Novel nanofiber-based technology could help prevent HIV/AIDS transmission

November 4 2014

Scientists have developed a novel topical microbicide loaded with hyaluronic acid (HA) nanofibers that could potentially prevent transmission of the human immunodeficiency virus (HIV) through the vaginal mucosa. This research is being presented at the 2014 American Association of Pharmaceutical Scientists (AAPS) Annual Meeting and Exposition, the world's largest pharmaceutical sciences meeting, in San Diego, Nov. 2-6.

HIV is an infectious virus that attacks T lymphocytes, a type of white blood cell that prevents infections and disease. Over time, HIV dramatically depletes the body's T cell population, leaving the body defenseless against opportunistic pathogens. HIV is transmitted through direct contact with blood, semen, pre-seminal fluid, vaginal fluids, rectal fluids, or breast milk from an infected person. According to AIDS.gov, the Center for Disease Control and Prevention estimates that more than 1 million persons aged 13 years and older are living with HIV infection, including 180,900 who are unaware that they have the virus. To date, there is no functional cure for HIV infection/AIDS. Currently available anti-HIV drug delivery methods are formulated as gels and suppositories, but can lack appropriate vaginal retention, are prone to medicine leakage, and may cause uncomfortable wetness.

To address these issues, Bi-Botti Youan, Ph.D and his colleagues from University of Missouri-Kansas City School of Pharmacy developed an anti-HIV drug loaded onto a mucoadhesive hyaluronic acid (HA) nanofiber delivery system. This delivery system is intended to stop HIV

transmission through the vaginal mucosa, providing a triggered release upon exposure to semen fluid during sexual intercourse. The researchers used an electrospinning method to prepare the nanofibers loaded with tenofovir, a topical anti-HIV compound. Both semen enzyme-dependent nanofiber degradation and drug release were then measured using chemical and analytical assays. The cytotoxic effects of the nanofibers on human vaginal cells and on the Lactobacilli bacteria (L. crispatus) present in vaginal flora were also assessed.

"The success of vaginal drug delivery systems depends on the length of time that the drug-containing formulation remains at the site of administration (ex. vagina, rectum). The mucoadhesive nanofibers developed in this study could be beneficial by causing much less discomfort and reducing the dosing frequency simultaneously due to their prolonged retention at the target site," said Youan.

The nanofiber-based formulation offers various potential advantages in vaginal drug delivery, including the ability to adapt delivery systems for different medical needs, with no leakage or messiness after their application. Furthermore, this technology could be beneficial in protecting drug molecules against enzymatic and other degradation that can occur in the body. Since human semen is the carrier of HIV virus transmission during male to female intercourse, a semen enzyme-triggered nanofiber delivery system as used in this study has the potential to inactivate or kill the HIV virus prior to exposure and penetration of the vaginal mucosa.

The next stage of Youan's research is to examine the safety and efficacy of the hyaluronic acid-based nanofiber templates. Further in vivo studies will be carried out using animal models to characterize the viral transmission, inhibition, potential biodistribution, pharmacokinetics, vaginal retention time, safety and immunological responses to the nanofibers.

Provided by American Association of Pharmaceutical Scientists