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Vaccine of Equine infectious Anemia

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Abstract. Equine infectious Anemia retrovirus causes equine infectious anemia and is mainly transmitted by insects from the group Hemiptera. This viral disease has an extremely high death rate due to the strength of the virus, and most importantly, there are still no EIAV vaccines that have been used out of China. Therefore, I will be researching about limited amount of EIAV vaccine designs that have been made for the past few years. The reason why researches of this vaccine have been chosen is because this disease has been a worldwide issue with others that study equine animals. Furthermore, the design of the vaccine will mainly focus on selecting the antigens of gp90 and gp45, which are the two that mostly come in contact with the host cell. The possible and most commonly used platform that will be chosen for this vaccine will be the live-attenuated vaccine, which has been commonly used against single-stranded viruses such as COVID-19.

Keywords: Equine infectious Anemia virus, glycoprotein 90, glycoprotein 45.

1. Introduction

Equine infectious Anemia (EIA) is a fatal viral disease that mainly acts on the Equidae family, including animals such as horses, donkeys, Equus, mules, and so on. It was first discovered in 1843 in France by veterinarians. This infectious disease can be found in various areas, and it can easily adapt to different environmental conditions. Meanwhile, this disease has an exceedingly high death rate of up to 80%, as animals would carry the virus forever once they get infected, and would also there are still no effective vaccines and treatments created against Equine infectious Anemia. This viral disease is chiefly caused by a lentivirus that belongs to the family Retroviridae [1].

Therefore, this means that horses transmit this type of disease via biting flies from the Tabanus family, such as Scaptia Beyonce and horseflies. The RNA genome of the virus converts into DNA and integrates into the cell genome, establishing proviral DNA, which is found in monocytes and macrophage cells. In other words, the virus mainly targets the equine immune system. At the same time, the virus duplicates itself in the animal's blood cells, which ultimately circulates through the body. Meaning that the virus would spread through the horse's blood. In response, the immune system creates antibodies and destroys its blood cell components. With the permanent presence of Equine infectious Anemia, the equine's body will be at risk of getting infected by many other severe diseases as well [2].

There are three phases which respectively are phase Acute, Chronic, and Inapparent Carrier. In the first phase, the virus multiplies and attacks the immune system of the animal's body. This phase mainly occurs in the equine's bloodstream. Then, the level of the virus in the animal's body gradually increases but could switch between stages of remission and illness in the second phase. Lastly, in the stage of

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inapparent carrier, the animal eventually overcomes suffering from the virus, but it will still permanently carry the virus. Due to the weakening of the body, the attendance of EIAV would lead equine to result in icterus, weight loss, fever, anemia, swelling, and so on.

Unfortunately, this virus has still not been completely studied clearly. Therefore, there are still many mechanisms of parts of the virus that are left unidentified. While, there are two main parts of the EIAV which are surface glycoprotein SU(gp90) and transmembrane glycoprotein TM(gp45). Gp45 plays a significant role in viral replication and glycoprotein incorporation and mediates fusion between the virus and target cells, which causes cytopathia (CPE). Moreover, the surface protein SU (gp90) is a greatly glycosylated protein that is about the size of 90ku that is found in the viral envelope. On top of that, it also interacts with the receptors on the host cell membrane [3].

2. Transmission of the disease (horizontal and vertical)

POn one hand, EIAV is transmitted from one equine to another through the interaction of blood. The most common way is through bloodsucking insects such as Tabanids, Stomoxys, etc. In most cases, these bloodsucking insects can successfully transmit EIAV in 30 minutes after its feeding has been done on its donor. The effectiveness of the transmission of EIAV is exceedingly dependent on the level of virus in the infected animal.

On the other hand, scientists have researched transmission by experimenting with whether infected mares impact EIAV's offering. Scientists have selected a blood sample from one of the offspring and injected it into healthy recipients. If healthy horses develop the disease in their blood after the blood transmission, then vertical transmission is possible. Research says that one of the four recipients got infected, and the other two have shown contentious symptoms, while the last one remained negative. This result indicates that the infected mare could transmit the virus to its offspring through the placenta. Other experiments have also taken place. In conclusion, most studies have proved that with the disease, there is a small possibility that the mare passes the disease to its offspring by the placenta. While there is a very low risk of disease transmission for EIAV carriers to pass the disease to their offspring, they are also virtually absent.

To sum up, the virus is mostly transmitted mechanically, for example, by blood-sucking insects. It could also be transmitted through tools contaminated by infected blood or blood products [4].

3. Symptoms

Various symptoms have been seen over the years, including pyrexia, depression, ataxia, weight loss, bleeding, lethargy, fever, icterus, which is the yellowing of body tissues, swelling limbs, anemia, weakness, and so on. Many other questionable symptoms have been seen in many cases but could be presented due to different elements. Meanwhile, some other questionable symptoms have been found, but it is still not fully confirmed that EIAV caused it [5].

4. Brief introduction of the vaccine

As more updates are being made towards the disease EIA, the mechanisms of the virus have yet to be fully explained. Therefore, designing an effective and reliable vaccine would be extremely challenging. In many researches, scientists worldwide have been conducting experiments and studies to create a vaccine for this disease. Still, as this virus is a single-stranded virus, in other words, its sequences could change over time. It does not have a fixed form like most double-stranded viruses. Therefore, an effective vaccine mainly aims to cure EIAV is nearly impossible. Consequently, many scientists have yet to give up on research. This is also why many things about this virus are still left unknown [6].

5. Vaccine design

5.1. Why vaccine is significant

Vaccines have been used in our daily lives in the past few years. More and more scientists and doctors also claim that humans cannot live without vaccines. Additionally, there are many reasons why equine

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animals, especially horses, which are the main target of this vaccine, need the help of vaccines. Vaccines are essential for equine animals as they help the immune system adapt quickly and respond to the infectious agent. It also allows other equine animals to be taken into account for age, sex, and pregnancy diseases. Vaccines for tetanus, encephalomyelitis, rabies, equine herpes virus, equine viral arteritis vaccines, and so on are available. Lastly, vaccines could be more considerable as the worsening of living conditions and poor management of herd equines through the increase in numbers of horses each year.

5.2. Antigen selection

Gp90 and Gp45 are highly effective antigens, because as far as scientists know, gp90 and gp45 are the major core proteins. Where gp45 replicates the virus and mediates fusion between the virus and target cells, in the meantime, gp90 interacts with the host cell. Not only do these two glycoproteins help in the growth and infection of the virus in the patient body, but these two elements are also the main elements that do not have genetic material in EIAV. This means that some of the rest are without genetic material but do not play an effective role, or it is not necessary to be used in the vaccine as it does not contribute as part of the virus. Moreover, the majority of the rest have genetic material, which will cause the virus to spread easily from animal to animal, just like the actual virus. This concluded that not only do gp45 and gp90 not transmit to one another as they do not have genetic material, but they also have some of the most noticeable proteins involved in transmitting and infecting [7].

5.3. Platform selection

Various types of vaccines have been widely used, such as live-attenuated vaccines, inactivated vaccines, toxoid vaccines, mRNA vaccines, and viral vector vaccines. Research has been done on each type of vaccine to find the most suitable vaccine platform for EIAV, as EIAV is single-stranded. Therefore, mRNA vaccines, live attenuated vaccines, and VLP vaccines were especially brought to attention. VLP vaccine was the first platform that could have been used, however, many scientist have decided not to use it as it has a low yield, which means that it has extremely low efficiency in vaccine production. Moreover, cases of EIAV are found globally, which implies that the yielding capacity is exceptionally crucial [8].

Meanwhile, researches have been made on the COVID-19 vaccines, whose variants are similar to EIAV, where both are single-stranded and so on. Scientists have also given up on using the VLP platform as the manufacturing procedure is more complex, and no applicable data was published for human clinical trials. Therefore, the VLP vaccine is not suitable as a platform for the EIAV vaccine. Finally, the attenuated vaccine has been as it overcomes the single or unchanged antigen of genetically engineered vaccines and inactivated vaccines, and these vaccines are similar to natural infection in that they help prevent and create a solid and long-lasting immune response. It can continuously evolve new variants, gradually enrich the diversity of antigens, and then induce more abundance of the immune response. Additionally, it creates an effective and long-lasting immune response, which is highly crucial in this case as strong immunoprotective cellular and antibody responses are needed in EIAV[9]. Especially when it comes to viruses like EIAV that would most likely permanently exist in the infected body; lastly, this type of vaccine is also very cheap and creates a harmless version of the virus, which could also be why it is highly effective in one's body,in this paper, kind of platform of vaccine were conpared (Table 1) [9].

Table 1. The compare of different vaccine

	Advantage	Disadvantage
Virus-like-particles (VLP)	It has decreased capacity to generate a strong immune reaction for enduring protection.	As the process of its production is complex, it has low yield and high price of production.
mRNA vaccine	Traditional vaccines could take longer to design and produce compared to these vaccines.	Causes severe allergic reactions, increased antibody effects, and fatalities.

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Table 1. (continued).

Live attenuated vaccine	Produces a robust and durable immune reaction.	Might not always be suitable for everyone.
Inactivated vaccine	This type of vaccine could be easily stored and shipped.	Decreased capacity to generate a strong immune reaction for enduring protection.

6. Model and experiment

6.1. Animal model

American Quarter horses may be a kind of modle for the experiment, because of this breed has the largest population of all equine animals. At the same time, equine animals would not be used in all experimental trials in order to prevent the causing of allergic reactions and other illnesses. Therefore, white mice, which are widely used in experiments, could be considered for use in the first two trials. Then, American Quarter horses would be used in the last few trials as their immune systems would be more likely closer to the rest of the equine animals compared to white rats. One disadvantage of this breed is that it could have some genetic issues, which could cause the inaccuracy and reliability of the experimental results. In other words, the final product might act less efficiently for many different breeds of equine animals due to the gap in genetic issues[10].

6.2. The methoed of vaccine evaluation

CFSE method would be used in order to detect the growth of different T lymphocyte subtypes, which play an essential role in immune reactions and the development of diseases. Furthermore, the proliferation of CD4 and CD8 T lymphocytes in the strongly infected horses and immunization by the vaccine strain could be detected. Hence, it would then verify the feasibility and secureness of the vaccine. Lastly, this method could also be used to learn the immune mechanism of the vaccine [11].

7. Conclusion

Overall, the design of the vaccine could be feasible. While the mechanism, structure, and treatments of EIAV still need to be fully discovered. Therefore, there is significantly less research on the possible treatments of EIAV, which would be useful in terms of vaccine design if there is. Because the current biological research on the pathogenesis of EIAV is still insufficient, developing a vaccine based on the current research foundation may not be the best choice. However, as studies on EIAV replication and the host immune response it induces become more comprehensive, the developed vaccines will be more effective. Nevertheless, the summary of antigens, platforms, animal modle and other factors in this paper can still provide a very meaningful theoretical foundation for vaccine development.

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