



PANDEMICS AND VACCINES OVER YEARS, EMPHASIZING ON COVID- 19 VACCINES (2020-2025) – A HISTORICAL NARRATIVE REVIEW

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Abstract: Infectious diseases stretching beyond a community or wider geographic area can wreck havoc by infiltrating an extensive range of population, resulting in epidemics or pandemics. In such a scenario, to subdue and contain the infection from spreading, vaccines come to the rescue. Vaccines give rise to artificial acquired immunity and have proved highly crucial in containing various pandemics across the pages of history. The most recent pandemic of Covid 19(2019-2022) caused massive blow to the global healthcare with high mortality rates and posed a huge challenge to global economy and social relationships. The vaccines were then made available in the market and subsequently proved beneficial in containing the infection peaks and reducing the severity of the disease rather than completely preventing deaths. Today, almost all countries are out of the covid 19 situation, nevertheless the virus still lurks around the corner with cases arising at random. This keeps the vaccines still in the game and it is important that they should be made available and easily accessible, for which the nations are working together to strike the chord. This study unfolds into a Historical Narrative Review following both Historic and scientific discussion in tracing the origin and history of vaccines, their timeline and role in pandemics over the time. The study then shifts focus to brief the effort of various countries across the globe in invention and supply of different types of vaccines against covid 19, which the world in unison wielded as the ultimate weapon to keep Covid-19 at bay.

Keywords: infectious diseases, plague, Covid 19, pandemics, vaccines,

Introduction

Vaccination is the most effective method of preventing infectious diseases.[1] Infectious diseases are disorders caused by organisms, such as bacteria, viruses, fungi or parasites. Many organisms live in and on our bodies. They are normally harmless or even helpful. But under certain conditions, some organisms cause disease. Some infectious diseases can be passed from person to person. Some are transmitted via insects or other animals. As long as the infection remains confined to a single or few individuals, proper medicines, diet and regimen are suffice to cure the condition. But when the infection stretches far beyond the area or the country, infiltrating large number of populations at a rapid pace, vaccines become the inevitable weapon to subdue the disease. An epidemic is defined as “An unusual occurrence of a disease in a community or a region, clearly in excess of the “expected occurrence”. Hence a pandemic is an epidemic usually affecting a large proportion of the population, occurring over a wide geographic area such as a section of a nation, the entire nation, a continent or the world. For example, Influenza pandemics of 1918 and 1957, cholera El Tor in 1962 and acute haemorrhagic conjunctivitis in 1971 and 1981.[2] Over the years, vaccines played an important role in containing these infectious diseases. The objective of this study is to explain the history of vaccines, especially of the Covid 19, the recent Pandemic.

Materials and Methods

This study follows Narrative Review based on historic and scientific discussion. Through historical narration, the origin of Vaccines is traced out, and the invention and application of different types of Covid 19 vaccines by different countries are explained in form of scientific discussion. The unconventional methods of oral history, participatory research and observation are used.

Vaccines – How do they work?

Vaccines are preparations of live or killed microorganisms or their products used for immunization. Infection and immunity involve interaction between the animal body (host) and the infecting microorganism. The term “immunity” has traditionally referred to the resistance exhibited by the host towards injury caused by microorganisms and their products. Immunity against infectious diseases is mainly of two types: Innate (Native) and Acquired (Adaptive). Acquired immunity is of two types, Active and passive. Active acquired immunity is further classified into Natural active immunity and Artificial active immunity. In this, Natural Active Immunity results from either a clinical or an apparent infection by a microbe. On the other hand, Artificial Active immunity is the resistance offered by vaccines.[3]

Vaccine typically contains an agent that resembles the disease causing micro organism and stimulates the body's immune system, so that it can recognise the agent and destroy it. Thus the immune system also recognises and destroys any similar microorganism associated with that agent when encountered in future.[4]

Timeline of Pandemics

The first wave of plague washed over the world from 541 to 750 A.D. From its origin in the Egyptian port city Pelusium, it spread across the entire Mediterranean and eventually reached Persia and the British Isles.

PLAGUE OF JUSTINIAN, widely known as the Bubonic plague, the first plague pandemic affected 30-50 million people in Europe and West Asia between 541-542 A.D.

ROMAN PLAGUE OF 590, also the bubonic plague, a part of the first plague pandemic, affected the Roman Byzantine Empire in 590 A.D.

PLAGUE OF SHEROE, also the bubonic plague, affected Mesopotamia in 627-628 A.D.

PLAGUE OF 664, also bubonic plague, a part of first plague pandemic, affected the British Isles in 664-689.

PLAGUE OF 698-701, also bubonic plague, affected the Byzantine empire, West Asia, Syria and Mesopotamia.

PLAGUE OF 746-747, also bubonic plague, a part of first plague pandemic, affected the Byzantine empire, West Asia and Africa. By 750, after a last outbreak in Naples, the first pandemic was over. [5]

A series of scientific advances and discoveries were made in the course of seeking treatment and vaccines to combat the spread of infectious diseases, from the Spanish flu epidemic in 1918 to the Zika outbreaks in the present decade. Honigsbaum, a medical historian, also examined the effect of the epidemics in exacerbating the existing racial, ethnic, and social inequalities.[6] Across these pages of pandemic history, the under developed scientific system with meagre means of effective and proper preventive medicines led to disastrous effects.

History of vaccines

When looking at the history of vaccines timeline you can start in 15th century China. The Chinese recognized that people who survived smallpox did not get the disease again. They decided to take smallpox scabs from people who had mild cases, dry them out, grind them into a powder and blow the powder up the nostrils of healthy people. The effectiveness of these early vaccination efforts is not well known, but they had the right idea: taking a weaker version of the virus, and introducing it to healthy people to allow their immune system to build up antibodies (cells that fight off the virus). A more sophisticated take on vaccinations can be traced back to the late 18th century. From there, vaccines have made leaps and bounds of progress. Here is a look at the vaccine timeline over the past 225 years.

Development of the first vaccine

An accidental observation by Louis Pasteur, that chicken cholera bacillus cultures left on the bench for several weeks lost their pathogenic property but retained their ability to protect the birds against subsequent infection by them, led to the discovery of the process of attenuation and the development of live vaccines. He attenuated the cultures of anthrax bacillus by incubation at high temperature and proved that inoculation of such cultures in animals induced specific protection against anthrax. It was Pasteur who coined the term "vaccine" for such prophylactic preparations. However, this commemorated the first of such preparations, namely cowpox, employed by Edward Jenner for protection against small pox. [7]

- 1796- Dr. Edward Jenner collected bits of cowpox pustule-the animal variant of smallpox - from the arm of a milkmaid named Sarah Nelmes and scratched it into the arm of an 8-year-old boy.
- 1881 - French Biologist Louis Pasteur developed a successful vaccine against anthrax. Pasteur exposed anthrax pathogens to heat and oxygen to weaken, but not kill them.
- 1885 - Pasteur developed a successful vaccine against rabies. Pasteur used the same approach he did for the anthrax vaccine.
- 1914 - Pertussis, or whooping cough, vaccine is developed.
- 1926 - Diphtheria vaccine is developed.
- 1938 - Tetanus vaccine is developed.
- 1948 - Pertussis, diphtheria and tetanus vaccines are combined and given as the DTP vaccine.
- 1955 - Jonas Salk develops a break-through polio vaccine based on a dead poliovirus.
- 1963 - Measles vaccine is developed.
- 1967 - Mumps vaccine is developed.
- 1969 - Rubella vaccine is developed.
- 1977- The smallpox vaccine is no longer recommended. Because of the vaccine's success, the disease is considered eradicated.
- 1981 - Hepatitis B vaccine is developed.
- 1996 - Chickenpox vaccine is developed.
- 1998-1999 - Rotavirus vaccine is developed.
- 2000 - Hepatitis A vaccine is developed.
- 2000 - Polio vaccine is no longer recommended. Because of the vaccine's success, the disease is no longer considered a threat.
- 2001 - Pneumococcal vaccine is developed. [8]

Before the onset of COVID-19, there were at least five pandemics in the current century, H1N1 in 2009, polio in 2014, Ebola (West Africa in 2014), Zika (2016) and Ebola (Democratic Republic of Congo in 2019).

Covid 19 outbreak

In 2012, a novel corona virus, distantly related to the SARS corona virus (SARS-CoV) caused several deaths connected with pneumonia in patients originating from the Middle East, called MERS-CoV (Middle East Respiratory Syndrome corona virus). Over 20 countries reported cases and by 2016 there had been 1700 reported cases.[9]

In December 2019, a new infectious respiratory disease emerged in Wuhan, Hubei province, China and was named by the World Health Organization as COVID-19 (coronavirus disease 2019). A new class of corona virus, known as SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) has been found to be responsible for occurrence of this disease. It appeared to be a zoonosis, involving transmission from bats to camels and then to humans. [10]

As far as the history of human civilization is concerned there are instances of severe outbreaks of diseases caused by a number of viruses. The COVID-19 pandemic is considered as the most serious global health crisis of the century and the greatest challenge that the humankind faced since the Second World War. According to the report of the World Health Organization (WHO) as of April 18, 2020, the outbreak of COVID-19, affected over 2164111 people and killed more than 146,198 people in more than 200 countries throughout the world. It then rapidly spread around the world, posing enormous health, economic, environmental and social challenges to the entire human population. The coronavirus outbreak severely disrupted the global economy. Almost all the nations were struggling to slow down the transmission of the disease by testing & treating patients, quarantining suspected persons through contact tracing, restricting large gatherings, maintaining complete or partial lock down etc.[11] COVID-19 outbreak was declared as the sixth public health emergency of international concern on 30 Jan 2020 by the WHO. Compared to the other diseases, COVID-19 was much more widespread.

The WHO recommended some precautionary measures in containing the disease. The measures included avoiding close contact with people suffering from acute respiratory illness, regular hand washing with soap & water or hand sanitizer particularly after direct contact with sick people or their environment, maintaining cough etiquette, and avoiding unprotected contact with farm or wild animals etc. [12]

Vaccination against Covid 19

Vaccines induce immunity to pathogens through the activation of cellular and anti body (or humoral) immune responses and the generation of immunological memory mediated by B lymphocytes. Several vaccines for prevention of COVID-19 were already in the development pipeline, using a variety of platforms including whole inactivated virus, protein subunit, non replicating viral vectors and novel RNA and DNA platforms. As of 29 October, there were 45 candidate vaccines in clinical evaluation and 156 candidate vaccines in preclinical evaluation according to the latest WHO report. National regulatory authorities granted emergency use authorizations for thirty-four COVID-19 vaccines. Nine vaccines were approved for emergency or full use by at least one stringent regulatory authority recognized by the World Health Organization (WHO): Pfizer-BioNTech, Oxford AstraZeneca, Sinopharm BIBP, Moderna, Janssen, Corona Vac, Covaxin, Novavax and Convidecia. Five others are under assessment by the WHO: Sputnik V, Sinopharm WIBP, Sanofi- GSK and SCB-2019.

Specific versions of five vaccines were authorised by the European Medicines Agency (EMA): Pfizer-BioNTech, Janssen, Novavax, Moderna and Oxford- AstraZeneca. Specific versions of another four vaccines were under evaluation by the EMA: Sputnik V, CoronaVac, Sanofi-GSK and Valneva. [13]

In some countries, vaccines were authorized solely for travel purposes. They may not had been approved for the general population. For example, the Corona Vac, Covishield, BBIBP-CorV and Covaxin vaccines are not part of Australia's national vaccination program, however, they were recognised for the purpose of travel to Australia. [14]

Bringing a glimmer of hope, Russia on August 11, 2020 declared itself the first country to approve a coronavirus vaccine "Sputnik V" after the Soviet-era satellite that was the first launched into space. Scientists in the West raised concerns about the speed of development of Russian vaccines, suggesting that researchers might be cutting corners and coming under pressure from authorities to deliver. The World Health Organization said any WHO stamp of approval on a COVID-19 vaccine candidate would require a rigorous safety data review. [15]

U.K became the first country in the West to approve a Covid 19 vaccine –“Covishield” which was made available in India. SII is the manufacturing partner for Covishield. [16] India began administration of COVID-19 vaccines on 16 January 2021. As of 17 June 2022, India administered over 1.9 billion doses overall, including first, second and precautionary (booster) doses of the currently approved vaccines. [17] (India initially approved the Oxford-AstraZeneca vaccine (manufactured under license by Serum Institute of India under the trade name Covishield) and Covaxin (a vaccine developed locally by Bharat Biotech). They have since been joined by the Sputnik V (manufactured under license by Dr. Reddy's Laboratories, with additional production from Serum Institute of India being started in September, Moderna vaccines, Johnson & Johnson vaccine and ZyCoV-D (a vaccine locally developed by Zydus Cadila) and other vaccine candidates undergoing local clinical trials. [18]

COVAX, the vaccines pillar of the Access to COVID-19 Tools (ACT) Accelerator, is co-led by the Coalition for Epidemic Preparedness Innovations (CEPI), Gavi, the Vaccine Alliance, and the World Health Organization (WHO) - working in partnership with developed and developing country vaccine manufacturers.[19] On 29th June, the DCGI approved the Moderna vaccine (which is being imported by Cipla) for emergency use. [20]

On 7 August 2021, the Drug Controller General of India (DCGI) approved emergency use of the Johnson and Johnson single-dose vaccine. On 16 Aug 2021, India administered around 8.81 million doses of COVID-19 vaccines, achieving the highest single-day record and overtaking its own previous record of 8.61 million doses, by 16 August the cumulative doses had surpassed the 55 million mark. On 20 August 2021, India granted emergency use approval to the world's first DNA based COVID-19 vaccine, ZyCoV-D manufactured by ZydusCadila for adults and children aged 12 years and above. [21]. By the end of 2020, experts believed that Covishield could be the first vaccine against Covid-19 to be available in India as Pfizer and Moderna, by March or April of 2021.[22]

Vaccine development and distribution – 2020-2024

As of early May 2020, there were over 30 vaccine candidates in development in India, many of which were already in pre-clinical trials. The Pune-based Serum Institute of India (SII) is the world's largest vaccine maker. In August 2020, SII received approvals for phase 2 and phase 3 trials of its version of a vaccine being developed by AstraZeneca and the University of Oxford's Vaccitech. The SII planned to manufacture 1.5 and 2.5 billion doses of the AstraZeneca vaccine per-year under the trade name "Covishield". By its approval in January 2021, the company had stockpiled 50 million doses, but well short of its own target of 400 million.

Hyderabad-based Bharat Biotech, in collaboration with U.S.-based FluGen, expected to begin the first clinical trials of a nasal vaccine by late-2020. The Indian Council of Medical Research partnered with Bharat Biotech in May 2020 to develop a COVID vaccine entirely within India. In June 2020, it received DCGI approval to begin phase 1 and phase 2 trials on its vaccine, BBV152 (trade name "Covaxin"). In September 2020, it was reported that in pre-clinical trials on animals, Covaxin was able to build immunity.

Cadila Healthcare began vaccine development in March 2020, including a viral vector vaccine and a DNA plasmid vaccine. In mid-July 2020, Cadila held early human trials of its vaccine candidate ZyCoV-D, received approval for phase 3 trials in January 2021. It began large-scale production in April 2021, with Cadila expecting to receive emergency authorisation between May and June 2021. On 1 July 2021, Cadila Healthcare reported the efficacy to be 66.6% against symptomatic COVID-19 and 100% against moderate or severe disease in its interim analysis of its phase 3 trial data.

In September 2020, Dr. Reddy's partnered with the Russian Direct Investment Fund (RDIF) to conduct phase 3 trials of the Sputnik V vaccine in India, and to distribute the vaccine there once approved. In April 2021, phase 3 clinical trials were approved for another vaccine, Corbevax, a protein subunit that is being developed by BioE, the Baylor College of Medicine, and Dynavax Technologies.

In mid-July, it was reported that approval of the Moderna and Pfizer vaccines, as well as a shipment of vaccines donated by the United States (which includes the AstraZeneca, Janssen, Moderna, and Pfizer vaccines), had faced delays due to requests from their manufacturers for indemnity clauses from Indian authorities, which would relieve them from legal liability for adverse reactions. On 21 September 2021, the Indian Government said that it will not purchase the Pfizer-BioNTech and Moderna vaccines as domestic output of more affordable and easier-to-store vaccines has jumped. On 6 February 2022, DCGI approved sputnik light covid vaccine for emergency use in India. According to a June 2022 study published in The Lancet, COVID-19 vaccination in India prevented an additional 4.2 million deaths from December 8, 2020 to December 8, 2021. [23]

India's COVID-19 Vaccination Programme was launched on January 16, 2021. By January 6, 2023, the program had administered over 220 crore doses, covering 97% of eligible citizens with at least one dose and 90% with both doses. India being a culturally diverse country has to overcome significant social challenges and beliefs to accelerate the vaccination drive. The Government trained 2.6 lakh workers, 4.8 lakh support staff and designed an online platform to assess and monitor vaccine tracking and delivery. This approach proved successful not only in self-sufficiency but also gave rise to "Vaccine Maitri", an initiative to supply vaccines to other countries.[4] On September 11, 2023, the Food and Drug Administration (FDA) approved the updated (2023–2024 Formula) COVID-19 mRNA vaccines by Moderna and Pfizer-BioNTech for persons aged ≥ 12 years and authorized these vaccines for persons aged 6 months–11 years under Emergency Use Authorization (EUA).

In 2023, the variants these vaccines were designed to protect against were no longer circulating widely among the population, as OMICRON emerged. On September and October 2023, the Food and Drug Administration approved and authorized updated 2023–2024 Formula monovalent XBB.1.5 component-containing COVID-19 vaccines, formulated to target current variants more closely, specifically Omicron variant XBB.1.5, for persons aged ≥ 6 months.. [25]

Currently used vaccines– 2025

Universally, the CDC recommends everyone aged 6 months and older should get vaccinated by vaccines updated from Pfizer-BioNTech, Moderna, and Novavax monovalent formulations targeting the Omicron JN.1 lineage. [26] In India, covid 19 booster doses of vaccines for Omicron sub-variants, such as Covovax and CorBEVax are suggested under the initiative "Covid Suraksha 3.0". This focuses essentially on high risk groups like health care workers, frontline workers, immunocompromised individuals, senior citizens with co-morbidities rather than mass immunization. [27]

Conclusion

Historically, vaccines have proved to be helpful in containing the infection and protecting the population from various infectious diseases and even eradicated small pox and eliminated polio. Covid-19 vaccines, which are the focal point of this review also highlights the same. Vaccines from different countries though in various kinds have proved to prevent deaths and complications of covid like long covid. As of December 26th 2025, only 6 active covid cases were reported in India. [28] However, reduction in

covid 19 cases cannot be attributed to vaccines alone; under reporting of cases, cases misdiagnosed as flu, use of multiple vaccines, global efforts and faded virulence of the covid strain itself can also be factored in.

Limitations of the Review

This review is more of a narration on historical perspective of pandemics and their corresponding vaccinations and less of a scientific approach. Different kinds of vaccines for covid 19 from 2020-2025 are discussed but the clinical and epidemiological themes like vaccine effectiveness, efficacy, adverse events and vaccine coverage are not discussed.

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