**Forum: Promoting Science**

**Agenda: On measures to promote universal use of vaccines**

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**Introduction**

For thousands of years, our human species have been in close contact with various of diseases. It isn’t an exaggeration to say that the diseases have changed our history. Only a century ago, the leading causes of death were the outbreaks of infectious disease. Over time, scientists and physicians developed method to protect our human species from disease using vaccines. Referring to a French chemist Louis Pasteur who developed rabies vaccine, vaccines are defined as “suspension of live (usually attenuated) or inactivated microorganisms (e.g., bacteria or viruses) or fractions thereof administered to induce immunity and prevent infectious disease or its sequelae.” Now we have vaccines that can prevent more than 20 life-threatening diseases. Immunization using vaccines have been the major driving forces to meet the Millennium Development Goals (MDGs) signed in 2000. For MDG 4, which is to reduce child mortality; the vaccination saved 2-3 million children each year from deadly childhood diseases.

According to the Centers for Disease Control and Prevention, “vaccines have reduced preventable infectious disease to an all-time low and now few people experience the devastating effects of measles, pertussis and other illnesses.” Smallpox, a deadly disease that affected humans for thousands of years, was officially eradicated after the Global Smallpox Eradication Program launched in 1967. Also, after the vaccine for diphtheria was developed, only two cases have been reported to Center of Disease Control (CDC) between 2004 and 2014. The measles vaccination had prevented an estimated 23.2 million deaths between 2000 and 2018.

Despite the effectiveness of vaccines, WHO listed vaccines hesitancy as the top 10 threats to global health. Each year, nearly 20 million people have insufficient access to vaccines. Annually, about 1.5 million people die annually from diseases that can be prevented by vaccination. The global vaccination coverage, which is the proportion of the children worldwide who received recommended vaccines, remained unchanged for past few years. The consequences are more severe in developing countries. Almost 20% of children born every year in developing countries do not get the required immunizations scheduled as an infant. Possible barriers that slowed the process includes the lack of health care system in developing countries and incorrect information about vaccines. Also, many developing countries are not able to afford expensive vaccines for their people. However, going back to the main topic, immunization not only protect us from diseases, but it also prevents the spread of disease to other people. Vaccines are key to promote global health and are the most efficient tool to prevent and control the outbreaks of infectious disease. We can never ignore how vaccination had saved our human species from life-threatening diseases for hundreds of years.

**Key Terms**

**Infectious Disease**

A disease caused by virus or microorganism (pathogen) that are considered communicable disease which means they can spread from person to person. Examples of infectious disease are influenza, cold, chicken pox, measle, malaria and tuberculosis.

**Vaccines**

A small biological mixture that is made up of weak or dead germs that stimulates a person’s immune system to create immunity to a specific disease, preparing the body from that disease.

**Inoculation**

The process of introducing an antigenic substance or vaccines into the body to trigger immune response against a specific disease. In early days, it was commonly practiced by blowing smallpox scrabs into a person’s nostril.

**Variolation**

The method of immunizing individuals against smallpox. It would induce a mild form of disease, which would prevent from being reinfected by same disease.

**Antigen**

A substance that can stimulate the immune system to produce antibodies. Bacteria, viruses, or fungi that cause infection and disease are example of antigens. Antigen has distinct surface features, known as epitotes, which results in specific resonsis.

**Antibody**

Also called as immunoglobulin, antibody is Y-shaped protein molecules produced by B cells of immune system in response to antigens. The paratope inside each antibody recognizes specific epitope on an antigen, carrying our lock-and-key binding mechanism. The binding cause direct neutralization or “tag” other segment of immune system to eliminate antigens from body.

**Anti-vaccination Movement**

A loosely organized conspiracy-theorists known as antivaccinationists who believes the vaccines contributes factors that can cause disease as it is not supported by scientific evidence. The antivaccinationists believe vaccines such as MMR (mumps, measles and rubella) and use of ingredient like thiomersal, a mercury-containing preservative, can cause health problems. It focuses on the long-term side effects of vaccination.

**Global Health**

An area for study, research, and practice that places a priority on improving health and achieving health equity for all people worldwide. It is also known as collaborative transnational research and action for promoting health for all.

**General Overview**

*Availability of vaccines in developing countries*

Immunization levels are low in developing countries because of factors such as expensive costs, lack of competition in market, lack of research and development, distribution, and weak health system. According to WHO, it is estimated that it costs over US$500 million and takes more than 15 years to develop a vaccine, which is inaffordable for developing countries who has weak economy. The infectious disease in developing countries differ from developed countries. However, due to lack of infrastructure, it is hard to conduct clinical trials in developing world. Vaccine hesitancy is one of the reasons for low immunization levels in developing countries. However, the reason behind it is not related to anti-vaccination movement; it is mostly because of lack of information on vaccines. The developing countries’ government are promoting education about vaccines and tries to solve the issue of misinformation. Developing countries faces challenges when transporting vaccines. The study showed that one in five children mainly in low-income countries do not receive childhood immunization due to difficulties in delivering. Vaccines are more temperature sensitive then other medical products, so reliable refrigeration is needed. However, cold chain process is not fully developed like developed countries do due to lack of transportation systems or no electricity in some areas in developing countries. Over the past decade, the developing countries were able to gain more access to vaccines by getting supports from other developed countries or organizations. Starting from 2000, after Gavi, the Vaccine Alliance was launched to introduce vaccines to developing countries, the governments of developing countries relies on the doners such as UNICEF and World bank. In the 68 countries that was supported by Gavi, 4.8 million more children were vaccinated against pneumonia and 2.3 million against rotavirus.

*Availability of vaccines in developed countries*

In contrast to developing countries, developed countries has high access to vaccines. Unlike the developing countries, the developed countries has economical ability which can afford to have new, expensive vaccines. The governments of developed countries provides financial supports for its people when vaccinated. For example in France, vaccination is available for all residents in country, mandatory for children, with 70% of vaccination cost is covered by public health issues. The French government also pays high attention to spreading information about vaccination. The recent study showed that United States, European Union had already confirmed purchase and secured the largest amount of potential doses. It is also stated that rich governments had already purchased about 80% of Pfizer’s Covid-19 vaccine, equal to 1 billion doses. However, it only represents 14% of global population. Due to its sufficient availability of vaccines, several developed countries partenered with funding organizations such as Gavi and Bill and Melinda Gates foundation to provide financial support for developing countries. Furthermore, developing countries has well refrigiration system implemented with advanced transportation system, it is more easy to transport and receive vaccines.

*Process of vaccination*

A vaccine works by training immune system to recognize and combat pathogens known as viruses and bacteria. In order to do this, substances called antigens from a pathogen are injected into the body. When these antigens are introduced, the body identifies it as hostile invader, then it triggers the B cells in immune system and start make antibodies. These antibodies bind to certain antigens depending on its epitope and mark it for destruction. Another cell called T cells are produced to destroy infected cells. Simultaneously, the white blood cell produce memory T cells and B cells to remember the antigens that have entered. It stimulates immune system in form of “immunological memory”. If the body is once again exposed to same pathogen, the memory cells makes the antibodies to produce more faster and more effective than the first time The memory cells allow you to perform strong response and attack the infected cells before the disease gets spread within the body. Depending on specific body area where pathogens are likely to invade and harm the body, different methods of injections takes place. For yellow fever and MMR vaccines, it is injected into the layer of fat between skin and muscle because it works best when it is distributed slowly into the body. Internasal delivery of vaccines are used for influenza which needs to go through nasal mucous barrier. Also, vaccines containing aluminum-based adjuvants are injected into outermost layer of skin to avoid damages to blood vessels and nerves. However, the vaccination does not provide lasting protection. Therefore, extra administration of vaccine may be needed to regain immunity.

*Types of vaccines*

**Live attenuated vaccines**

These vaccines introduce actual live pathogens into the body. However, the pathogens are weakened or attenuated before it is given, so that it can stimulate the immune system without full infection. Because these vaccines contain living pathogens, they are not given to people with weak immune system, such as people receiving HIV treatment or chemotherapy, who has high risk of getting sickness. Live attenuated vaccines result in life-long immunity with only one or two doses. It is used in chickenpox, rotavirus and MMR vaccine

**Inactivated vaccines**

Inactivated vaccines contain inactive version of virus or bacteria, the one that has been killed with heat or chemicals, and its cells are introduced to the body. Inactivated vaccines are not as accurate as live attenuated virus, which requires several doses, but it is safer since the pathogens cannot reproduce and cannot mutate back to its disease-causing form. Polio, hepatitis A and rabies vaccination contains inactivated pathogens.

**Subunit vaccines**

In subunit vaccines, only essential antigens of a pathogen that best stimulate a response is included. These vaccines can train immune system with low chance of adverse reaction and without provoking sickness. However, only certain vaccines can be produced this way since separating specific antigens is not always possible. It induces a weaker immune response. Subunit vaccines are used for hepatitis B, pertussis and human papillomavirus (HPV) vaccines.

**Toxoid vaccines**

Some disease damages the body by secreting harmful produces of bacteria, known as toxins. Vaccines for tetanus and diphtheria use toxoid, inactivated version of toxins by mixing with formaldehyde and water, to stimulate immune response.

**Conjugate vaccines**

For bacteria that cause haemophiles influenza type B (Hib), it is coated with sugar molecules that camouflage the antigens on their surface, causing difficulties for immune system to recognize especially in young immune systems of children. Conjugate vaccines are used to link recognizable antigens to sugar-coated camouflaged bacteria, which the body’s immune system is able to recognize and triggers immune response.

*Vaccine development for Covid-19*

Due to the increasing number of confirmed cases and death caused by Covid-19, attention of people around the world has been drawn to the development of Covid-19 vaccine. In response, In April, WHO in partnership with Gavi and CEPI, launched the COVAX initiative, in order to speed up the development of Covid-19 vaccines. Its goal is to secure 2 billion doses by end of 2021 and immunize up to 20 percent of participant countries’ population. As of October 19, 82 countries had joined the initiative and raised more than $2 billion. Up to this point, COVAX had secured about 700 million doses of Covid-19 vaccines, far more than UK, Japan and Canada. Also, Pfizer and BioNTech submitted the request to U.S. Food and Drug Administration (FDA) for Emergency Use Authorization (EUA) of their COVID-19 vaccine candidate. It is expected to produce up to 50 million vaccine does in 2020 and up to 1.3 billion does by the end of 2021. The results of Phase 3 trials showed their vaccine was 95 % effective in preventing the Covid-19 symptoms, without any adverse side effects.

*Barriers to vaccine usage*

Anti-vaccination movement has been around since Edward Jenner’s experiment which he inserted cowpox pustule into a boy’s arm in 1796, but became more prominent nowadays due to the wide use of social media. Anti-vaccination movement, presented by anti-vaxxers, the people who refuse the idea of vaccination. Despite the fact that vaccines are one of the most important advance in medicine, they believe the vaccines are “unsafe and infringe on their human rights.” Even though anxi-vaxxers represent minority of people, the idea is spreaded widely on the social media and internet, thus influencing many people’s decision whether to receive vaccination or not. There are many reasons that slowed down the process of vaccination, but the major cause is the misinformation about vaccines safety. The six common misconceptions about vaccines highlighted by WHO are: diseases were already declining before the invention of vaccines due to improvements in hygiene and sanitation; most people who get diseases are already vaccinated; some batches of vaccines are safer than others; vaccines cause many harmful side effects and illnesses; the diseases that vaccines prevent are no longer prevalent, so there is no need for vaccines; giving children multiple vaccines at once increases the risk of harmful side effects. In 1998, a former medical doctor named Andrew Wakefield published his research about the link between the measles, mumps, and rubella (MMR) vaccination and autism of children. Autism is a set of physchological behavirors often characterized by an emphasis on routine and repetition, fixed behavior patterns, and impared social interaction. In contradiction to his research, there are many studies which involves large sample sizes, that there is no ingredient in MMR vaccine that cause autism, concluding that there is no link between MMR and autism. However, this “scandal” had led to decreased usage of MMR vaccines, which resulted in increase in measles and mumps outbrakes in U.K. Some people assumed there was connection between thimerosal and autism. They believed thimerosal, a mercury-based preservative used in some flu vaccine, triggers autism. Every parents wants only what is good for their children and try to protect them from any harm. Hence, many parents started to refuse vaccination for their family. However, according to the CDC, the thimerosal used in vaccines didn’t have any harmful effects, and there is still no scientific evidence to the link between MMR vaccination and autism. moreover, in 2004, Institutes of Medicine reported that there is no association between autism and vaccines that contained thimerosal as a preservative.

*Immunization exemptions*

Medical, religious and personal exemption stops people from receiving vaccination. Medical exemption can be asked by parents who believe vaccines can harm their children. Common reasons the children can get exemptions are presence of allergy to an ingredient in a vaccine, serious reaction to vaccine in the past and consumption of medicine or disease that weakens children’s immune system. Parents can also refuse getting vaccinated based on their religious belief. Tenets of some religions prohibits vaccination. As an example, Christian Scientists believes diseases can be cured through praying, so vaccines are not necessary. Lastly, personal or philosophical exemptions can be obtained based on parents’ belief about vaccines safety. Common reasons for the concerns include the theory that vaccines cause autism. In United States, all states allow medical exemptions, states except California, Mississippi and West Virginia allows religious exemptions, and 17 states allows personal exemptions.

*Alternatives for vaccines*

Since the purpose of vaccination is just to strengthen the immune system, some people find no need to inject disease and poisonous materials into our body to achieve stronger immune system. They present several different alternative methods to strengthen our immune system. Breastfeeding is one of the popular ideas among parents to boost the immune system for the babies. When breastfeeding, the mother’s immunity is passed to the baby. A study showed that the mothers who have been naturally built-up immunity against the pathogen were able to protect their children four times longer than the mothers who were vaccinated. Consuming vitamin supplements and probiotics are known to keep your body away from disease. Vitamin D can prevent us from asthma, cancer and infectious disease. Probiotics can fight out the disease that attacks your intestines, respiratory tack and urinary tract. Lastly, healthy diets can protect the body from disease. Consuming variety of food in different colors can provide adequate nutrients. Manuka honey, red reishi and matake mushrooms are some highlighted food that has direct impact on improving immune system.

*Major Organization/Parties Involved*

**World Health Organization (WHO)**

World Health Organization is an UN agency that works with 194 Member States. It funds and coordinates international programs that promotes health, monitor disease and track global health statistics. WHO’s mass vaccination programs had hugely supported the eradication of smallpox in 1979, and 99 percent decrease in polio infection. WHO is working with partners to increase the global vaccination coverage through “Global Vaccine Action Plan 2011-2020”. Through the plan, WHO “works to increase funding for immunization and ensure safe and reliable vaccine supply system; supports individuals and communities to understand the value of vaccines and demand immunization as both their right and responsibility.”

**United Nations Children’s Fund (UNICEF)**

The United Nations Children’s Fund works with governments, non-governmental organizations (NGOs), UN agencies and initiatives to provide immunization to the children in need, build local capacity and advocating for the right of immunization. UNICEF majority focuses on vaccination children in every community, disease eradication, building demand for immunization through communication, innovation of new vaccines, and cold chain to make sure the vaccine gets reached to children.” In 2019, UNICEF successfully secured vaccines to reach more than half of the world’s children. UNICEF also established Vaccine Security Strategy to ensure sustainable supply of affordable and quality vaccines.

**Expanded Programme on Immunization (EPI)**

Expanded Programme on Immunization was launched in 1974 by WHO. The goal of EPI was to increase vaccination rate among children in developing countries. By 1990, vaccination was protecting over 80% of world’s children from six childhood disease: tuberculosis, polio, diphtheria, pertussis, tetanus and measles.

**Bill and Melinda Gates Foundation**

Bill and Melinda Gates Foundation is an American private foundation founded by Bill and Melinda Gates. It was launched in 2000 to provide technical and financial supports to those in need. To say, most of the organization and program’s major support comes from Bill and Melinda Foundation. Along with Gavi, the Vaccine Alliance, they provided $750 million to help provide vaccines across the world.

**Global Alliance for Vaccines and Immunization (Gavi, the Vaccine Alliance)**

The Global Alliance for Vaccines and Immunization was created in 1999 to expand the reach of EPI and help the poor countries to be introduced to new vaccines. Its major goal is to lower the vaccine prices for the low-income countries. The Alliance brings developing country and donor government, WHO, UNICEF, funding agencies and private sector partners together to actively support the ones in need financially. Since GAVI is launched, it immunized over 760 million children and prevented more than 13 million deaths.

**Coalition for Epidemic Preparedness Innovation (CEPI)**

Coalition for Epidemic Preparedness Innovation was launched in. CEPI is an alliance between governments, industry and other intergovernmental institute to “stimulate and accelerate the development of vaccines against emerging infectious diseases and enable access to these vaccines for people during outbreaks.” In 2020, CEPI was identified as “key player in the race to develop a vaccine” for Covid-19 disease. CEPI also invested in platform technologies that can be used for rapid vaccine development against unknown pathogens

**Timeline of Events**

*1000s –* Variolation, a primitive form of vaccines was first developed in China and India. According to *The Life and Death of Smallpox*, Chinese Emperor K’ang Shi who survived smallpox as a child, also had his children inoculated. But some claims the history of vaccines is dated as early as 200 B.C.

*1796 –* An English doctor, Edward Jenner performed the world’s first vaccination. Based observation that milkmaids who got cowpox didn’t show symptoms of smallpox, he inoculated cowpox pustule liquid from a milkmaid into a nine-year-old James Phipps’ arm. Few weeks later, Jenner inoculated smallpox on Phipps’ arm, but the smallpox didn’t develop.

*1803 –* The smallpox vaccines were introduced to the Americas by the Balmis Expedition sent by the King of Spain.

*1885 –* Louis Pasteur, a French chemist developed vaccines for rabies. He actually created a rabies antitoxin that was for post-infection antidote. He used it to prevent the spread of rabies in a boy named Joseph Meister who was bitten by a rapid dog.

*20th century –* Due to active vaccine research and development, vaccines for yellow fever, polio, whooping cough (pertussis), chicken pox, diphtheria, hepatitis A/B, measles, mumps and rubella was introduced.

*1974 –* WHO launched the Expanded Program on Immunization (EPI) to increase the vaccination rates among children in developing countries.

*1980 –* WHO declared naturally-occurring smallpox to be eradicated by mass vaccination program. Smallpox became the world’s first eradicated disease.

*1991 –* Polio was completely eradicated from Western Hemisphere.

*21th century –* Vaccines for rotavirus, human papillomavirus recombinant (HPV) and zoster was introduced.

*2005 –* Over 100 million of children were immunized.

*2020 –* In response to global Covid-19 pandemic, Bill and Melinda Gates Foundation donated more than $350 to support the vaccine development

**UN Involvement, Relevant Resolutions, Treaties and Events**

* In 2005, the World Health Organization (WHO) and the United Nations Children’s Fund (UNICEF) published the Global Immunization Vision and Strategy (GIVS) to promote vaccination usage to protect children against 14 diseases (i.e. diphtheria, pertussis, tetanus, measles, polio, tuberculosis, hepatitis B, Hib, rubella, meningococcal disease, pneumococcal disease, rotavirus, Japanese encephalitis and yellow fever). GIVS is the “the first ever ten-year Framework aimed at controlling morbidity and mortality from vaccine-preventable diseases and helping countries to immunize more people” The four main aims of GIVS are:
1. To immunize more people against more disease.
2. To introduce a range of newly available vaccines and technologies
3. To integrate other critical health interventions with immunization
4. To manage vaccination programs within the context of global interdependence
* The United Nations Programme on HIV/AIDs (UNAIDS) and WHO together established new HIV Vaccine Initiative (HVI) to address the lacking vaccines for HIV/AIDS. The mission of HVI is to “promote the development, facilitate evaluation, and address future availability of preventive HIV vaccines, with a focus on the need of developing countries”

**Possible Solutions**

*Raising awareness about benefits of vaccines*

As mentioned previously, the major cause of vaccination hesitancy is the misinformation. By providing training to health professionals and reaching out to the public, it will spread accurate information regarding to immunization in order to achieve a clear understanding of the benefits and risks of immunization. Professor Lawrence Gostin, Director of the WHO Collaborating Center on National and Global Health Law said “parents do not have rights to make informed decision about vaccinating their children, but they do not have the right to place their children, or other children, at risk of a serious infectious disease. We need to do a far better job of reaching out to vaccine-hesitant parents.” By providing accurate understanding of vaccination safety, it would strengthen the immunization advocacy and reduce the skepticism against vaccination caused by misinformation.

*Implementing disease surveillance system*

to effectively monitor the spread of vaccine-preventable disease and supply appropriate vaccines when needed. This would provide possible warning of outbreaks of disease as well as gathering the impact of disease control programs for development purposes. Strengthen surveillance system will provide disease data needed for immunization initiatives and monitor the impact of new vaccines. The data collected will also tell what type of vaccines should be applied in an area.

*Creating organizations, programs and agencies*

By creating governmental organization, initiative programs or public funding agencies can provide vaccines for less developed countries (LDCs). It will not only improve the supply of vaccine, vaccine delivery system and their availability to LDCs by providing adequate access to affordable vaccines, but also promoting strong immunization programs in local level. International organizations can promote communication and cooperation between countries, which then can be used to support less developed countries in need with vaccine supply. Funding from organizations or agencies can be used in investing research, development and production of new vaccines against new diseases. The parties should increase sustainability and cost-effectiveness of vaccine supply.

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