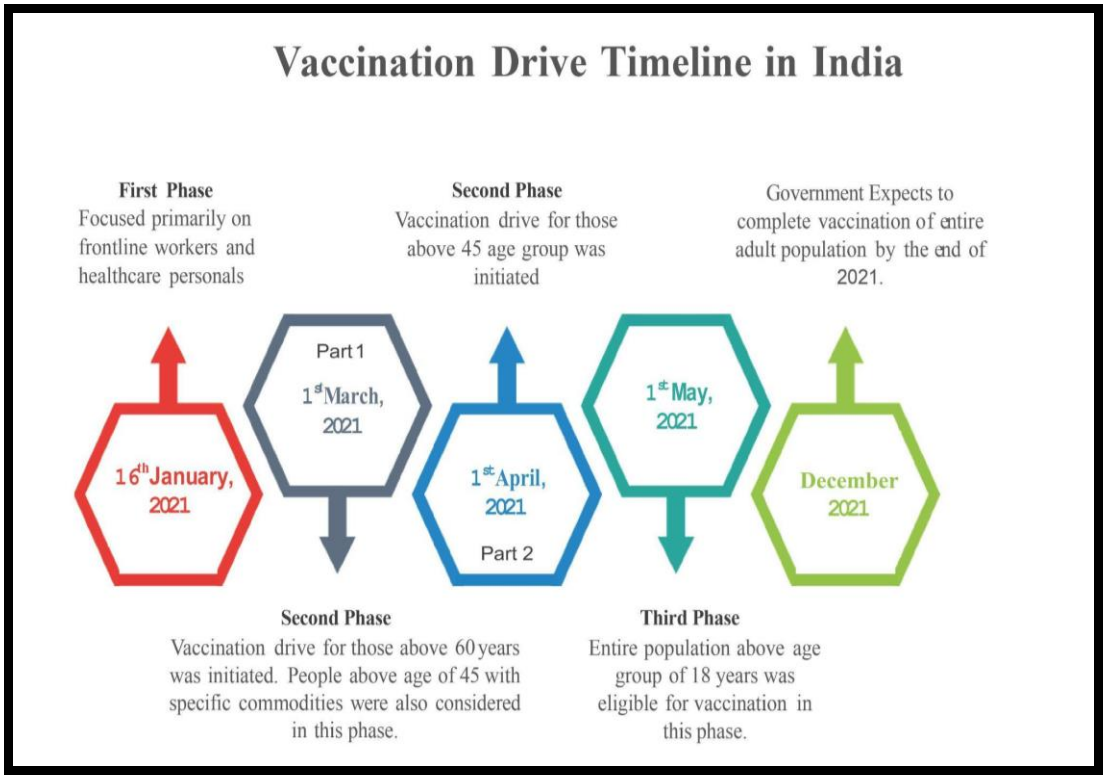

Figure 3 Vaccine drive timeline in India.

There are about six vaccines at present that are approved for use in India.

1. Covishield:

Covishield was developed by Oxford University in partnership with British-Swedish firm AstraZeneca. It is manufactured in India on a large scale by the Pune-based Serum Institute of India.

This vaccine got approval on the 1st of January, 2021 in India.

Covishield is based on viral vector type. Complete vaccination is considered by taking two doses of the Covishield vaccine.

Many countries have allowed travelers only if they are vaccinated with Covishield. The vaccine is restricted for the second dose if it shows a severe allergic reaction after administration of the first dose.

No trial for children's vaccination is being conducted so far (Poland *et al*., 2021).

Composition:

Components of the vaccine include L-Histidine hydrochloride monohydrate, Polysorbate 80, Ethanol, L-Histidine, Sucrose, Magnesium chloride hexahydrate, Sodium chloride, Disodium edetate dihydrate (EDTA), Water for injection (Serum Institute of India, 2021).

2. Covaxin:

Covaxin is an indigenous vaccine produced by Bharat Biotech International Limited in collaboration with the Indian Council of Medical Research (ICMR) and the National Institute of Virology, Pune.

The vaccine was approved for use on 3rd January 2021.

Covaxin is an inactivated vaccine type. The vaccine is administered in two doses with a time interval of 4 weeks.

The fact sheet released by Bharat Biotech suggests that the vaccine should not be taken with the immune system-compromised population.

Covaxin is under trial for children of age 2-17(Bharat Biotech, 2021).

Composition:

Whole-virion inactivated SARS-CoV-2 antigen (Strain: NIV-2020-770), and the other inactive ingredients include aluminum hydroxide gel, TLR 7/8 agonist (imidazoquinolinone), 2-phenoxyethanol, buffer saline, and phosphate (Bharat Biotech Covid-, 2021).

3. Sputnik V:

Sputnik is another vaccine that got approval on the 12th of April, 2021. About three million doses are

already provided by Russia to India. It is also expected that this vaccine will be produced locally by August.
It was originally developed by Gamaleya National Research Institute of Epidemiology and Microbiology in Moscow, Russia, in partnership with the Russian Direct Investment Fund. It is also based on viral vector type. Sputnik V is administered in 2 doses with a time interval of about 4 weeks.

Composition:
Recombinant adenovirus serotype 26 particles containing the SARS-CoV-2 protein S gene Particle. Tris (hydroxymethyl) aminomethane, sodium chloride, sucrose -, magnesium chloride hexahydrate, EDTA disodium salt dihydrate, polysorbate, ethanol 95%, water for injection (Dr. Reddy's, 2021).

4. Moderna Vaccine:
Moderna vaccine has been authorized for use in India in June 2021. The vaccine is produced by Moderna TX, Inc.
The Vaccine is based on mRNA type and administered as 2 shots with a time interval of about 4 weeks.

Composition:
Messenger ribonucleic acid (mRNA), lipids (SM-102, polyethylene glycol [PEG] 2000 dimyristoyl glycerol [DMG], cholesterol, and 1,2-distearoyl-sn-glycero-3-phosphocholine [DSPC]), trimethamine, trimethamine hydrochloride, acetic acid, sodium acetate trihydrate, and sucrose ((FDA)., 2020).

5. Johnson & Johnson's (JNJ.N):
The Vaccine got approval for use in India on the 7th of August, 2021. It is a viral vector type of vaccine which is administered as a single dose and seen that the effect lasts for a longer period compared to other vaccines. However, no delivery schedule has been given yet by the manufacturer (REUTERS, 2021).

Composition:
Recombinant, replication-incompetent Ad26 vector, encoding a stabilized variant of the SARS-CoV-2 Spike (S) protein, Polysorbate-80, 2-hydroxypropyl-β-cyclodextrin, Citric acid monohydrate, Trisodium citrate dihydrate, Sodium chloride, Ethanol (Johnson & Johnson, 2021)

6. Zydus Cadila:
The approval for the vaccine was given on August 20th, 2021. It is the world's first DNA-based Vaccine. The target population age group is 12 years and above. This vaccine is likely to be administered in three doses. This is the first vaccine that got approved for children (REUTER, 2021). The efficacy rate for the Zydus Cadila vaccine is 66.6%.
Below is a graph that shows the number of Vaccine doses administered by August 2021 in different states in India.

Reported Side effects of the Vaccines:
Even though vaccines are made to prevent disease, they may in some instances have mild/ severe side effects, depending on variable factors.

Commonly seen side effects of covid19 vaccines are pain, redness or itchy rashes, and swelling over the hand on which the vaccine is injected. While other side effects on other body parts include tiredness, headache, muscle pain, chills, fever, nausea (Astrazeneca, 2021). These effects are seen in all the vaccines approved so far. Side effects may last up to a few days.

Some vaccines also show some rare effects such as severe allergic reactions, anaphylaxis, and other severe respiratory problems. According to the Centre for Disease Control (CDC), these effects are extremely rare and are seen in 4-7 people per 1 million.

Concluding Remarks:

There are about 20 vaccines that have been approved for mass distribution worldwide by the authorities. Six vaccines are approved for use in India as of now.

All the Covid19 vaccines have shown promising effects against the disease in reducing the severity of Covid19. Although all vaccines differ in terms of their key component, efficacy, and safety profile (Yan & Yang, 2021). mRNA-based vaccines have shown promising effects with an average efficacy rate above 90% followed by Protein subunit-based vaccines. However, mRNA vaccines require extreme cold chains that put them last for logistics. Viral Vector vaccines are easy to make in a large amount within a short period which puts them in the first place in case of price (Ventures *et al*., 2021).

Vaccine efficacy rates vary between more vulnerable groups and those who are free from any underlying medical condition (Delany *et al*., 2014). Vaccines made

by Pfizer, Moderna, AstraZeneca, and Janssen are found to be effective against all variants of the virus. AstraZeneca's vaccine is the one that is authorized by a maximum number of countries (118) (Covid 19 Vaccine Tracker, 2021).

However, all the approved vaccines are safe and efficiently downregulate the severity of the disease. Vaccines have given hope to millions of people, and very soon we will wake up in a pandemic-free world with life and economic activities assuming normalcy.

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