New research helps explain why AIDS vaccine has been so difficult to develop

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For decades, a successful HIV vaccine has been the Holy Grail for researchers around the globe. Yet despite years of research and millions of dollars of investment, that goal has still yet to be achieved. Recent research by Oregon Health & Science University scientists explains a decades-old mystery as to why slightly weakened versions of the monkey AIDS virus were able to prevent subsequent infection with the fully virulent strain, but were too risky for human use, and why severely compromised or completely inactivated versions of the virus were not effective at all.

The research was conducted at OHSU's Vaccine and Gene Therapy Institute and is published online in the journal *Nature Medicine*.

Traditionally, there have been two methods for creating vaccines to combat infectious disease. The first approach utilizes a live, yet weakened strain of the disease in question. This weakened strain is not strong enough to cause illness yet potent enough to activate the immune system so that it can detect and fight a disease if it enters the body in the future. The second approach makes use of a dead form of the disease. As with the other approach, the introduction of the disease in a safe form educates and prepares the body for a possible future invasion.

In the early 1990s, a slightly weakened version of SIV, the monkey counterpart to HIV, was shown to protect monkeys for infection with the fully virulent version, but this weakened version was still able to cause AIDS in some monkeys and the protection was lost if the vaccine virus

was further weakened.

"Efforts to develop a live attenuated virus are analogous to the tale of 'Goldilocks and the Three Bears,'" explained Louis Picker, M.D., associate director of the OHSU Vaccine and Gene Therapy Institute. "The field was looking for a vaccine that was 'not too hot,' or 'not too cold,' but 'just right.' The problem was that it appears that weakening a virus to the level that is 'just right' is impossible. However, we thought that understanding the mechanism responsible for the protection afforded by the too-dangerous-for clinical-use attenuated vaccine would allow us to design a vaccine that would be both effective and safe".

The newly published research shows that the protection is due to anti-viral T cells maintained in lymphoid tissue by persistent live attenuated virus; weakening the virus prevents this persistence and curtails protection. Thus, unlike most vaccines, an effective HIV vaccine might have to persist in the body to be effective.

Picker's group has developed another persistent virus named cytomegalovirus (CMV) engineered to express SIV or HIV proteins and serve as the transport system (vector) used to raise protective immune responses against these AIDS-causing viruses. In May 2011, the Picker lab published findings that demonstrated how immune responses elicited by their vaccine candidate were able to completely control SIV in a significant number of exposed animals.

CMV is a persistent virus that most people carry, causes few or no symptoms, and elicits very strong cellular responses that are maintained for life. These immune responses are characterized by a type of T cell called an effector memory T cell that has potent anti-viral function and localizes in the same tissues targeted by the AIDS-causing viruses. Picker and his team hypothesize that CMV vector-generated anti-HIV responses would be constantly on the alert for HIV and would be able to

intercept and stop HIV infection immediately after exposure.

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