Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2021, 13(4):01-09

Review Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Vaccines in Recent Virology: A Prospect to Covid-19 Prevention

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ABSTRACT

Viruses and viral illnesses have for thousands of years been at the forefront of research, agriculture and medicine, with virology as a major challenge. Smallpox is a prime example. Smallpox is also the only disease ever eradicated on the planet that has made history literally different during the European conquest of the New World. Unfortunately, there have been very little general knowledge scientific developments in virus understanding. It is difficult to understand relevant facts, and it can seem inconsistent as though one researcher's advice is rejected. Furthermore, confusion is rampant on viruses and vaccines. This false information is persistent, widely circulated and increasingly difficult to overcome as the Internet provides more people with health information. Growing percentages of the parents prefer to delay or reject their child's vaccinations to avoid several kinds of harmful Viral Infections. Typically, vaccines work by creating "herd immunity," where vaccination is sufficiently large to prevent the maintenance of viral transmission lines to reduce susceptible hosts. However when vaccine levels decline too low, person to person infections can spread easy, leading to widespread disease outbreaks. This paper highlights about vaccines in Virology field.

Keywords: Virology; Vaccine; Infectious disease; Development

INTRODUCTION

Historically, infectious diseases have been the most important contributing factor to human morbidity and mortality until recently, when non-communicable diseases began to rival and sometimes exceed infections. Today, infectious diseases still account for large proportion of deaths and disability worldwide and still remain the most important cause of ill health. Infectious diseases are the world's greatest killers, accounting for more than 13 million deaths annually among children and young adults alone. Most deaths from infectious diseases occur in developing countries, where they account for half of all deaths. Places of every nation and every person is a risk because Infectious diseases today ignore geographic and political boundaries. Food products, livestock, exotic pets, and material goods and the microbes they carry are exchanged as cultures from every region of the world are explored. Infectious diseases continue to burden populations around the world. Both naturally occurring and intentionally introduced biological threats hold increasing potential to cause disease, disability, and death.

The Global Burden of Disease Study (GBDS) estimates that, in the year 2000, infectious diseases were responsible for 22% of all deaths and 27% disability-adjusted life years (DALY) worldwide [1]. They impose a particular

burden on children especially those under five although infectious diseases can affect people of all ages. This is not only because younger age group have a lower prevalence to non-communicable diseases but because they are more susceptible to new infections than adults, lacking the protective mechanism to reduce the impacts of these illnesses. Infectious diseases usually extracts a high toll of population in regions where the high proportion of the population is made up of young people like Africa, Latin America and many other developing regions. This paper will highlight and review about Virology and recent vaccines in the field.

OVERVIEW OF VIROLOGY

A virus is an intracellular parasite that is obligatory, meaning that it can only live within a host cell and relies on it for replication and metabolic processes, such as protein synthesis. Based on their genome (DNA or RNA) or other structural elements, such as the capsid, the envelope, and the viral receptor proteins (spikes), viruses may be identified. Within the host cell, the viral replication cycle occurs and includes attachment to and penetration of the host cell, nucleic acid uncoating, nucleic acid replication, virus protein synthesis, part assembly, and release of new viruses through budding or cell lysis. Between DNA and RNA viruses, the mechanism of nucleic acid replication varies. In order to inactivate and kill viruses, the host body has different physical and immunological defense mechanisms. However once an active infection is resolved, certain viruses have the potential to remain in a latent state throughout the host's body (e.g., Herpesviridae). Serologic examination and nucleic acid detection are the most important diagnostic methods in virology.

Virion

An infectious type of a virus that exists outside cells consisting of DNA or RNA, a capsid protein and often an envelope. Its structure includes viral genome Capsid and Envelope.

Viral Life Cycle

Viruses replicate by synthesizing and assembling their individual components within the host cell.

- Attachment to the host cell: viruses use host cell surface proteins and receptors for entry
- Penetration into the host cell
- Uncoating of the nucleic acid
- Replication of the nucleic acid and formation of virus proteins by transcription and translation.
- Assembly of virus components
- Viral release which includes

a) Enveloped viruses: released through budding

b) Non-enveloped viruses: released *via* host cell lysis

SPREADING OF INFECTIOUS DISEASES

Direct Touch, Direct Contact

A simple way to catch most infectious diseases is to come into contact with an infected person or animal *via* direct touch, infectious diseases may be transmitted, such as:

Person to individual: Infectious diseases usually spread to anyone who is not infected by the direct transmission of bacteria, viruses or other germs from one person to another through hugs, kisses, or coughs or sneezes. The sharing of body fluids from sexual contact may also spread these germs.

From animal to human: In extreme circumstances, being bitten or scratched by an infected animal (even a pet) can make you sick and can be fatal. It can also be harmful to treat animal waste. For example, by scooping your cat's litter box, you can get a toxoplasmosis infection.

Mother to unborn child: A pregnant woman can pass on germs to her unborn baby that cause infectious diseases *via* the placenta or through breast milk, some germs may pass through. During birth, germs in the vagina may also be passed to the infant.

Indirect Contact

Disease-causing organisms also can be passed by indirect contact. Many germs can linger on an inanimate object, such as a tabletop, doorknob or faucet handle. When you touch a doorknob handled by someone ill with the flu or a cold, for example, you can pick up the germs left behind. If you then touch your eyes, mouth or nose before washing your hands, you may become infected.

Insect bites: Some germs rely on insect carriers such as mosquitoes, fleas, lice or ticks which move from host to host. These carriers are known as vectors. Mosquitoes can carry the malaria parasite or West Nile virus. Deer ticks may carry the bacterium that causes Lyme disease.

Food Contamination

Disease-causing germs can also infect one through contaminated food and water. This mechanism of transmission allows germs to be spread to many people through a single source.

Vaccination

Vaccination is the administration of a vaccine to help the immune system develop protection from a disease. Vaccines contain a microorganism or virus in a weakened, live or killed state, or proteins or toxins from the organism. The body's immune system helps protect against pathogens that cause infections. It either the microorganisms out or tracks them down and get rid of them. Pathogens that mostly cause problem are the ones the body doesn't recognize. They overwhelm the immune system which will lead to serious illness. Vaccination is a way to "teach" the immune system how to recognize and eliminate an organism [2].

When a sufficiently large percentage of a population has been vaccinated, herd immunity results. Herd immunity protects those who may be immune compromised and cannot get a vaccine because even a weakened version would harm them. Herd immunity protects those who may be immune compromised and cannot get a vaccine because even a weakened version would harm them [3]. Vaccination is the most effective method of preventing infectious

diseases widespread immunity due to vaccination is largely responsible for the worldwide eradication of smallpox and the elimination of diseases such as polio and tetanus from much of the world.

How a Vaccine Works?

Vaccines are a way of artificially activating the immune system to protect against infectious disease. The activation occurs through priming the immune system with an immunogen. Stimulating immune responses with an infectious agent is known as immunization. Vaccination includes various ways of administering immunogens [4]. Most vaccines are administered before a patient has contracted a disease to help increase future protection. A healthy immune system defends against invaders. The immune system is composed of several types of cells. These cells defend against and remove harmful pathogens. However, they have to recognize that an invader is dangerous. It stimulates the body to make antibodies against antigens of pathogens. It also primes immune cells to remember the types of antigens that cause infection. That allows for a faster response to the disease in the future.

Vaccines work by exposing you to a safe version of a disease. This can take the form of:

- Protein or sugar from the makeup of a pathogen
- Dead or inactivated form of a pathogen
- Toxoid containing toxin made by a pathogen
- Weakened pathogen

When the body responds to the vaccine, it builds an adaptive immune response. This helps equip the body to fight off an actual infection.

Vaccines are usually given by injection. Most vaccines contain two parts. The first is the antigen. This is the piece of the disease your body must learn to recognize. The second is the adjuvant. The adjuvant sends a danger signal to your body. It helps your immune system to respond more strongly against the antigen as an infection. This helps you develop immunity.

Brief History of Vaccine Development in Virology

The story of vaccines did not begin with the first vaccine, Edward Jenner's use of material from cowpox pustules to prove protection against smallpox. It begins with the long history of infectious disease in humans and with early uses of smallpox material to provide immunity to that disease. The Chinese employed the inoculation of smallpox as early as 1000 CE and was practiced in Africa and Turkey before it spread to Europe and Americas. Edward Jenner’s innovations begun with the successful 1796 use of cowpox material to create immunity for smallpox and the practice was spread. His method went through medical and technological changes over the 200 years and resulted to the eradication of smallpox. Louis Pasteur's 1885 rabies was the next to make an impact on human disease and development followed rapidly at the dawn of bacteriology. Antitoxins and vaccines against diphtheria, tetanus, anthrax, cholera, plague, typhoid, tuberculosis and more were developed through the 1990s. At the middle of the

20th century was an active time for vaccine research and development. Methods for growing viruses in the laboratory led to rapid discoveries and innovations of vaccines for polio. Innovative techniques now drive vaccine research with recombinant DNA technology and new delivery techniques leading scientists in new directions.

Previous Virus Incidence Causing World Disruption and their Vaccines for Curing Them

The previous virus incidence causing world disruptions include:

ZIKA: Zika virus disease is caused by a virus transmitted primarily by Aides mosquitoes. It can be transmitted by pregnant women to developing babies and infection during pregnancy can cause microcephaly and other serious birth defects. Mosquito bite is the most common form of zika transmission. The virus has been isolated for the first time in 1947 in the Zika forest in Uganda. It has remained mainly in Africa, with small and sporadic outbreaks in Asia. A major epidemic was reported n the Island of Yap (Micronesia) in 2007 which affected 75 percent of population. Large outbreaks occurred in 2015 and 2016 in Puerto, Rico and the US Virgin Islands and limited local transmission in Florida and Texas. This virus spread all over the world and case count is difficult because symptoms of the disease tend to be mild and not everyone affected is seen by a healthcare Professional.

The symptoms may include mild fever, rash, conjunctivitis, muscle and joint pan, malaise or headache. The best way to prevent Zika is to reduce mosquito populations and avoid bites. There is no specific vaccine for Zika virus. Treat the symptoms and get plenty of rest (National Foundation for Infectious Diseases, n.d).

Whooping cough: Whooping cough is also known as Pertussis. Pertussis is a highly contagious and serious infection that spreads easily from person to person through coughing, sneezing and breathing. The infection causes coughing spells that are so severe which can be hard to breath, eat or sleep. This can lead to cracked ribs, pneumonia, o hospitalization. Babies who get whopping cough are infected by older siblings or parents. According to Centers for Disease Control and Prevention (CDC), there are estimated 16 million cases of whooping cough and about 195,000 deaths per year in the world. 200,000 children got sick whooping cough each year in the US and about 9,000 died before Pertussis vaccine became widely available in the 1940s (National Foundation for Infectious Diseases, n.d). The classic symptom is whoop (the sound of one gasping for breath during a bad coughing spell). Whooping cough can be spread before symptoms appear.

Diphtheria-tetanus-Pertussis (DTP) is the vaccine used for curing the infection. The Centers for Disease Control and Prevention (CDC) recommends whooping cough vaccines for people of all ages. Babies and children should get 5 doses of Diphtheria-tetanus-Pertussis. One dose at 2-6 months, one at 15-18 months and another at 4-6 years. Preteens at 11-12 years should get the booster dose of tetanus-diphtheria-Pertussis (TDAP). Teens or adults who did not get vaccinated against TDAP should get one dose. Pregnant women should get TDAP during the third trimester of each pregnancy (National Foundation for Infectious Diseases).

Tetanus: Tetanus commonly called lockjaw is a bacterial disease that affects the nervous system. It is contracted through cuts or wounds that get contaminated with tetanus bacteria. The infection is present worldwide and mostly found in soil and most surfaces. Tetanus is a vaccine-preventable disease that is not transmitted from person to person.

Headache, muscular stiffness in the jaw (lockjaw), stiffness of the neck, difficulty swallowing, hardening of abdominal muscles, spasms, sweating and fever are common initial symptoms of tetanus.

Diphtheria-tetanus-Pertussis is the vaccine used in curing tetanus. Some people receive their first dose as children in the form of a combined vaccine called diphtheria-tetanus-acellular pertussis (DTAP). Health officials who recommend that adults and adolescents receive a tetanus-diphtheria-acellular pertussis (TDAP) or TD (tetanus-diphtheria) booster vaccine every 10 years (National Foundation for Infectious Diseases, n.d).

Norovirus: Norovirus is a group of related viruses that are highly contagious. One can get norovirus from an infected person, contaminated food or water, or by touching contaminated surfaces. It is commonly referred to as food poisoning or a stomach bug. Noroviruses are the most common cause of gastroenteritis in the US. Norovirus cause between 19-21 million cases of gastroenteritis each year in the US. Norovirus outbreaks have been reported in many settings including healthcare facilities, restaurants, schools and childcare centers. Vomiting, stomach cramping, nausea and diarrhea are symptoms of norovirus (National Foundation for Infectious Diseases).

No vaccines are currently available to prevent norovirus. The best way to prevent norovirus is washing the hands thoroughly with soap and water. If one has the illness, drinking of plenty of liquids to prevent dehydration is needed.

Mumps: Mumps is a contagious disease caused by a virus. Outbreaks of mumps still occur in the US especially among people who live in close quarters or close contact with an individual who has mumps. It spreads through coughing, sneezing, close contact or sharing cups or water bottles, kissing or playing sorts with one that has been infected. Mumps starts with a few days fever, headache tiredness and loss of appetite. Symptom typically appears 16-18 days after infection but this period can range from 12-25 days after infection. The measles-mumpis-rubella (MMR) vaccine is the best way to protect against mumps (National Foundation for Infectious Diseases).

Measles: Measles is a highly contagious respiratory disease that can result in severe, sometimes permanent, complications including pneumonia, seizures, brain damage, and even death. Measles is caused by a virus that lives in the nose and throat mucus of an infected person and spreads easily through breathing, coughing, and sneezing. When someone with measles coughs, sneezes, or talks, infected droplets spray into the air (where other people can inhale them) or land on a surface, where they remain active and contagious for several hours Measles is so contagious that if one person has it, up to 90% of the people close to that person who are not immune will also become infected. Infected people can spread measles to others from four days before through four days after the rash appears. Measles can be serious:

The measles mumps rubella (MMR) vaccine is a safe and effective way to prevent measles. In the US, two doses of the measles mumps rubella are recommended for children. Adolescents who were not vaccinated could get two doses.

Ebola: Ebola is a rare and deadly disease caused by infection with the Ebola virus genus, a virus of the Filoviridae family. Ebola can cause illness in humans and other primates (monkeys, gorillas, and chimpanzees). In what is now the Democratic Republic of the Congo, Ebola was first discovered in 1976 near the Ebola River. In many African countries, outbreaks have occurred sporadically since then. The Ebola outbreak of 2014-2015 was the worst in history, affecting many West African nations. Although the risk of an Ebola outbreak in the United States is very low, precautions have been taken by the Centers for Disease Control and Prevention (CDC) to prevent an outbreak from happening (National Foundation for Infectious Diseases).

Healthcare workers caring for patients with Ebola and those in close contact with patients with Ebola are at the greatest risk of becoming ill, since they may come into contact with patients' blood or body fluids. When in direct contact with humans (through broken skin, skin areas opened by cuttings, abrasion, dermatitis, squashed skin, or mucous membranes) the virus is spread with:

- Fluids of the blood or body
- Items tainted with the virus (e.g. needles)
- Animals that have been tainted.

Newly Developed Vaccines in Curing Infectious Diseases

According to the World Health Organization, 240 vaccines were in development for 25 infectious diseases [5]. However, As of April 2020, the United States biopharmaceutical companies have about 260 vaccines under production to prevent and treat diseases like cancer, Alzheimer's disease, allergies and autoimmune disorders. These vaccines reflect considerable hope for the future with several new technologies used in the pipeline to protect against malaria and even preventive vaccines for different kinds of cancer, prevent the transmission of the human immunodeficiency virus (HIV). Vaccines of interest in development include those for the following conditions: Dengvaxia, the first licensed dengue vaccine approved by the Food and Drug Administration in May 2019. It can be used at birth. RV144, a promising HIV vaccine. 20-valent Pneumococcal Conjugate vaccine (20vPnC) for Pneumococcal infection.

DISCUSSION

Shingnx Vaccine used for curing shingles; GSK Company produced the second shingle vaccine and approved in 2017. Shingrix is a recombinant adjuvant zoster vaccine and is recommended in adults 50 years of age and older for the prevention of herpes zaster (bittern). The second dose is given 2–6 months after the first dose [6]. Following the outbreak of Ebola virus in 2014 majorly in West Africa, researchers has been studying the virus and came up with a

vaccine called A recombinant Ebola virus disease vaccine (Ad5-EBOV) which has been successfully developed jointly by Beijing Institute of Biotechnology and CanSino Biologics Inc.

Another approved meningococcal group B vaccine is Trumenba developed by Pfizer, initially approved in 2014 to prevent invasive disease caused by Neisseria meningitidis serogroup. A new HBV vaccine, recombinant, with adjuvant (Heplisav-B) has been developed by Dynavax Technologies Corporation for preventing hepatitis B virus infections.

Is there any Vaccine for Coronavirus Disease?

There are currently no vaccines for coronavirus disease. The Food and Drug Administration has approved the antiviral drug remdesivir for treating certain patients who are hospitalized for COVID-19. Many clinical trials are underway in the United States and other countries to evaluate new drugs for treating patients with COVID-19. A recent study from Italian researchers showed a relatively slow mutation of the SARS-CoV-2 coronaviruses, which are at the root of the COVID-19 disease, indicating that any vaccine that is effective in preventing people being infected should be generally effective over a relatively long time across regions separated by the disease (Darrell, 2020). However, studies has been made showing that Coronavirus mutates slowly just like Flu. This latest evidence for the hypothesis that the virus behind it travels very slowly with its genetic makeup is also excellent news for the COVID-19 pandemic. Any vaccine is likely to continue at least one year, but this study at least indicates that it will operate broadly and for at least a few years. There are currently 560 unique treatments being tested globally for COVID-19 and COVID-19 related complications. The chart shows the phases of development for current COVID-19 treatments. When analyzing the active clinical trials, of the 1,560 active clinical trials, a little more than half (57%) are targeting the virus directly, while the rest of the trials focus on related effects of COVID-19 such as pneumonia. Of the 1,560 active clinical trials, 990 trials are testing medicines previously approved for another indication, such as antiviral combinations, and over 230 trials are testing novel compounds [7-9].

CONCLUSION

In the past, vaccines have a long list of accomplishments. In terms of protection of people and populations from severe infectious diseases and reducing healthcare costs, vaccines were highly beneficial all over the world. Vaccines for babies, adolescents and adults in developing countries are more readily available. Over 90 percent of children in the European, African and Asian region receive basic infant vaccine at least. The provision of effective vaccination worldwide faces many challenges. First, in many countries including the USA, the United Kingdom and China, vaccine hesitation remains a problem. In the case of insufficient supply, e.g. lack of vaccine, lack of a bid, there is no vaccine hesitation in this case. Incorrect travel/distance to immunization clinics and inadequate contact with the vaccination programme, etc. However, the use of vaccines cannot be over-emphasized and most researches are currently on-going to aid the advancement of vaccine use.

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