International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 4 Apr. 2021, pp: 266-271 www.ijaem.net ISSN: 2395-5252

Contribution of Vaccination in global health

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Submitted: 15-04-2021 Revised: 28-04-2021 Accepted: 30-04-2021

ABSTRACT: Vaccination has made the greatest contribution to global health by saving millions of human lives and existence. Since 19th century a progression was seen towards the studies and research in the field of pharmaceuticals, especially vaccination. Due to some infectious diseases in countries in that century saved no option for the researchers rather than develop a permanent solution (vaccines) or life-saving drugs for eradication / prevention of the diseases. A vast decline was seen in infant mortality due to infectious disease after the development of vaccines. The development and deployment played a vital role in eradicating the diseases. Along with vaccination, self-hygiene, nutrition, proper sanitization and sense of awareness ideas emerged transforming the scenario of the world. Vaccination has made an enormous contribution to human and animal health, especially in the developing world. Mortality rate due to the deadly smallpox, measles and mumps was massive in the pre-vaccination period with up to a half of the population dying from the former during epidemics and measles was only a little less lethal in susceptible population. This review briefly describes some the major achievements of vaccination in past, the present scenario of vaccination contributing in global health.

KEYWORDS: vaccination, global health, vaccine

I. DISCUSSION

Edward Jenner was the first person to develop the idea of vaccine and using it as a public health tool. In 1796, Edward Jenner conducted experiments for developing a vaccine that can fight against a deadly disease of that time 'smallpox'. He developed vaccine by substituting smallpox material with cowpox lesion which was mild infectious to humans, but generated an immune response against smallpox. It protected cross-protection against smallpox infection. After the success of vaccine, Europe, USA and other countries adopted vaccine as a public health tool and started implementing vaccination. Although it experienced a lot of opposition from some sections of community when vaccination was compulsorily imposed in UK. Antivaccination camps were seen over the world who were in opposition due to political or religious reasons. Smallpox vaccine was the first vaccine deployed across the world so we can say that the first deadly disease to be eradicated from world was smallpox. The disease had distinctive clinical features, much feared disease which was prevalent in those times and also its sub-clinical infections were less. Measles on the other hand also had a local transmission which was also eradicated. The challenge after that was to eradicate or control asymptomatic infections like infection by polio virus which showed no symptoms but was widespread. Distemper viruses caused a lot of loss by targeting cattle and impoverished the population living on poultry and farming. The diseases such as tuberculosis, rabies, typhoid, cholera, plague, diphtheria, yellow fever, Guinea worm, etc were creating havoc by killing people especially infants. With the development of vaccines and life saving drugs the brutality of the diseases is minimized and they became curable. Novel technologies were enabled for the rational development of vaccine. Graph 1 shows the percentage of vaccination coverage in 2019.

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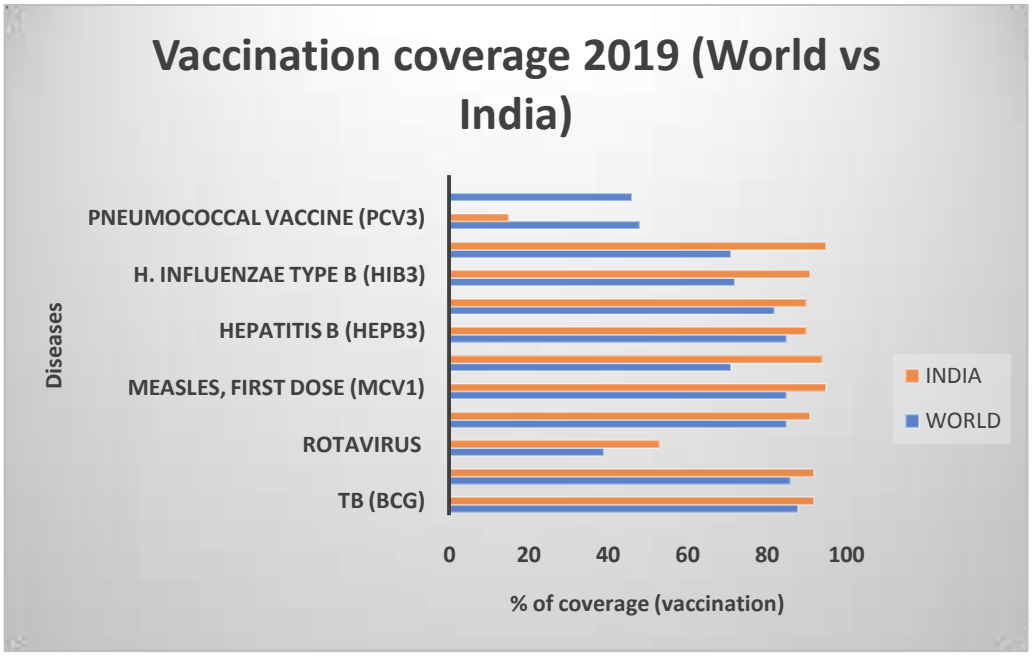

Graph 1 : Vaccination coverage 2019

The basic mechanism by which vaccines work is simple. It creates immunity in the receiver's body by inducing dead form of infection causing pathogen. So, when the body encounters the live-disease causing pathogen it sets up for defense. The social benefit of high vaccination coverage is immunization. The more population gets vaccinated, less the chances of the infections. This is one mode of hindering the transmission of infectious disease. When a large population is vaccinated, the community gets protection which creates herd immunity by minimizing the chances of infections within them. Herd immunity is a barrier between the disease-causing pathogen and human body. These includes the mass of people who are not vaccinated or the group which are immune-compromised. It minimizes the chances of infection to them also. When an individual is vaccinated, the individual himself act as a barrier for the transmission of disease. When the number of individuals reaches to an extent when pathogen can no longer access the human body by infecting it is called Herd Immunity Threshold (HIT). For instance; Measles which is highly infectious airborne disease needs highest HIT rates. For that two doses of measles vaccination offers 99% of protection while in absence of immunization comes with 100% lifetime risk.

Previously deaths due to infectious diseases were infant deaths due to their low immunity. But with the development in vaccines and awareness of vaccination the graph has tremendously declined over globe. But WHO estimates that 19.5M infants worldwide are still at risk of vaccine-preventable disease (VPDs) because they miss out on basic vaccines. Also, all the allotted doses of a vaccine need to be received for its more effective. For instance; for measles two doses of vaccine are recommended. An estimated 85% of children receive their first dose but this rate drops to 65% for second dose. So proper awareness is also necessary to avoid VPDs. Table 1 shows the vaccination schedule issued by the Government of India for children.

Table 1 : Vaccination schedule as per GOI

AGE	VACCINES
Birth	BCG, OPV(0), HepB
6 Weeks	OPV (1), Penta1 (DPT + HepB + HiB)

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10 Weeks	OPV (2), Penta2 (DPT + HepB + HiB)
14 Weeks	OPV (3), Penta3 (DPT + HepB + HiB), IPV
9 Months	MMR-1, /MR/Measles, JE Vaccine 1
16 – 24 Months	MR-1, OPV Booster, DPT 1st Booster, JE Vaccine 2
5 – 6 Years	DPT 2nd Booster
10 Years	TT1
16 Years	TT2

Vaccine Development

Vaccines contain tiny fragments of the disease-causing organism or the blueprints for making the tiny fragments. They also contain other ingredients to keep the vaccine safe and effective.

Antigen: All vaccines contain an active component (the antigen) which generates an immune response, or the blueprint for making the active component. An antigen is a substance that produced antibodies against a pathogen in the body. An antigen resembles to a molecular or molecular structure of the pathogen that can be bounded by any antigen specific antibody. Generally, presence of antigen triggers the production of antibody. Figure 1 shows how antibody binds with antigen.

Preservatives: the vaccine contains preservatives which prevents the vaccine from being contaminated. As one vial consists of dose which can administered to more than one person, upon opening the vial the vaccine contamination chances are high. Some vaccines which are one-dose vials doesn't contain preservatives as they are discarded after the single dose is administered. The common preservative used in vaccines is 2-phenoxyethanol.

Stabilizers: Stabilizers are the chemicals that prevent reactions from occurring within the vaccine. Stabilizers can be sugars (lactose, sucrose), amino acids (glycine), gelatin, and proteins (recombinant human albumin, derived from yeast).

Surfactants: Surfactants are added to the vaccine formulation to keep the components in vaccine blended together. They prevent settling and clumping of elements that are in the liquid form of the vaccine.

Residuals: Residuals are tiny amounts of various substances like proteins, antibiotics, yeast, etc. used during manufacturing or production of vaccines that are not active ingredients in the completed vaccine. They are measured in ppm or ppb.

Diluent: A diluent is a liquid used to dilute a vaccine to the correct concentration immediately prior to use. The most commonly used diluent is sterile water.

Adjuvant: Adjuvants are generally small amount of Al salts which improves the immune response of the vaccine at the site of injection.

The vaccine once developed, passes through evaluation and screening tests for the observation of immune response. In preclinical phase, experimental vaccine is first tested on animals to evaluate the potential of vaccine to prevent disease. If the vaccine triggers an immune response, it is then tested in human clinical trials in three phases.

Phase 1: In the first phase a small number of volunteers are given the vaccine to assess its safety and evaluate the immune response. The determination of right dose is also done in this phase. In this phase vaccines are tested in young, healthy adult volunteers.

Phase 2: The vaccine is then given to several hundred volunteers to further assess its safety and ability to generate an immune response. Participants are distinguished according to their same characteristics (such as age, sex) as the people for whom the vaccine is intended. There are usually multiple trials in this phase to evaluate various age groups and different formulations of the vaccine. A group that did not get the vaccine is usually included in phase as a comparator group to determine whether the changes in the vaccinated group are attributed to the vaccine, or have happened by chance.

Phase 3: The vaccine is next given to thousands of volunteers – and compared to a similar group of people who didn't get the vaccine, but received a comparator product – to determine if the vaccine is

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effective against the disease it is designed to protect against and to study its safety in a much larger group of people. Most of the time phase three trials are conducted across multiple countries and multiple sites within a country to assure the findings of the vaccine performance apply to many different populations. During phase two and phase three trials, the volunteers and the scientists conducting the study are shielded from knowing which volunteers had received the vaccine being tested or the comparator product. This is called "blinding" and is necessary to assure that neither the volunteers nor the scientists are influenced in their assessment of safety or effectiveness by knowing who got which product. After the trial is over and all the results are finalized, the volunteers and the trial scientists are informed who received the vaccine and who received the comparator. Figure 2 explains the phases of vaccination trials.

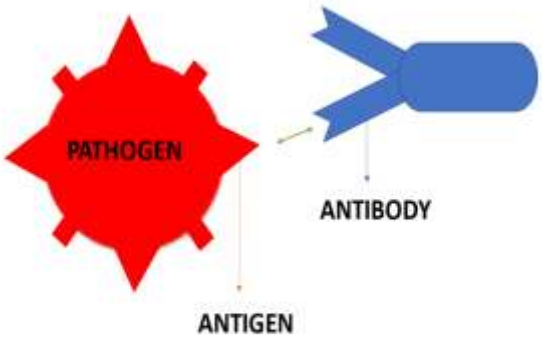

Figure 1 : Antigen mechanism

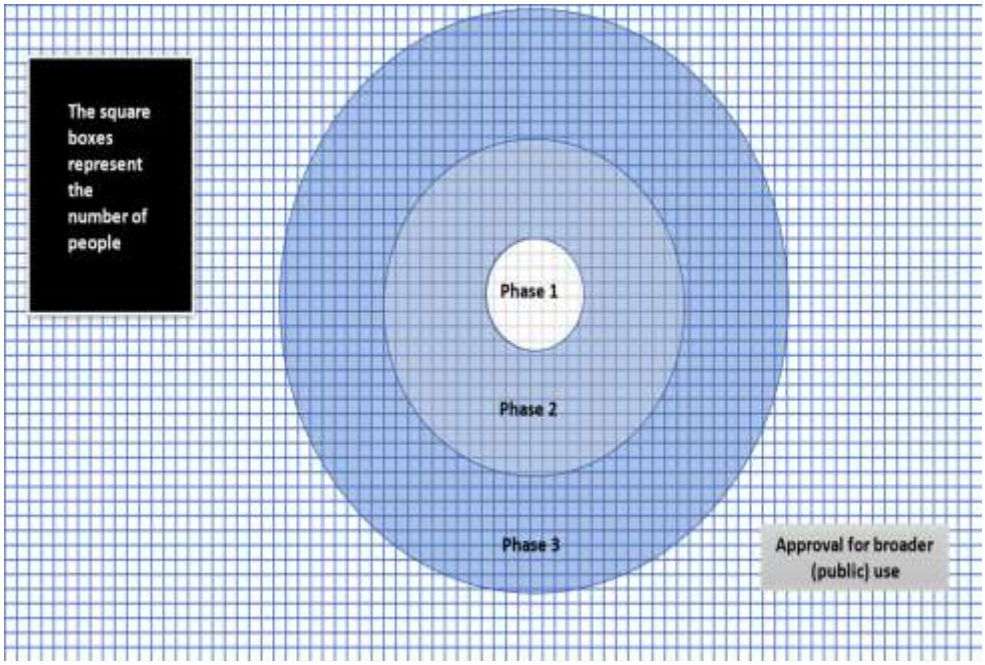

Figure 2: Phases of Vaccination trial

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The world is in the midst of a COVID-19 pandemic. As vaccination is the only tool that can protect against the deadly Corona virus.As of 18 February 2021, at least seven different vaccines across three platforms have been rolled out in countries. Vulnerable populations in all countries are the highest priority for vaccination.At the same time, more than 200 additional vaccine candidates are in development, of which more than 60 are in clinical development. COVAX is part of the ACT Accelerator, which WHO launched with partners in 2020. COVAX**,** the vaccines pillar of ACT Accelerator, convened by CEPI, Gavi and WHO, aims to end the acute phase of the COVID-19 pandemic by:

- speeding up the **development** of safe and effective vaccines against COVID-19;
- supporting the building of **manufacturing capabilities**; and
- working with governments and manufacturers to **ensure fair and equitable allocation** of the vaccines for all countries – the only global initiative to do so.

Vaccines are a critical new tool in the battle against COVID-19 and it is hugely encouraging to see so many vaccines proving successful and going into development. Working as quickly as they can, scientists from across the world are collaborating and innovating to bring us tests, treatments and vaccines that will collectively save lives and end this pandemic. Safe and effective vaccines will be a gamechanger: but for the foreseeable future we must continue wearing masks, physically distancing and avoiding crowds. Being vaccinated does not mean that we can throw caution to the wind and put ourselves and others at risk, particularly because it is still not clear the degree to which the vaccines can protect not only against disease but also against infection and transmission.Over 90 million people have received one dose, and over 11 million people have been fully vaccinated after receiving two doses.The country's drugs regulator has given the green light to two vaccines - one developed by AstraZeneca with Oxford University (Covishield) and one by Indian firm Bharat Biotech (Covaxin). Several other candidates are at different stages of trials.India launched vaccination drive on 16th January, but it was limited to healthcare workers and frontline staff - a sanitation worker became the first Indian to receive the vaccine.From 1st March 2021, the eligibility criteria were expanded to include people over 60 and those aged between 45 and 59 with other illnesses.The third phase, which began on 1st April 2021, includes everyone above the age of 45.India's total vaccinations crossed 100 million on 10th April 2021 as new Covid-19 cases rose at a record rate. Total active cases breached 1 million again with over 152,000 new ones on the same day.

At an average of over 3.5 million a day over the past week, India's vaccination rollout is among the highest in the world. However, given the large population, it's not enough to make a dent in the pandemic. Less than 10% of the population — most have received only the first dose—has been covered in close to three months. Vaccinations need to be stepped up, to about 5 million a day. Serum says it has been providing 65-70 million doses every month to India, and exported nearly an equal amount since it began production early this year. Vaccination is voluntary. State-run clinics and hospitals are offering free jabs, but people can also pay 250 rupees ($3.4; £2.4) a dose at private facilities. The government is spending around $5bn to provide free doses at state-run clinics, public health centres and hospitals. Table 2 and Graph 2 shows the progress of different countries in vaccine dose administration.

Table 2 : Doses of vaccines administered in countries

Country	**Vaccination in Millions**
US	178.84
China	155.15
India	101.28
UK	38.44
Brazil	29.21
Germany	17.04
France	14.11

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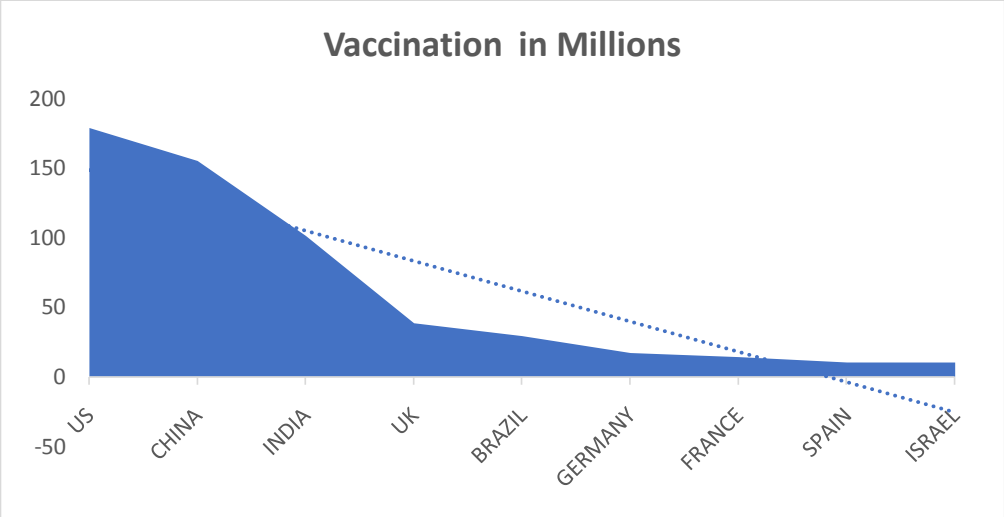

Graph 2: Doses of vaccines administered in countries

II. CONCLUSION

The evolution of vaccine has saved millions of lives. The scenario of vaccination was a complex procedure in past due to illiteracy and less awareness. The review concludes that immunization is the necessity in the present crisis of COVID19. From the past events it is seen vaccination is the only tool against deadly diseases thus efforts of immunization are evitable. India is striving hard for the COVID19 vaccination process and implementing the highest doses of vaccine to the citizens. Also, India is exporting vaccine doses to the neighboring countries in order to achieve global immunization.

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