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INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/16347
DOI URL: http://dx.doi.org/10.21474/IJAR01/16347

RESEARCH ARTICLE

A SYSTEMIC REVIEW COVID-19 VACCINE

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Manuscript Info

Manuscript History
Received: 26 December 2022
Final Accepted: 30 January 2023
Published: February 2023

Key words:-
ZYCOV-D (Zydus Cadila), COVAXIN (Bharat Biotech), COVISHILED (Serum Institute of India), COVAVAX (Serum Institute of India), BNT162b2(Pizer and Biotech)

Abstract

One of the biggest issues facing the world now is the COVID-19 epidemic. Since there was neither a specific treatment nor a specific vaccine at the time, various pharmaceutical companies—particularly Indian pharmaceutical companies—started developing an effective COVID-19 vaccine. There are many different types of vaccines, including those based on DNA, mRNA, R-DNA technology, proteins, and inactivated viruses-based vaccines. These vaccines are all made by an Indian pharmaceutical business. Following the development, the Indian Council of Medical Research (ICMR), the Drug Controller General of India (DCGI), the Food and Drug Administration, and the WHO approved the use of the vaccine for clinical trials and emergencies. After three trials, an Indian-made vaccine shows high efficacy. The fundamental function of the vaccine is to activate CD8+ cytotoxic T-cells and trigger B-cell clone growth. Lead cytogeneses IL-5 and IL-4 promote IgG antibodies, which strengthen our protection against COVID-19 and its variations.

Introduction:-

COVID-19 initially appears in the Chinese city of Wuhan. COVID-19 caused severe acute respiratory syndrome coronavirus-2 (SARS-COV-2) with 192 million cases and 4.1 million deaths worldwide. COVID-19 causes infections for more than three days and asymptomatic infections for three weeks. COVID-19 originally appeared about 2020, at a time when no specific therapy was available, thus various old vaccination treatments and antiviral medicines such as remdesivir, lopinavir, dexamethasone, and ritonavir were employed; nevertheless, effective treatment and drugs are recommended [1-7].

SARS-COV-2 spike protein (S) S1 subunits binds with ACE-2 Angiotension conversion enzyme-2 identical site receptor binding sites also known as receptor binding site (RBS) in SARS-COV-2 host cells. The host transmembrane serine-2 (TMPRSS2) and host endosomal cytosine proteases cathepsins B and L (cat B/L) were then activated [1,4,5]. MERS-CoV (an older variant of SARS-CoV-2 that utilized dipeptidyl peptidase or DPP4 as the host receptor) may be beneficial in the creation of an effective vaccine against SARS-CoV-2 utilising any of the existing vaccine production platforms.

To create a vaccine, first, select an immunomodulatory drug and then include antibodies from COVID-19 patients. There are different type (fig-1) of vaccine like a Protein-based vaccinations, RNA-based vaccines, DNA-based vaccines, non-replicating vaccines, vaccines that imitate viruses, and R-DNA-based vaccines are available. [3, 6, 9].

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Zycov-D is a DNA technology-based vaccine manufactured by Zydus Cadila of India. It is administered in a single dose and has shown overall good efficacy in clinical results. Zycov-D vaccination demonstrated 94% efficacy against COVID-19 in individuals aged 16 to 60. ZYCOV-D vaccine is a DNA plasmid (E.coli plasmid) vaccination that encodes spike protein. These plasmids include unmethylated patterns, which improve immunostimulatory characteristics [8]. A vaccine is administered intravenously using a spring powered injection [9] because vaccine requires traversing the cell's plasma membrane and nuclear membrane [10].

COVISHIELD is a recombinant DNA technology-based vaccine and is manufactured by the serum instate of India. A vaccine made from replication-deficient chimpanzee adenovirus vector encoding the SARS-CoV-2 Spike (S) glycoprotein. A vaccine is an effect in the genetic material of the part of coronavirus is expressed which stimulates an immune response. Vaccines showed good clinical outcomes 67% (95% (CI): 57%-94%) and after the second dose, 100% (72-100%) prevent COVID-19 infarction [12].

COVAXIN is manufacture by BHARAT BIOTECH by using whole-virion inactivated vero-cells derived platform technology. According to the clinical outcomes after the second dose, COVAXIN is 93% effective against COVID-19. Alhydroxiquim-II, a vaccine adjuvant, is used in conjunction with the vaccination to enhance the immune response and offer longer-lasting protection [14].

COVAVAX is created utilizing recombinant DNA technology and the baculovirus expression system, and insect cells are derived from old cells. NOVAVAX, the new name for COVAVAX, is created by employing a protein that closely resembles the viral version S spike protein. According to their testing, COVVAX made using serum institute in India is more than 90% efficient [15].

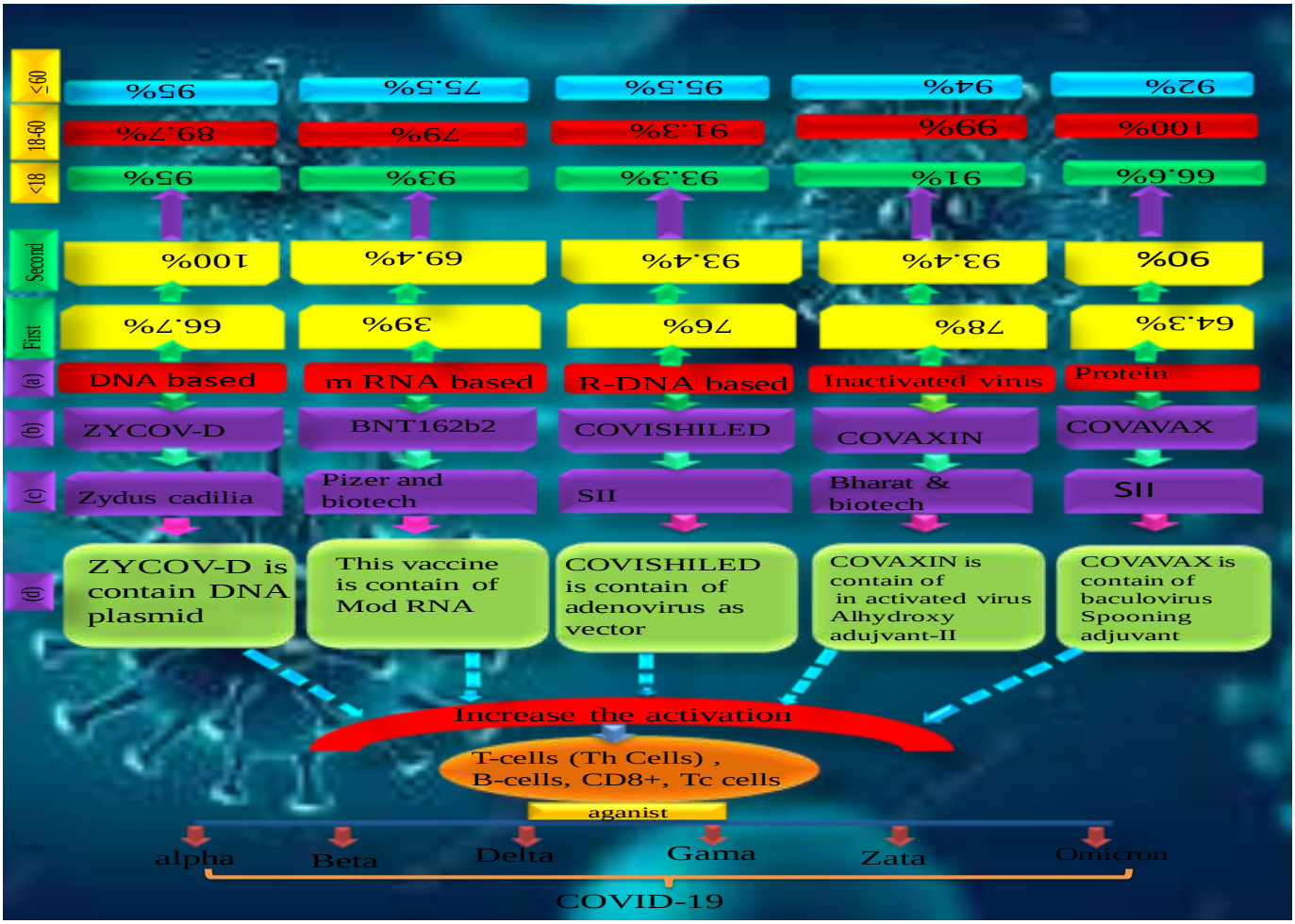

Fig 1:- Is describe all Indian vaccine in details and against COVID-19 variants.

Method:-

This systematic review reported all clinical data outcomes, fig-3, 4, 5, 6,7,8, 9, 10 in this figure is shown Indian made vaccine efficiency shown overall 100% against COVID-19 and their variants. Indian made vaccine like ZYCOV-D, COVAXIN, COVISHILED, COVAVAX, BioNTech SE clinical outcomes is show on their websites and different research papers, this all result included in this review paper.

Search strategy and eligibility criteria:

In this systematic review search on electronic bibliographic databases: PubMed, Embase, Web of Science, and the Cochrane Central Register of Controlled Trials. Figure show Detail efficiency of vaccine. In this systematic search were applied vaccine efficiency,vaccine protocols, vaccine mechanisms of all vaccines.

To be included in this systematic review prospective or retrospective meet all following topics (1) vaccine approval for using clinical trials, (2) vaccine mechanism and their clinical out comes, (3) vaccine efficiency

Protocols:

India's National COVID Vaccination Program is built on scientific and epidemiological evidence, WHO guidelines and global best practices. Anchored in systematic end-to-end planning, it is implemented through effective and efficient participation of States/UTs and the people at large.

Fig 2:- Is show Indian vaccine types.

Vaccine:

The newly discovered RNA beta-strand virus COVID-19 is caused acute respiratory syndrome SARS-COV-2, SARS-COV-2 spike protein is bound to angiotensin convert enzyme (ACE-2) and receptor binding site (RBD)[53]. The host-transmembrane serine-2 (TMPR552) and the host endosomal cysteine proteases cathepsins B and L (catB/L) have hidden a region of the SARS-COV-2 virus's primary protein with glycan. The host receptor exploited by SARS-COV-2 was DPP4. This component is crucial for the production of vaccines [16].

The adjuvant is not present in the new generation of vaccines developed utilizing R-DNA technology. A new vaccine is created by combining viral DNA and lipid nanoparticles of the S-protein, two distinct vectors that carry

the S-DNA protein's gene to the host cell [5]. After receiving a vaccination, the adaptive immune system creates a defense using MHC molecules.

MHC have two type MHC-II is found on APC these compromised b-cells, macrophages and lymph nodes. S-protein which is present on cells surface MHC-II molecules and native hapler T-cells (Th-cells) T-cells receptor (TCR) complex interact with this antigen leading activation of CD4+ Th-cells, Secondly activation of B7 on APC the CDC-28 on Th-cells that can recognize S-protein antigens. Vaccine activated CD4+ Th-cells then released cytogenesis and interleukin (IL-2) is activates CD8+ cytotoxic T-cells and triggide clonal expansion of B-cells, Lead cytogeneses IL-5 and IL-4 promotion of IgG antibodies against S-protein [8], as result increasing immune response against virus. Then in second step MHC-I activates CD8+ native TC-cells through TCR complex interaction with S-protein expressed in nucleated cells, APCs, and platelets vaccine leads activation IL-2 from activates CD4+ Th cells which is lead cytotoxic response against SARS-COV-2 and its variants [6].

RNA cased vaccine:
Moderna and Pizer NBiotech's BNT12b2 vaccines are m RNA-based vaccines. The end coding of the spike protein (S) is present in SARS-COV-2. Consequently, the vaccine produces a particular protein that prompts an immune response against the SARS-COV-2 virus. The primary ingredients of this vaccine, which causes the breakdown of end codes, are phosphocholine and cholesterol complexed with lipid nanoparticles (LNPs) and polyethylene glycol (PEG).

This vaccine is preserved using salt (potassium chloride and monobasic potassium phosphate dehydratase) as a buffer and sugar to keep it cool. DNA fragment with immunogen open regarding frame (ORF) connected S' is the untranslated region (UTR) and their template on T7 RNA encoding SARS-COV-2 spike protein. Purification of the m RNA by vaccine enzymatic addition [17-20].

BION Tech and Phizer manufactured the BNT162b1 vaccine. At the currently recommended vaccination dosages of 10, 30, or 100 g, the RBD-binding IgG SARS-COV-2neutrlazation antibody titers seem to be sufficient. SARS-COV-2 adverse effects of moderna and Phizer Bio NTech (fig 2). Furthermore, m RNA-based vaccinations demonstrated excellent effectiveness.

DNA based vaccine:
DNA-based vaccines are based on hormone and cell-mediated immunity and are created using genetic components. SARS-COV-2 translocated into the host nucleus and deactivated transcription and vaccine transcription in the host [21]. Mycocytes' immunity is elicited by a DNA-based vaccination given to APC through MHC singling. This, in turn, promotes interferon (INF-) production during viral infection within the host, and CD+4 HEPLER T-cells generate IL-10, IL-12, and TNF-, while CD4+ creates IL-4. Through DNA vaccination, led expression plasmid PGX001, antigene transfer from monocytes to professional APCs significant to cytotoxic T-cells elicits synthesis of S protein reactive RBG, IgG, and T-cell response [22-28].

ZYCOV-D (Zydus Cadila of India):
The ZYCOV-D vaccine is made in India by Zydus Cadila and is based on plasmid DNA technology. The business employed Chimpanzee adenovirus, Moderna, and Pfizer as their vaccines [9]. This vaccination caused a cell-mediated response that rendered infectious pathogens inert. The endogenous route that the vaccine processes results in the activation of B- and T-cell responses. Activated lymphocytes also produce and kill pathogen cells. ZYCOV-D is a DNA-containing gene that is reactive due to proper polypeptide folding and produces antigens over an extended period. The first round of the studies will take place in 2020 and will involve participants between the ages of 18 and 55. After the second dosage showed 100% efficiency, the vaccine's efficacy was 66.7% (95% (CI) 147.6-80.7) [29].

Pfizer and biotech vaccine (Biotech SE (Nasdaq: BNTX), and BNT162b2)
Pfizer and Biotech administered the first dosage described in fig-3 following the vaccine's successful inoculation in 38% (29-45%) (Alpha variation), 17% (10-23%) (Beta variant), and 30% (17-41%) (Delta) of asymptomatic subjects. The prevalence of symptoms was 27% (13–39%) (Alpha variation), 43% (22–59%) (beta and Gama), and 33 %(15–47%). (Delta). Hospitalization affects 83% (62-93%) of the alpha, 56% (82%) of the gamma, and 33% (15-47%) of the delta.

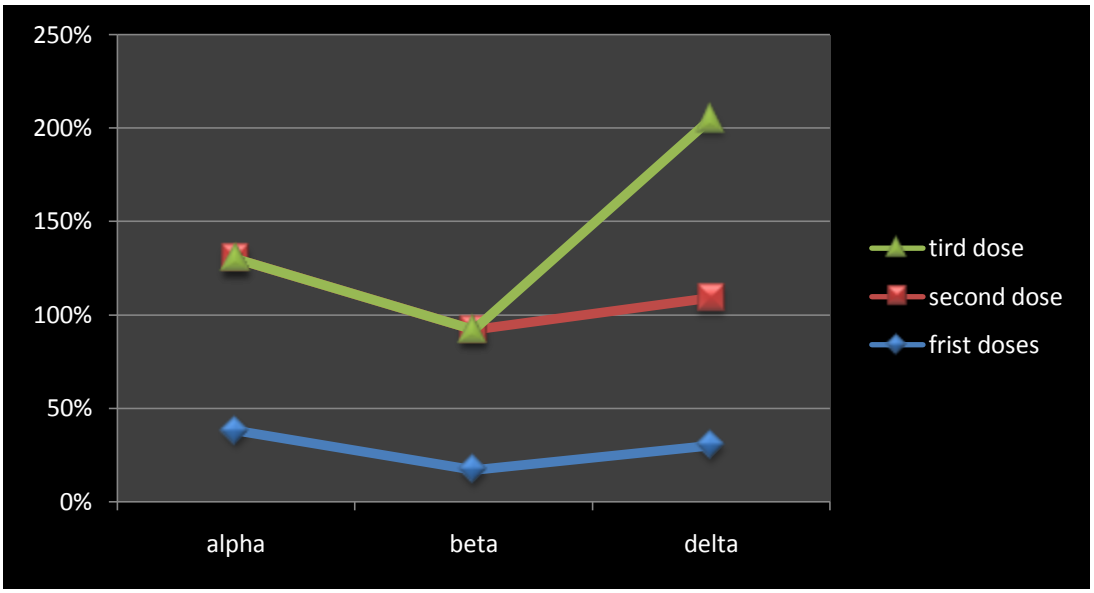

Fig 3:- In this graph pizer and biotech vaccine efficiency during the first dose.

Upon administration of the second dosage, asymptomatic causes showed 92% (90-93%) (alpha), 75% (71-79%) (beta), and 79% (75-82%) (alpha) (beta) (Delta). Instances with symptoms 92% (88-94%) (alpha), 88% (61-96%) (beta and Gama), and 83% (78-87%) (delta variants). 95% (78-99%) of the hospitalization cases were "alpha," 100% (74-100%) "beta," 96% (88-99%) "delta," and 70% (66-76%) (omicron). 96% (89-99%) (delta), 76% (56-86%) after the third dosage (omicron) which are describe in fig-4.

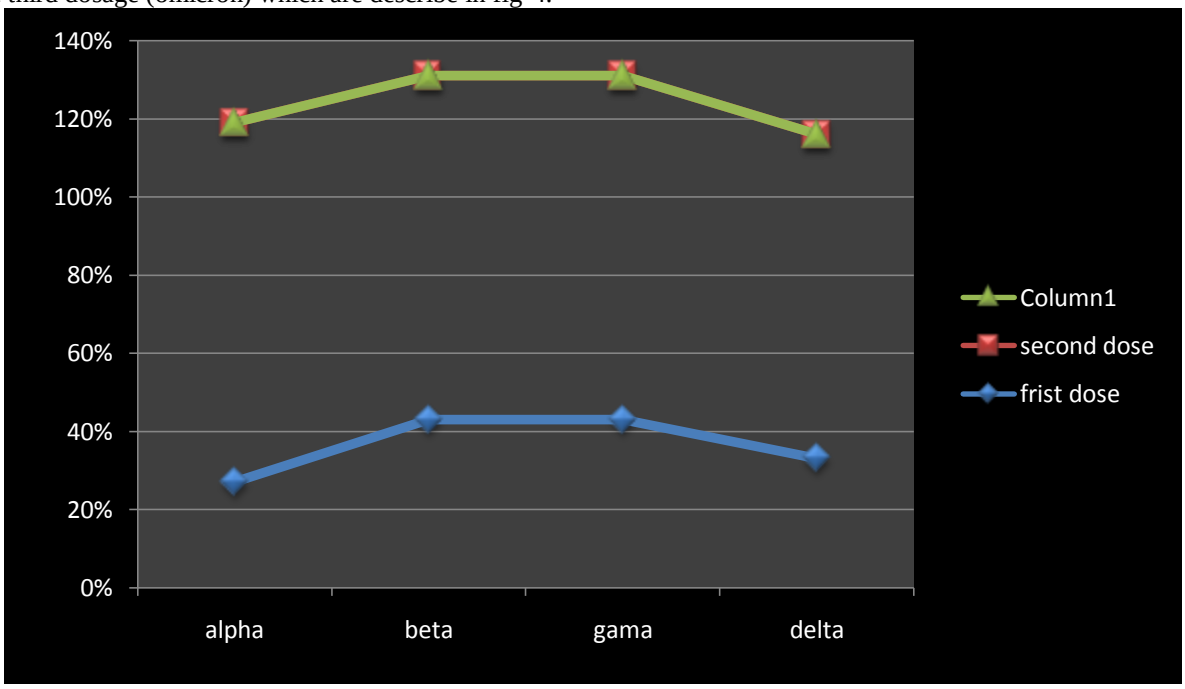

Fig 4:- Is describing pizer and biotech vaccine efficiency after given second dose.

The US Food and Drug Administration granted emergency use authorization for the Pfizer and biotech vaccination (FDA). Vaccine protection against servers disease is expected to be preserved owing to cell-mediated immunity, According to WHO and strategic advisory experts [30–32]. After six months, a second dosage is often recommended for individuals who are 18 years of age or older. Pfizer and the biotech business will produce 100 million doses in July 2020, 300 million doses in mild 2020, 120 million doses in Europe, 40 million doses in Japan, 20 million doses in the UK, and 34.4 doses in Singapore.

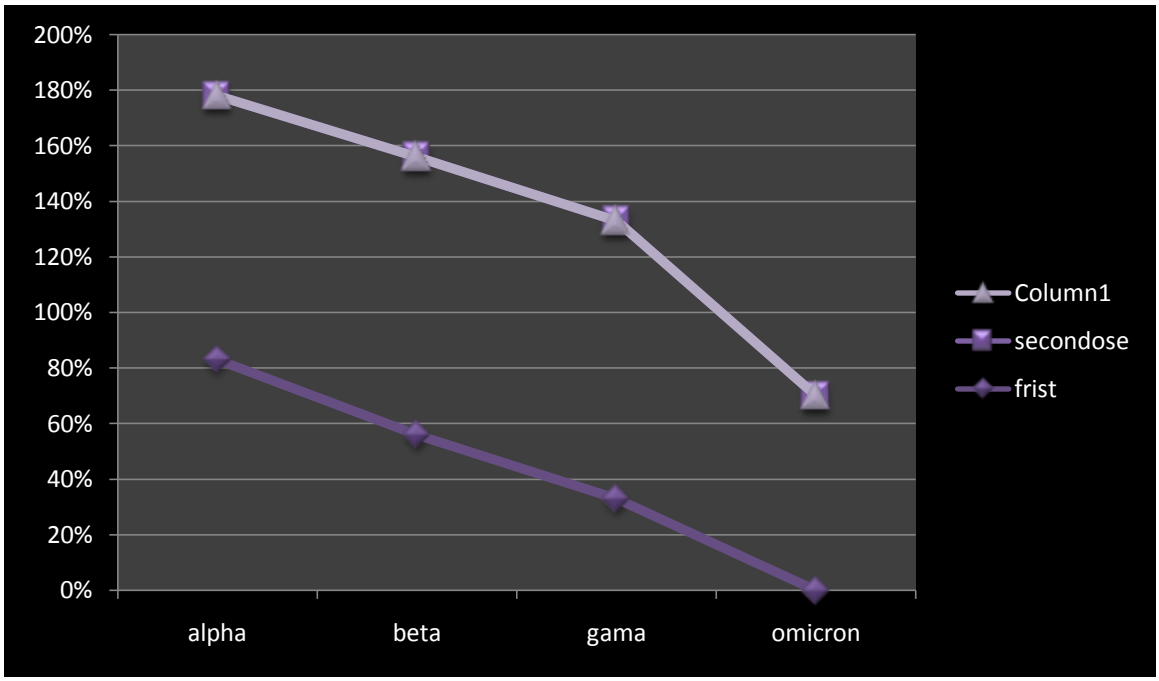

Fig 5:- Is describing pizer and biotech vaccine fight against COVID-19 variants.

One dose of this vaccine comprises 15 mcg each of "a nucleoside-modified messenger RNA (modRNA) encoding the viral spike (S) glycoprotein of SARS-CoV-2 Wuhan-Hu-1 strain (Original)" and "of modRNA encoding the S glycoprotein of SARS-CoV-2 [33]". Accroding the clinical trials shown in fig 6 Pfizer and biotech vaccines were acknowledged for 16-year-old participants and demonstrated 100% outcomes, particularly for 12–15-year-old volunteers who had shown 91% efficacy. Pfizer and biotech are 94% effective in adults aged 16 to 60 ([CI]: 49%–99%). Pfizer or Moderna vaccines revealed a 94% lower incidence of COVID-19 in those older than 60. typically 36% by 14 days of dosage 2, 69% between 8–9 days of dose 3, and 44% within 90 days of dose 3. Pfizer experiments show a two-week impact following booster dose administration. According the Bernal et al., [55] BNT162b2 shown clinical outcomes for 65 or 75 ages patients shown 95% ((CI)1.23-1.77).

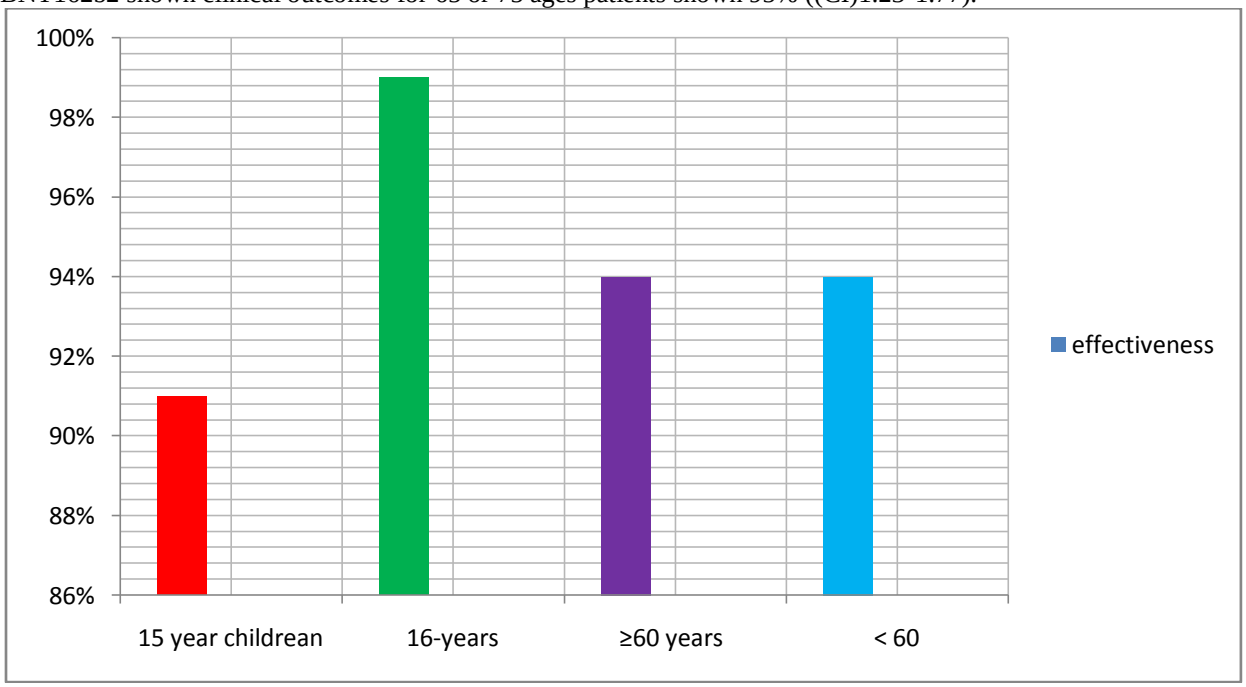

Fig 6:- Is describe over all vaccine efficiency of pizer and Biotech.

Covishield:
COVISHIELD is manufactured in India by serum, and the firm has agreements with Oxford, Axtra Zeneca, Codagenix, and Novavax. COVISHIELDTM is a single-vector vaccine made up of a recombinant, replication-deficient Chimpanzee adenovirus (ChAdOx1) vector expressing the S glycoprotein of SARS-CoV-2. SARS-CoV-2 'S' glycoprotein is expressed locally after injection, eliciting neutralizing antibody and cellular immunological responses. SII and ICMR are now conducting COVISHIELD Phase 2/3 clinical trials at 15 different locations around the nation. Serum Institute of India Pvt, Ltd. (SIIPL) is the world's largest vaccine manufacturer by the number of doses produced and sold globally (more than 1.5 billion doses), supplying the world's cheapest and WHO-accredited vaccines to as many as 170 countries [34]. It has finished enrolling all 1600 participants as of October 31, 2020.

Clinical evidence shown in figure-7 The COVISHIELD vaccine has demonstrated 63% overall vaccination effectiveness and 81% in avoiding severe Covid-19 infections in those who have received all recommended doses. (95% (CI): 57%-74%). The recommended vaccine doses at 14 and 21 days are 54% (27%-71%) and 49% (95% CI: 96.7), respectively.

The recommended dose of the vaccine for the first and second doses is typically 0.5 ml. 90% (N=111 95% CI: 96.7 NE) effective following the second dosage in participants between the ages of 18 and 64. Studies have revealed a 75.5% efficacy rate for volunteers up to 64 years old. After two months of full immunization, the COVISHIELD booster dosage is administered, and its efficacy is 70–75% [35].

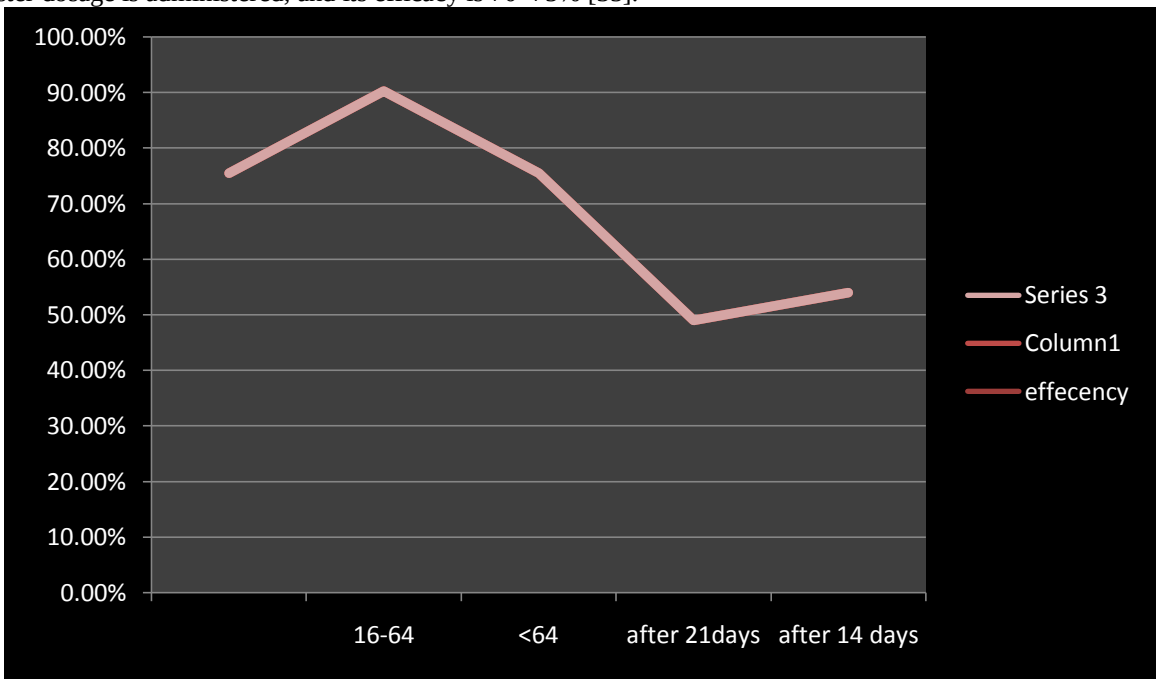

Fig 7:- Is describe over efficiency of COVISHILED vaccine based on ages.

Covaxin:
The national institute of virology, ICMR, and BHRAT BIOTECH International Limited collaborate to produce COVAXIN. COVAXIN inhibits the virus' ability to multiply within Vero cells. Together with alhydroxiquim-II (Algel-IMDG), this has midazoquionline chemosorbed onto aluminum hydroxyl gel, these immunizations help to strengthen our immunity. The inactivated virus with Kansas-based ViroVax's The use isoquinoline class of adjutants (TLR7/8 agonists), which changes the T-cell response towards Th1, a T-Helper 1 phenotype, lowers the risk of immunopathological induced increased illness and is thought to be safer than Th2 responses against SARS-CoV-2 [39]. According to Sapkal et al., [56] reported in their studies after given second dose trials patients shown hormonal and cell mediated response and whole viron inactivated SARS-COV-2 and who patients have gave two dose sown naturalization of their antibody and also increase response of T-cells and B-cells.

COVAXIN first-phase studies with vaccination volunteers demonstrate immunogenicity [40]. Second-phase studies had positive results [41], while third-phase trials with 25,800 participants in November yielded 81% vaccination effectiveness. COVAXIN has given over 4 billion vaccination doses worldwide.

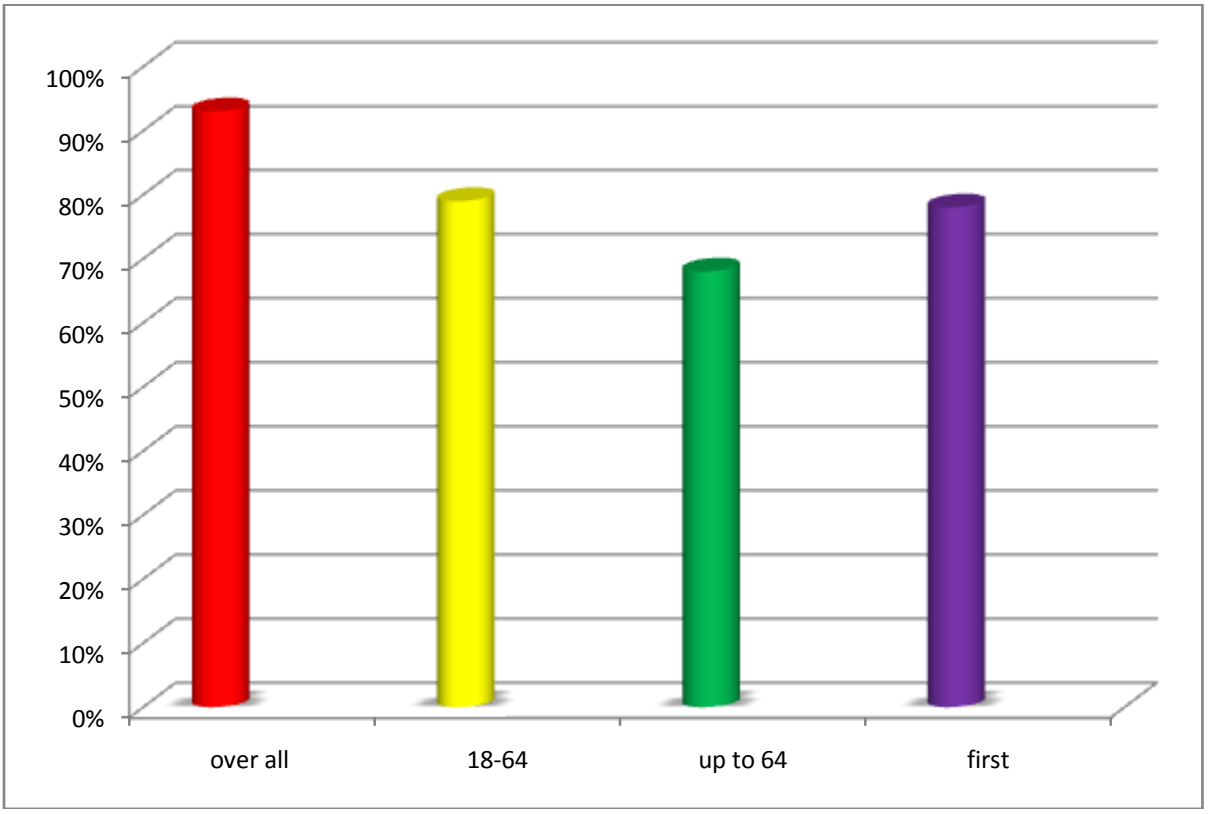

Fig 8:- COVAXIN vaccine efficiency based on ages.

NCTO4471519, COVAXIN (BBV152), COVAXIN (fig-9) two dosage completed volunteers with robust naturalization antibody response with T-cells, B-cells Covaxin has shown to be effective against SARS-COV-2, alpha, beta, Gama, delta, zeta (B.1.1.28), and Kappa (B1.617.1) viruses [37,38]. The vaccine is made from inactivated Vero cells and uses Alhydroxiquim-II as an adjuvant. COVAXIN has a 100% overall efficiency against COVID-19. The effective rate against COVID-19 is 93.4%. Generally, the efficacy of a second vaccination dosage administered 14 days following the first dose is 78%. Vaccine efficacy versus SARS-COV-2 is 93%, 79% efficiency in adult participants, and 68% efficiency in 60-year-old volunteers [42].

Covovax:

In 40 other nations, the Novavax corona virus vaccine (brand names: Nuvaxovid and Covovax) is used to protect against the coronavirus. Spike protein (S), which makes COVOVAX, stabilizes the perfusion conformation. A vaccine is a saponin-based matrix-mI that activates cells of the innate immune system to heighten the immune response to a particular S protein. One of the immunological reactions to S-protein that B-cells and T-cells elicit is the production of neutralizing antibodies. According to fig-9 clinical findings for COVOVAX, immunization effectiveness is 95% [44].

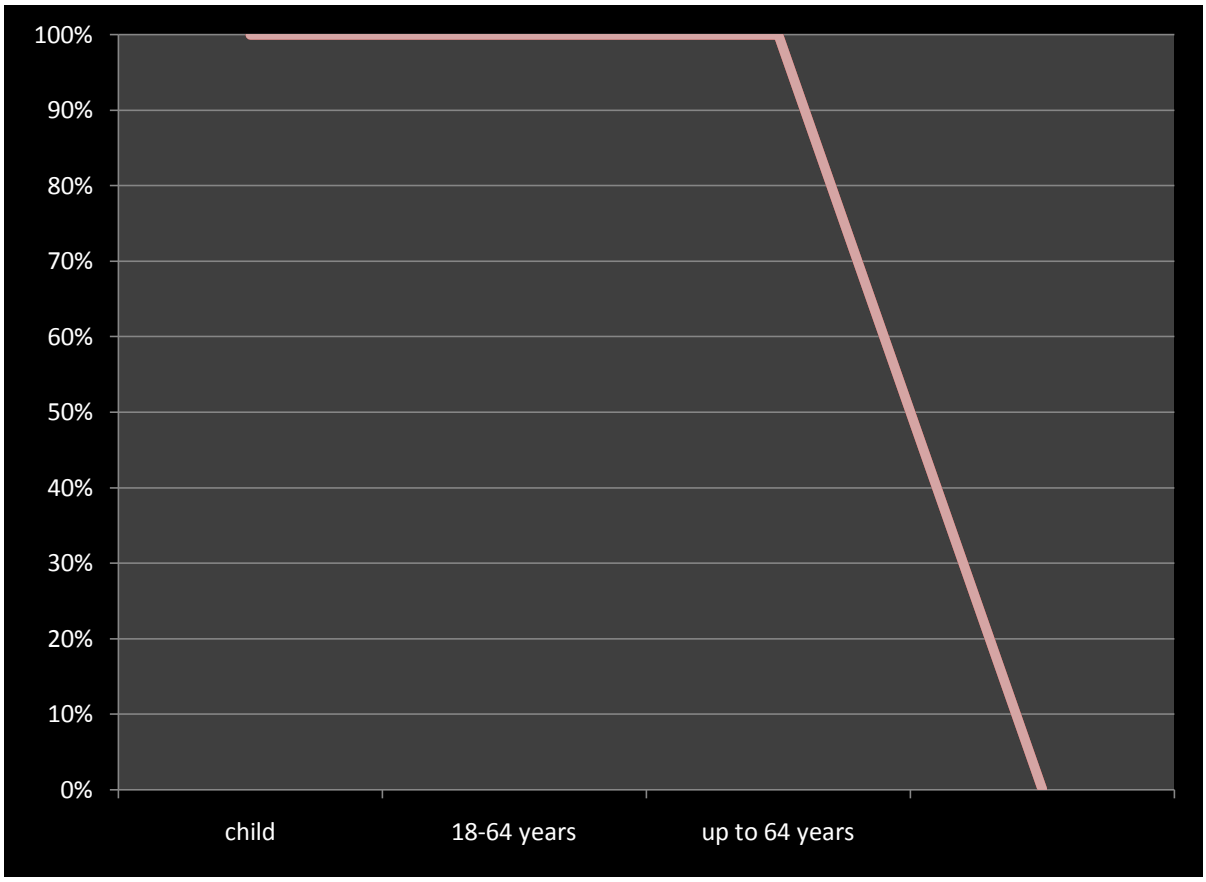

Fig 9:- Figure COVAVAX vaccine efficiency based on their ages.

The recommended dose of COVOVAX for volunteers is 5g. Clinical results show a vaccination efficacy of 89.7% (75% (CI), 80.3 to 94.6) after 7 days. Clinical trial results showed 95% vaccination efficiency for 60-year-old volunteers, and in >18 years and in 18 to 64 years ages 89.7% (95% (CI) 80.2 to 94.6%). Recent analysis has revealed 96.4% and 86.3% against B.1.1.7. a dosage increase After three months, vaccination is advised [43].

Result:-

The results of all data collecting, including data from academic papers, companies, and Google, reveal that the India vaccination is effective against SARS-COV-2 and its variants, including alpha, beta, Gama, delta, omicron, and Zeta. Clinical studies have shown that the Pizer vaccine effectively protects children between the ages of 6 months to 5 years. Fig-10 described For volunteers/adult patients after the second dosage, ZYCOV-D demonstrated 66,7% (95(CI)147.6-80.7) efficiency, whereas Pfizer Biotech demonstrated 94% ((CI)49%-99%). Following the second dosage, the efficacy of COVISHILED was 90.3%, COVAXIN was 79%, and COVAVAX was 89.7% (95 %(CI)80.2-94.6%). In India, the COVID-19 vaccination for older citizens up to 60 years old is 94%, COVISHILED 75.5%, COVAXIN 68%, and COVAVAX 95% effective.

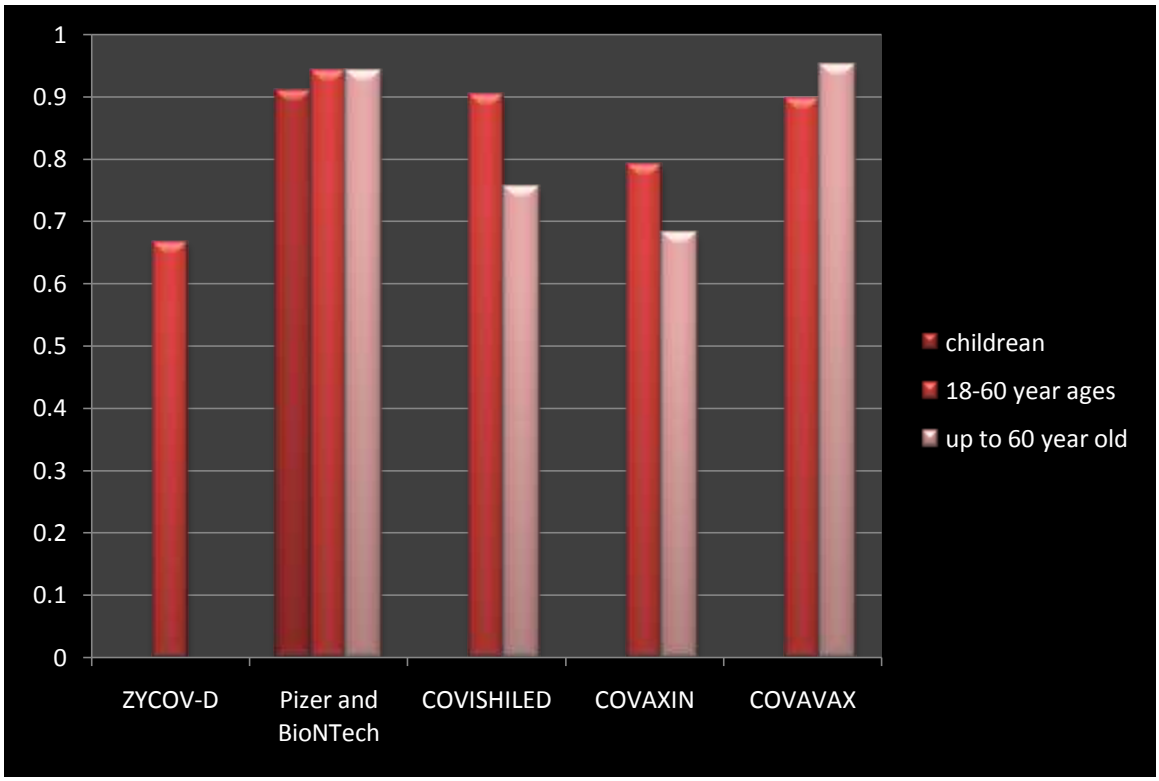

Figure 10:- Is show all vaccine discuses in above part which show in this graph. This graph is show various vaccine efficiency following age.

Discuses:-

COVID-19 has spread around our world at a time when no specific therapy or vaccination is available, therefore many people have stepped out and begun COVID-19 preparedness, particularly in India. Other national pharmaceutical firm collaborates with Indian company, such as Bharat biotech with the Indian Council of Medical Research (ICMR) and the National Institute of Virology (NIV), and Serum Institute of India Pvt Ltd with Oxford University, among others. India has created (NYSE: PFE), BioNTech SE (Nasdaq: BNTX), and BNT162b2 developed by Pizer BioNtech, COVAXIN (Bharat Biotech), COVAVAX (Serum Institute of India), ZYCOV-D (Cedilla Healthcare Limited), COVISHILED (Cadila Healthcare Limited), COVISHILED (Cedilla Healthcare Limited), COVISHILED (Cadil (Serum Institute of India Pvt Ltd). During all phases of clinical studies, all types of Indian vaccines showed good clinical results.

Vaccinations are accessible in a number of forms, including mRNA-based vaccines, DNA-based vaccines, and r-DNA-based vaccines. In 1990, the first DNA-based vaccination was created and included into the vaccine idea [45,46]. The utilisation of a host cell's DNA plasmid as a vector, as well as the inclusion of CpG unmethylated sequencing, may boost immune response in this sort of immunisation. Despite the fact that clinical trials using DNA vaccines have triggered cellular and hormonal responses as well as demonstrated therapeutic advantages [47-51]. In addition to DNA-based vaccinations, there are larger scale, lower manufacturing costs, and superior storage stability [52]. A vaccine based on m-RNA is an entirely novel concept. This type of vaccination is made by fusing together RNA fragments that end up coding for a protein antigen. A vaccine based on m-RNA improves its stability and protein translocation efficiency, which boosts immune response. The mRNA-1273 vaccine, one of the mRNA-based vaccines, has demonstrated strong and high efficacy against COVID-19 and its variations. All types of Indian vaccines, including as mRNA-based vaccines, DNA-based vaccines, and r-DNA, have demonstrated good clinical results in all phases of clinical trials, as discussed below.

(NYSE: PFE), BioNTech SE (Nasdaq: BNTX) and BNT162b2 developed by Pizer BioNtech, this vaccine is 36% efficient after the second dosage, 44% efficient after the third dose, and overall 95% efficient against COVID-19 Capponi et al.,[54] analysis on 5-11-year-old children and demonstrated 90.7% efficiency. Bharat Biotech produces

COVAXIN (BBV152), an mRNA-based vaccine that binds to SARS-COV-2 particles that contain RNA and cannot be replicated [14]. Clinical outcomes of (SIIPL) A phase 3 research comprising adults aged 18 and older in the United Kingdom during the SARS-CoV-2 Alpha variant predominance found that two vaccination doses had a 90% effectiveness. Accroding to the WHO advisesery approve the use of CovovaxTM/NuvaxovidTM in anyone under the age of 18. According to research, all Indian vaccines were effective against COVID-19 in the final stage. COVID vaccination was administered to more than 5.51 billion individuals. COVID vaccination was administered to almost 5.51 billion individuals.

Conclusion:-

In conclusion all Indian manufactured vaccine like ZYCOV-D, COVAXIN, COVAVAX, COVISHILED, BNT162b2 all vaccine shown adverse affect against COVID-19 and their varants. In addition to vaccine entering in body and increase T-cells, B-cell and boost our immunity, finally Indian manufacture vaccine approval in most of country.

Reference:-

1. Kaur SP, Gupta V. COVID-19 vaccine: a comprehensive status report. Virus Res. 2020;288:198114. https://doi.org/10.1016/j. virusres.2020.198114.
2. Noor R. Antiviral drugs against severe acute respiratory syndrome coronavirus 2 infection triggering the coronavirus disease-19 pandemic. Tzu Chi Med J. 2020;33:7–12. https://doi.org/10.4103/tcmj. tcmj_100_20.
3. Asaduzzaman SAI, Zakaria A, Kheya IS, Fahad N, Sikandar YB, Noor R. A comparative study between the severe acute respiratory syndrome-coronavirus-2, severe acute respiratory syndrome coronavirus, and the Middle East respiratory syndrome coronavirus. Biomed Biotechnol Res J. 2020;4:S65–74. https://doi.org/10. 4103/bbrj.bbrj_99_20.
4. TofailAhmed Raja A, Alshamsan A, Al-Jedai A. Status of the current COVID-19 vaccine candidates: implications in the Saudi population. Saudi Pharm J. 2020;28:1743–8. https://doi.org/10.1016/j. jsps.2020.10.019.
5. Zhu FC, Guan XH, Li YH, Huang JY, Jiang T, Hou LH, et al. Immunogenicity and safety of a recombinant adenovirus type-5- vectored COVID-19 vaccine in healthy adults aged 18 years or older: a randomised, double-blind, placebo-controlled, phase 2 trial. Lancet. 2020;396(10249):479–88. https://doi.org/10.1016/S0140-6736(20)31605-6.
6. Sikandar YB, Shabnam I, Noor R. Remdesivir and dexamethasone: the two eligible candidate drugs against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection. Biomed Res J. 2020. https://doi.org/10.4103/BMRJ.BMRJ_10_20.
7. Altuntas F, Ata N, Yigenoglu TN, Bascı S, Dal MS, Korkmaz S, et al. Convalescent plasma therapy in patients with COVID-19. Transfus Apher Sci. 2020;102955:102955. https://doi.org/10. 1016/j.transci.2020.102955.
8. Jump up to:[a b c d] Dey A, Chozhavel Rajanathan TM, Chandra H, Pericherla HP, Kumar S, Choonia HS, et al. (July 2021). "Immunogenic potential of DNA vaccine candidate, ZyCoV-D against SARS-CoV-2 in animal models". Vaccine. **39** (30): 4108–4116. doi:10.1016/j.vaccine.2021.05.098. ISSN 0264-410X. PMC 8166516. PMID 34120764
9. Raghavan P (2 July 2021). "Explained: How ZyCov-D vaccine works, how it is different". The Indian Express.
10. Rauch, S., Jasny, E., Schmidt, K. E., & Petsch, B. (2018). New vaccine technologies to combat outbreak situations. Front Immunol 9: 1963.
11. Khobragade A, Bhate S, Ramaiah V, Deshpande S, Giri K, Phophle H, Supe P, Godara I, Revanna R, Nagarkar R, Sanmukhani J, Dey A, Rajanathan TMC, Kansagra K, Koradia P; ZyCoV-D phase 3 Study Investigator Group. Efficacy, safety, and immunogenicity of the DNA SARS-CoV-2 vaccine (ZyCoV-D): the interim efficacy results of a phase 3, randomised, double-blind, placebo-controlled study in India. Lancet. 2022 Apr 2;399(10332):1313-1321. doi: 10.1016/S0140-6736(22)00151-9. PMID: 35367003; PMCID: PMC8970574.
12. This is from "SUMMARY OF PRODUCT CHARACTERISTICS ChAdOx1 nCoV- 19 Corona Virus Vaccine (Recombinant) COVISHIELD™"
13. . https://www.bharatbiotech.com/images/press/barat-biotech-bbv152-covaxin-phase3-final-analysis-03July2021.pdf
14. https://cdsco.gov.in/opencms/export/sites/CDSCO_WEB/en/Smpcserum.pdf
15. https://ir.novavax.com/2021-12-28-Novavax-and-Serum-Institute-of-India-Receive-Emergency-Use-Authorization-for-COVID-19-Vaccine-in-India#:~:text=Novavax%20and%20Serum%20Institute%20of,in%20India%20%2D%20Dec%2028%2C%2020

21&text=Novavax%20creates%20transformational%20vaccines%20that,world's%20most%20pressing%20infectious%20diseases.
16. Noor, R. (2021). Developmental Status of the Potential Vaccines for the Mitigation of the COVID-19 Pandemic and a Focus on the Effectiveness of the Pfizer-BioNTech and Moderna mRNA Vaccines. Current clinical microbiology reports, 1-8
17. Vaccines and Related Biological Products Advisory Committee Meeting December 10, 2020. FDA briefing document: PfizerBioNTech COVID-19 vaccine. https://www.fda.gov/media/ 144245/download Accessed on December 20, 2020.
18. Joffe S. Evaluating SARS-CoV-2 vaccines after emergency use authorization or licensing of initial candidate vaccines. JAMA. . https://doi.org/10.1001/jama.2020.25127.
19. Corbett KS, Edwards D, Leist SR, Abiona OM, Boyoglu-Barnum S, Gillespie RA, et al. SARS-CoV-2 mRNA vaccine development enabled by prototype pathogen preparedness. Nature. 2020;586: 567–71. https://doi.org/10.1038/s41586-020-2622-0.
20. Wrapp D, Wang N, Corbett KS, Goldsmith JA, Hsieh CL, Abiona O, et al. Cryo-EM structure of the 2019-nCoV spike in the prefusion conformation. Science. 2020;367(6483):1260–3. https:// doi.org/10.1126/science.abb2507.
21. Silveira MM, Moreira GMSG, Mendonça M. DNA vaccines against COVID-19: perspectives and challenges. Life Sci. 2020;267:118919. https://doi.org/10.1016/j.lfs.2020.118919
22. Wrapp D, Wang N, Corbett KS, Goldsmith JA, Hsieh CL, Abiona O, et al. Cryo-EM structure of the 2019-nCoV spike in the prefusion conformation. Science. 2020;367(6483):1260–3. https:// doi.org/10.1126/science.abb2507.
23. Chung YH, Beiss V, Fiering SN, Steinmetz NF. COVID-19 vaccine frontrunners and their nanotechnology design. ACS Nano. 2020;14(10):12522–37. https://doi.org/10.1021/acsnano.0c07197.
24. 18. Mulligan MJ, Lyke KE, Kitchin N, Absalon J, Gurtman A, Lockhart S, et al. Phase I/II study of COVID-19 RNA vaccine BNT162b1 in adults. Nature. 2020;586(7830):589–93. https://doi. org/10.1038/s41586-020-2639-4.
25. Duerr GD, Heine A, Hamiko M, Zimmer S, Luetkens JA, Nattermann J, et al. Parameters predicting COVID-19-induced myocardial injury and mortality. Life Sci. 2020;260:118400. https://doi.org/10.1016/j.lfs.2020.118400. 184 Curr Clin Micro Rpt (2021) 8:178–185
26. Donnelly JJ, Liu MA, Ulmer JB. Antigen presentation and DNA vaccines. Am J Respir Crit Care Med. 2000;162(4 Pt 2):S190–3. https://doi.org/10.1164/ajrccm.162.supplement_3.15tac10.
27. Smith TRF, Patel A, Ramos S, Elwood D, Zhu X, Yan J, et al. Immunogenicity of a DNA vaccine candidate for COVID-19. Nat Commun. 2020;11(1):2601. https://doi.org/10.1038/s41467-020- 16505-0.
28. Liu MA. A comparison of plasmid DNA and mRNA as vaccine technologies. Vaccines (Basel). 2019;7(2):37. https://doi.org/10. 3390/vaccines7020037.
29. Dey, A., Rajanathan, T. C., Chandra, H., Pericherla, H. P., Kumar, S., Choonia, H. S., ... & Maithal, K. (2021). Immunogenic potential of DNA vaccine candidate, ZyCoV-D against SARS-CoV-2 in animal models. Vaccine, 39(30), 4108-4116.
30. World Health Organization (2021). "International nonproprietary names for pharmaceutical substances (INN): recommended INN: list 85" (PDF). WHO Drug Information. **35** (1): 259–60. Archived (PDF) from the original on 19 April 2021. Retrieved 19 April 2021.
31. Stevis-Gridneff, Matina (28 April 2021). "How Europe Sealed a Pfizer Vaccine Deal With Texts and Calls". The New York Times. Retrieved 16 October 2022.
32. Malpani R, Maitland A (21 October 2021). Dose of Reality: How rich countries and pharmaceutical corporations are breaking their vaccine promises (PDF). The People's Vaccine Alliance. Archived (PDF) from the original on 18 January 2022. Retrieved 24 June 2022.
33. Nazaryan A (9 November 2020). "So is Pfizer part of Operation Warp Speed or not? Yes and no". Yahoo!. Archived from the original on 10 November 2020. Retrieved 9 November 2020.
34. https://www.seruminstitute.com/product_covishield.php
35. Pramod, S., Govindan, D., Ramasubramani, P., Kar, S. S., Aggarwal, R., Manoharan, N., ... & Thabah, M. M. (2022). Effectiveness of Covishield vaccine in preventing Covid-19–A test-negative case-control study. Vaccine, 40(24), 3294-3297.
36. https://www.mohfw.gov.in/pdf/GuidanceNeartoHomeCovidVaccinationCentresforElderlyandDifferentlyAbled Citizens.pdf

37. Vadrevu KM, Ganneru B, Reddy S. et al. Persistence of immunity and impact of a third (booster) dose of an inactivated SARS-CoV2 vaccine, BBV152; a phase 2, double-blind, randomised controlled trial. medRxiv, 2022. https://doi.org/10.1101/2022.01.05.22268777.
38. Edara VV, Patel M, Suthar MS, Covaxin (BBV152) vaccine neutralizes SARS-CoV-2 Delta and Omicron variants. medRxiv, 2022. https://doi.org/10.1101/2022.01.24.22269189.
39. Sapkal GN, Yadav PD, Ella R, Deshpande GR, Sahay RR, Gupta N, Vadrevu K M, Abraham P, Panda S, Bhargava B. Inactivated COVID-19 vaccine BBV152/COVAXIN effectively neutralizes recently emerged B.1.1.7 variant of SARS-CoV-2. J Travel Med. 2021 Jun;28(4):1–3.
40. Mahase E. Covid-19: what new variants are emerging and how are they being investigated? BMJ [Internet]. 2021 Jan;372:n158: https://www.bmj.com/content/bmj/372/bmj.n158.full.pdf
41. WHO Says Indian COVID Strain 'a Variant of Concern' [Internet]. 2021 [accessed 2021 Aug 2]: https://www.webmd.com/lung/news/ 20210510/who-says-indian-covid-strain-a-variant-of-concern
42. Behera, P., Singh, A. K., Subba, S. H., Sahu, D. P., Chandanshive, P. D., Pradhan, S. K., ... & Batmanabane, G. (2022). Effectiveness of COVID-19 vaccine (Covaxin) against breakthrough SARS-CoV-2 infection in India. Human Vaccines & Immunotherapeutics, 18(1), 2034456.
43. Yap, C., Ali, A., Prabhakar, A., Prabhakar, A., Pal, A., Lim, Y. Y., & Kakodkar, P. (2021). Comprehensive literature review on COVID-19 vaccines and role of SARS-CoV-2 variants in the pandemic. Therapeutic Advances in Vaccines and Immunotherapy, 9, 25151355211059791.
44. Serum Institute of India and Novavax Receive Emergency Use Authorization in India for COVOVAX™
45. L. Li, N. Petrovsky, Molecular mechanisms for enhanced DNA vaccine immunogenicity, Expert Review of Vaccines 15 (2016) 313–329.
46. J.A. Wolff, R.W. Malone, P. Williams, W. Chong, G. Acsadi, A. Jani, et al., Direct gene transfer into mouse muscle in vivo, Science 247 (1990) 1465–1468.
47. M.M. Silveira, T.L. Oliveira, R.A. Schuch, A.J.A. McBride, O.A. Dellagostin, D. D. Hartwig, DNA vaccines against leptospirosis: A literature review, Vaccine 35 (2017) 5559–5567.
48. Lee LYY, Izzard L, Hurt AC. A review of DNA vaccines against influenza. Front. Immunol.. 2018;9:1568.
49. M. Ingolotti, O. Kawalekar, D.J. Shedlock, K. Muthumani, D.B. Weiner, DNA vaccines for targeting bacterial infections, Expert Review of Vaccines 9 (2010) 747–763.
50. C. Coban, K. Kobiyama, N. Jounai, M. Tozuka, K.J. Ishii, DNA vaccines: a simple DNA sensing matter? Hum Vaccin Immunother 9 (2013) 2216–2221.
51. Hobernik D, Bros M. DNA vaccines-how far from clinical use? Int. J. Mol. Sci.. 2018;19.
52. Y. Xu, P.W. Yuen, J.K. Lam, Intranasal DNA vaccine for protection against respiratory infectious diseases: the delivery perspectives, Pharmaceutics 6 (2014) 378–415.
53. **"New positive β strand RNA virus is causes of diabetes and other disorders. ."**, International Journal of Science & Engineering Development Research (www.ijsdr.org), ISSN:2455-2631, Vol.8, Issue 1, page no.1228 - 1240, January-2023, Available :http://www.ijsdr.org/papers/IJSDR2301196.pdf
54. Capponi, M., Pulvirenti, F., Cinicola, B. L., Brindisi, G., Conti, M. G., Colaiocco, G., ... & Spalice, A. (2022). Short-term side effects and SARS-CoV-2 infection after COVID-19 pfizer–BioNTech vaccine in children aged 5–11 years: An Italian real-world study. Vaccines, 10(7), 1056.
55. Bernal, J. L., Andrews, N., Gower, C., Robertson, C., Stowe, J., Tessier, E., ... & Ramsay, M. (2021). Effectiveness of the Pfizer-BioNTech and Oxford-AstraZeneca vaccines on covid-19 related symptoms, hospital admissions, and mortality in older adults in England: test negative case-control study. bmj, 373.
56. Sapkal, G. N., Yadav, P. D., Ella, R., Deshpande, G. R., Sahay, R. R., Gupta, N., ... & Bhargava, B. (2021). Inactivated COVID-19 vaccine BBV152/COVAXIN effectively neutralizes recently emerged B. 1.1. 7 variant of SARS-CoV-2. Journal of Travel Medicine, 28(4), taab051.