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A Vaccine for HIV

Alan Kleinman
Monarch Canyon Road Coarsegold, CA, United States.
**Corresponding author: Alan Kleinman.*

Abstract
HIV has been infecting people for more than 30 years. The viral genetic sequence is well known including viral proteins produced. Why haven't any successful vaccines for this infection been produced despite all this time passing and all this understanding of the virus? This paper presents the problems associated with the production of a useful vaccine, not just for HIV but for many other diseases as well.

Keywords: Vaccine; HIV; genetic sequence; viral proteins

Introduction

Primary Care Providers (PCPs) are the people that usually administer vaccines. The only thing those PCPs usually look for is any adverse reaction to the vaccine. Some PCPs administer certain vaccinesm where more than adverse reactions are monitored but additional testing is done to test if the vaccine is effective. For example, Hepatitis B vaccine effectiveness is tested. [1,2] The hepatitis surface antigen is administered and at a predetermined time interval, the patient is tested for antibodies to that antigen. This is done to evaluate whether the patient has successfully produced those antibodies and has protection against infection by hepatitis B. A significant number of people (5-15%) do not respond to any hepatitis B vaccine. [3,4]. One of the problems are that the person is simply unable to produce the antibodies because they don't have the genetic capabilities.

HIV Vaccines

People with HIV do produce antibodies to the virus. These antibodies are often time used to detect whether the person has HIV. [5] Why can't a vaccine be produced for HIV when it is clear that people can produce antibodies to the virus? The answer is suggested here. [6]. In this paper is the following quote: "We're still trying to outsmart the virus, says vaccine expert Anna Durbin, MD. Its elusive, ever-changing nature leaves popular methods of vaccine development falling flat." The virus mutates and antibodies to one variant of the virus do not cross-react with other variants of the virus. This is not unknown. Influenza mutates and a vaccine for one variant may not cross-react with a different variant so multiple different vaccines are administered and this must be done on a yearly basis. HIV is known to have an extremely high mutation rate on the order of 10−5–10−3 errors/bp/cycle depending on the different types of investigation methods used to measure that rate. [7] This high mutation rate means that there will be a large amount of diversity in the population for every possible target to the virus. Unless the antibodies produced by a vaccine can cross-react with all the possible variants of an antigen, the vaccine will only work on a portion of the viral population.

Polio Virus and Mutation Rates

The polio vaccine is one of the greatest stories of vaccine success so far. The deadly disease of poliomyelitis was killing and impairing tens of thousands of people as recently as 1988 to only 6 confirmed cases in 2021. [8] The mutation rate of the polio virus is in a similar range as HIV on the order of 4.5x10-4. [9] All RNA viruses have extremely high mutation rates. [10] This is an ever-changing virus but this has not prevented the development of an effective vaccine for poliomyelitis. The vaccines used to prevent poliomyelitis were developed more than 60 years ago and are still effective today.

Descent With Modification

Vaccine usage suffers the same problem that antimicrobial drug resistance suffers from. Descent with modification causes diversity in a population which can defeat an antimicrobial agent by altering the target for these agents. It also defeats a vaccine. A single antigen can stimulate the production of

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multiple different antibodies [11]. This is due to the antigen having multiple epitopes or locations on the antigen that stimulate the production of antibodies specific to the particular epitopes. Descent with modification alters these epitopes and therefore alters the antibodies produced to these epitopes. This alteration of antigens (epitopes) by descent with modification is well demonstrated by the need to change the influenza vaccine yearly in an attempt to prevent an influenza epidemic that year.

Conclusion

The production of an effective vaccine for HIV is being prevented by more than a high mutation rate and an ever-changing nature. The polio virus has a high mutation rate and is ever-changing but that hasn't prevented a vaccine from being developed to prevent poliomyelitis. The inability to produce an HIV vaccine may be due to a collection of problems. It may be due to the human genome lacking the correct genetics to mount an immune response to the antigens (epitopes) of the HIV virus as demonstrated by people that can't develop antibodies to the Hepatitis B vaccine. 111 Natural immunity plays a big part in the response of a population to a disease. This was demonstrated in the H1N1 pandemic of 2009. In this pandemic, elderly people were not impacted the most. "Additionally, CDC estimated that 151,700-575,400 people worldwide died from (H1N1) pdm09 virus infection during the first year the virus circulated. Globally, 80 percent of (H1N1) pdm09 virus-related deaths were estimated to have occurred in people younger than 65 years of age. This differs greatly from typical seasonal influenza epidemics, during which about 70 percent to 90 percent of deaths are estimated to occur in people 65 years and older." [12]. It may be due to changing antigens (epitopes) of HIV which means that a single vaccine will not be universally effective as with the influenza virus and a combination of vaccines for the virus will have to be used. This problem is not limited to HIV. The development of a vaccine for Covid was rushed out for public use before it was fully tested. This resulted in a vaccine that did not cover all variants of the virus as demonstrated by infection and disease caused by mutated variants of the virus and the need for multiple boosters and modified vaccines. Vaccines have given a wonderful benefit to people by preventing many serious diseases but they aren't the panacea.

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