Vaccination For Viral Diseases

Abstract:

The past year or so has seen unprecedented happenings, bringing the life to a halt. The things which were totally un-imaginable, happened. The humans were stopped right in their tracks and everyone felt so powerless. The COVID 19 pandemic not only has resulted in the financial losses worldwide, it has also led to death of about 51 lakh people worlds Though it has happened in the past when viral infections caused widespread death, but in modern era no one, even imagined that a virus can bring humanity to a halt.

Viruses cause many diseases some of which can cause death, while others can cause severe debility. Majority of diseases caused by viruses attack infants and young children, but it affects people of all ages. One of the most effective method for preventing death and disability from a number of viral illnesses is vaccination.

There are a variety of vaccines that are both effective and safe which help prevent diseases caused by viruses which can cause deaths and hospital admissions and further consequences.

Edward Jenner was the first person in modern day history to have used cow pox material to induce immunity to small pox way back in 1796. However, some evidence does exists that Chinese employed small pox inoculation as early as 1000 CE. it was also practised later in Turkey and Africa.

Keywords: Vaccination, Adults, Viral, Illness, Immunity.

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Introductuion + aim/objective of the study
Methodology
Results
Discussion + and very important recommendation

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Introduction:

The past year or so has seen unprecedented happenings, bringing the life to a halt. The things which were totally un-imaginable, happened. The humans were stopped right in their tracks and everyone felt so powerless. The COVID 19 pandemic not only has resulted in the financial losses worldwide, it has also led to death of about 51 lakh people worlds Though it has happened in the past when viral infections caused widespread death, but in modern era no one, even imagined that a virus can bring humanity to a halt.

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There are a variety of vaccines that are both effective and safe which help prevent diseases caused by viruses which can cause deaths and hospital admissions and further consequences. (2)

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History of viral illnesses and pandemics

The story of vaccination did not begin with first vaccine, it began long ago with when the humans started suffering from infectious diseases. Humans have since long been suffering from infectious diseases which have taken the form of pandemics. Major pandemics that have inflicted humans include plague, chorea, flu, severe acute respiratory syndrome (SARS), middle east respiratory coronavirus viruses and more recently SARS CoV 2. In case of bacterial pandemics use of modern-day antibiotics are very effective to control the pandemics along with other measures like sanitation, vector control. However, for viral diseases one of the strongest measures to control the pandemics is vaccination. Hence the need to work on vaccination in viral disease, is a modern-day demand.

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Edward Jenner established vaccinology in the West by inoculating a 13-year-old child with vaccinia virus (cowpox). The boy later proved to have developed immunity to smallpox. Since 1798, the first smallpox vaccine has been developed. Methodological execution of large-scale smallpox immunisation during the next two decades in the 18th and 19th centuries resulted in the disease's elimination across the globe in 1979

In humans, Louis Pasteur's efforts were pivotal in the invention of live attenuated cholera vaccines and inactivated anthrax vaccines (1897 and 1904, respectively). In the late 19th century, the plague vaccine was developed. Several bacterial vaccines were created between 1890 and 1950, notably the Bacillus Calmette-Guerin (BCG) vaccine, which is being used today.

The Salk (inactivated injected) polio vaccine and the Sabin (live attenuated oral) polio vaccine were produced using viral tissue culture technologies in the late twentieth century. Polio has been eradicated in many places throughout the world thanks to widespread vaccination

Later vaccines were developed for measles, mumps and rubella. Measles is currently next on the list for elimination with the help of vaccination.

The bygone two decades has seen the molecular genetics being applied to development of vaccination and its in-depth knowledge into immunology, and genetics have been applied to vaccine development. Ongoing achievements into the progress of recombinant hepatitis B vaccines, the acellular pertussis vaccine, and for seasonal influenza vaccine are commendable. (3)

Newer technology now foreheads vaccine research with recombinant DNA technology and newer methods of delivery of vaccines are leading scientists in new arenas. Vaccine research is beginning to focus on non-infectious conditions like Allergy and Cancer.

Vaccines and brief overview

The vaccination and immunisation are done routinely for infants and children and almost each country has a vaccination schedule.

The WHO started the universal program on immunization in 1974. Less than 5 % of the world's children under one year of age were immunized against deadly viral diseases like

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Polio, Measles and Pertussis. Currently a rough estimate states that 83 % of the world's children under one year of age receives vaccines against these diseases. New vaccines against hepatitis A and B are slowly being included. Still one-fifth of the world's children that is around 22.4 million infants are not immunized against these diseases. It is estimated that about 1.5 million children died from vaccine-preventable diseases in 2011 which could have been prevented if universal vaccination was being used. (4)

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What is a vaccine

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A vaccination is a biological preparation that boosts your immune system against a certain disease. A vaccination is made up of components that resemble the microorganisms that are responsible for the infectious diseases. They are made from killed forms of the microbe or its toxins or one of the antigens. Sometimes live viruses are used which are modified to have lost their infectivity but retain their immunogenicity The agent incites the body's immune mechanism to recognize the agent as foreign. Then bodies immunity destroys the infectious agent on coming in contact with it. Body's immune system also develops memory against the microorganism so that the immune system can more easily recognize and quickly destroy microorganisms on further encounters. (5)

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How does vaccines work

Vaccines holds weakened or inactive antigens which initiates an immune response in the body. The body will create antibodies to combat the disease whether the vaccination is made up of the antigen itself or the blueprint. The live virus vaccine contains weakened version which will not cause the disease in the person receiving the vaccine, but will initiate an immune response. The response to exposure of virus is similar to what would have happened in the body if it was exposed to the disease-causing microorganism.

Some vaccines require multiple doses, where booster doses are given weeks or months apart. These booster doses are needed facilitate development of long-lived antibodies and memory cells in the body. In this manner, the human body is aligned to offset the specific disease-causing organism, which builds up the memory of the pathogen such that a rapid response is readily available to fight the infectious agent in coming times. (6)

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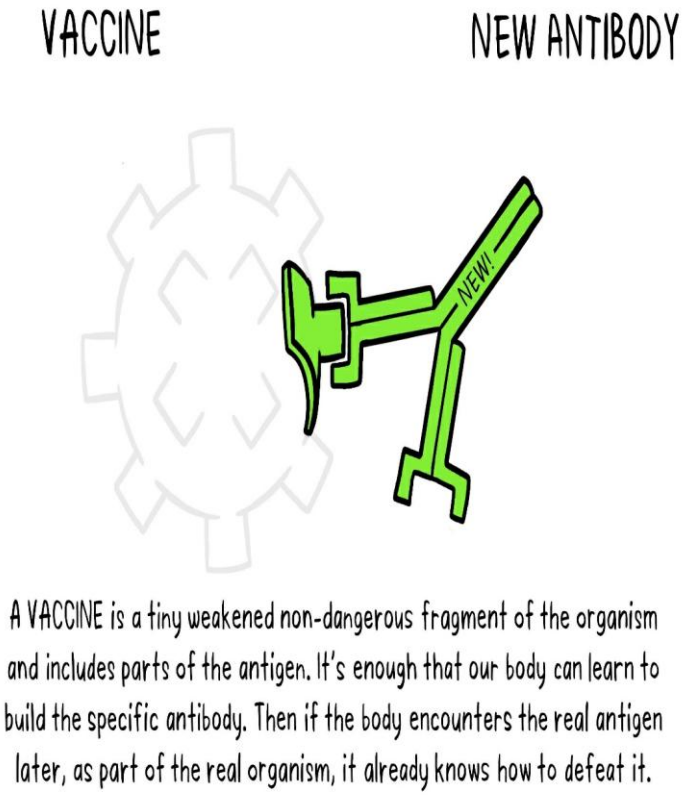

Fig 1. Types of vaccines

Broadly the available vaccines are classified as

- **Live virus vaccines** use the live virus which is attenuated or weakened form of the virus.
- **Killed (inactivated) vaccines** which are usually made from one of the constituents of virus or bacteria or the whole virus which is killed.
- **Toxoid vaccines** contain chemicals or toxins made by the virus or bacteria.
- **Bio-synthetic vaccines** usually contain substances quite similar to constituents of the bacteria or virus.

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Table 1: Types of vaccines [e]

Vaccine type	Examples
Live attenuated	Measles, Mumps, Rubella (MMR vaccine) Varicella (chicken pox), Influenza vaccine, Rotavirus vaccine, yellow fever, Oral polio vaccine
Inactivated / Killed antigen	Polio (IPV), Hepatitis A vaccine, Rabies
Toxoid (Inactivated)	Diphtheria, Tetanus
Sub Unit/ conjugate	Hepatitis B, Influenza, H influenzae type b Pneumococcal, Meningococcal
Viral vector vaccine	Zaire Ebola virus (rVSV-ZEBOV)

(7)

According to the World Health Organization (WHO), approved vaccinations are currently available for the twenty-five avoidable illnesses listed below.

- Cholera
- Covid 19
- Dengue
- Diphtheria
- Hepatitis A, Hepatitis B
- Hemophilus influenzae type b
- Human papilloma virus
- Influenza
- Japanese encephalitis
- Measles
- Mumps
- Pertussis
- Pneumococcal meningitis
- Poliomyelitis
- Rabies
- Rota virus
- Rubella
- Tuberculosis
- Typhoid
- Varicella zoster
- Yellow fever

(8)

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Routes of administration

The vaccines can be administered either orally, intramuscularly, sub-cutaneous or by intra-dermal route. Also, vaccines can be given through intra- nasal route for e.g. influenza vaccine.

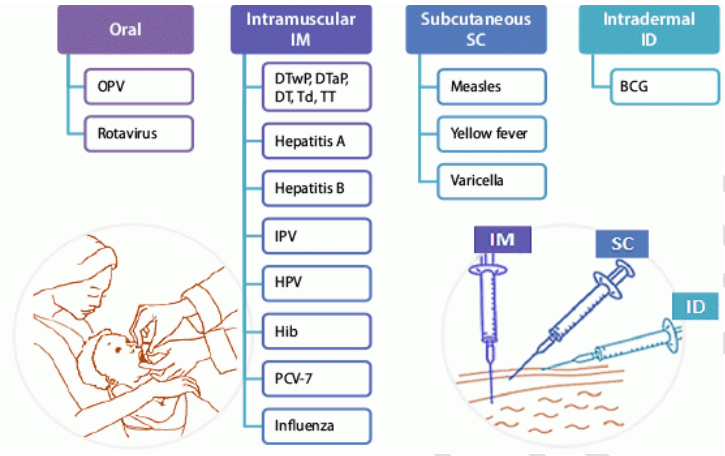

Fig 2. Vaccination schedule in India

Vaccination program has led to the eradication of many viral diseases like small pox, one of the most infectious and deadly disease. It has also led to control of many viral diseases like measles, mumps, rubella, polio and chicken pox. [9]

India has its own immunization program, few of the salient points of which are as

- Expanded Programme on Immunization which was launched in 1978 later it was recoined as Universal Immunization Programme in 1985. Since 2005, it is the very core of the National Rural Health Mission programme.
- It is one of the largest public health programmes in the world which encompasses approximately 2.67 crore new-borns and 2.9 crore pregnant females per year.
- The two major achievements of Universal Immunization Programme have been the elimination of polio in 2014 and elimination of maternal and neonatal tetanus in 2015.

Currently, the national immunisation schedule is as given in table below

Universal Immunization Programme covers free immunization which is provided against 12 vaccine preventable diseases:

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- On national scale against the following 9 diseases - Diphtheria, Pertussis, Tetanus, Polio, Measles, Rubella, severe form of Childhood Tuberculosis, Hepatitis B and Meningitis & Pneumonia caused by Hemophilus Influenza type B
- Regionally against 3 diseases - Rotavirus diarrhoea, Pneumococcal Pneumonia and Japanese Encephalitis; of which Rotavirus vaccine and Pneumococcal Conjugate vaccine are being expanded while Japanese Encephalitis vaccine is provided only in endemic areas.
- An infant is said to be fully immunized if he receives all due vaccine scheduled according to the national immunization schedule till one year of age.

National Immunization Schedule

Age	Vaccines given
Birth	Bacillus Calmette Guerin (BCG), Oral Polio Vaccine (OPV)-0 dose, Hepatitis B birth dose
6 Weeks	OPV-1, Pentavalent-1, Rotavirus Vaccine (RVV)-1***, Fractional dose of Inactivated Polio Vaccine (fIPV)-1, Pneumococcal Conjugate Vaccine (PCV) -1***
10 weeks	OPV-2, Pentavalent-2, RVV-2***
14 weeks	OPV-3, Pentavalent-3, fIPV-2, RVV-3***, PCV-2***
9-12 months	Measles & Rubella (MR)-1, JE-1* , PCV-Booster***
16-24 months	MR-2, JE-2*, Diphtheria, Pertussis & Tetanus (DPT)-Booster-1, OPV –Booster
5-6 years	DPT-Booster-2
10 years	Tetanus Toxoid (TT)/Tetanus & adult Diphtheria (Td)
16 years	TT/Td
Pregnant Mother	TT/Td1, 2 or TT/Td Booster**

1. * JE in 231 endemic districts
2. ** One dose if previously vaccinated within 3 years
3. ***Rotavirus vaccine and PCV in selected states/districts as per details below:
   - Rotavirus: Andhra Pradesh, Assam, Haryana, Himachal Pradesh, Jharkhand, Madhya Pradesh, Odisha, Rajasthan, Tamil Nadu, Tripura & Uttar Pradesh.
   - PCV: Bihar, Himachal Pradesh, Madhya Pradesh, Uttar Pradesh (12 districts) & Rajasthan (9 districts).

Fig 3. Vaccination of viral disease for adults

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- All adults need a seasonal flu (influenza) vaccine every year as the strain changes because on antigenic shift and drift. Flu vaccine is especially important for immunocompromised adults.

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- To guard against pertussis (whooping cough), everyone should obtain a Tdap vaccine once if they did not get it as a child, and then a Td (tetanus, diphtheria) or Tdap booster dose every 10 years. Pregnant women should obtain the Tdap vaccine every time they get pregnant, ideally between the ages of 27 and 36 weeks.
- HPV vaccination, which protects against the forms of human papillomaviruses (HPV) that cause the majority of cervical, anal, vulval, and oral cancers, as well as genital warts, is also recommended.

  HPV vaccination should be given for all preteens at age 11 or 12 years.

  HPV vaccination for each one by the age of 26 years. (If not already).

HPV vaccination is not advisable for persons older than age 26 years. Some adults aged 27 to 45 years who are not already vaccinated may decide to receive HPV vaccine after consultation with their physician about their possible benefits of vaccination. HPV vaccination in this age group does not provide much benefit as exposure to the virus would have already occurred prior to vaccination in sexually active patients. (10)

Impact of vaccination

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Vaccination has been a boon to global health. Two major viral diseases namely smallpox and rinderpest, have been eradicated. Worldwide coverage of vaccination against many important infectious diseases has improved drastically since the onset of WHO's Expanded Programme of Immunization in 1974 and of the Global Alliance for Vaccination and Immunization in 2000. Polio is another viral disease on the verge of eradication and success is on the way to control spread of measles.

In spite of these success stories, still about 6.6 million children still die per year and about half of these deaths are attributable to infections like pneumonia and diarrhoea, which could be prevented by timely vaccination.

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Timely progress of vaccines against more complex infections, such as malaria, tuberculosis and HIV, are challenging and much progress is still awaited. Success against these infections may require judicious combination of vaccine, wherein each part would stimulate a different arm of the immune system. In the longer run, certain vaccines are likely to be employed to prevent or modulate the course of some non-infectious diseases like therapeutic cancer vaccines, future vaccination projects would also help to fight against addiction, diabetes, hypertension and Alzheimer's disease. (11)

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In the end, we still need to work to ensure the good financing, timely provision, equitable distribution, and administration of vaccines to all in the world. Especially for those who are in far flung areas. The World Health Organization (WHO), the Bill and Melinda Gates Foundation and the United Nations Children's Fund (UNICEF), are just a few of the organisations involved, with their fundings which have been exemplary in expanding vaccine benefits to all and sundry. The vitality of these organizations and worldwide co-operation and participation was essential in early development of vaccine in the 2019 global pandemic of SARS-CoV-2. (12)

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Future and challenges

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Immunization agenda 2030 {action plan}

Immunisation Programmes for primary health care/universal health coverage	• Ensure adequate health workforce availability • Build and strengthen comprehensive vaccine-preventable disease surveillance supported by strong and reliable laboratory-based systems • Secure high-quality supply chains and effective vaccine management to facilitate equitable coverage in immunisation and establish synergies with other primary health care supply chains where possible • Generate fit-for-purpose immunisation data for evidence-based decision-making • Ensure functional vaccine safety systems in close collaboration with national regulatory agencies
Commitment & Demand	• Build and sustain strong social, financial and political commitment for immunisation • Strengthen leadership, management and coordination for immunisation at all levels • Ensure people and communities value, actively support and seek out immunisation services
Coverage & Equity	• Reach high equitable immunisation coverage at national level and in all districts • Increase coverage of vaccines among the most disadvantaged populations • Reduce the number of children not reached through the immunisation programme ("zero-dose" children)
Life course & Integration	• Strengthen policies and service delivery to provide new and underused vaccines and appropriate catch-up vaccination across the life-course • Establish integrated delivery touchpoints for immunisation and other public health interventions across the life course
Outbreaks & Emergencies	• Decrease the number and magnitude of outbreaks of epidemic-prone vaccine-preventable diseases • Ensure timely, well-organized responses to outbreaks of epidemic-prone vaccine-preventable diseases • Establish timely and appropriate vaccination services in acute emergencies and humanitarian crises
Supply & Sustainability	• Build and sustain healthy markets across all antigens at the global level • Safeguard access quality assured vaccines in a timely fashion in all countries • Ensure sufficient financial support for immunisation programmes across all countries to achieve universal coverage • Increase immunisation expenditure from domestic resources for aid dependent countries, and when transitioning away from aid, secure government domestic funding to sustain coverage of all vaccines after transition
Research & Innovation	• Establish and strengthen country capacity to identify, create and manage innovation • Develop new vaccines and technologies and improve existing products and services for immunisation programmes • Introduce and scale up new and underused vaccines and improved technologies, services and practices

(13)

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Fig 4. Global future of vaccination

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Protein subunit vaccines are being rapidly included as the future of vaccination. They take a different method to stimulate the immune system which differs from the mRNA and DNA Covid-19 vaccines. This method incites our immune system by offering a part of the virus that is incapable of causing disease. In recently concluded clinical trials, protein subunit vaccines have shown very good efficacy in protecting against Covid-19. They are also more stable and do not require the maintenance of strict cold chain. Thus, making them easier to distribute among remote areas.

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Advances in adjuvants –

Adjuvants help generate an added immune response, allowing the use of less dose of vaccine to generate the same level of protection, This ultimately increases the number of doses that can be made which is useful when the entire humanity needs vaccines to fight the same virus at the same time. (14-19)

Conclusion

Immunization is a long-term investment that will result in a healthier, safer, and more prosperous society for everyone.

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Morbidity and Mortality: Methods and Data Used in the Global Burden of Disease 2017 Study." INJURY PREVENTION 26, no. SUPP_1, 1 (October 2020): 125–53. https://doi.org/10.1136/injuryprev-2019-043531.

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