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A Review article on Novel Nanotechnology Methods for HIV/AIDS Prevention and Treatment

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ABSTRACT :

A subset of the family Retroviridae, the genus Lentivirus includes the human immunodeficiency virus (HIV), which causes acquired immunodeficiency syndrome (AIDS). Sexual contact, sharing of intravenous injection supplies, and mother-to-child transmission (during childbirth and lactation) are the main ways that HIV is spread [1]. The United Nations Programme on HIV/AIDS (UNAIDS) claims that one of the most serious health issues facing the world today is HIV/AIDS;

The "Global AIDS Response Progress Reporting 2014" states that around 39 million people have died from HIV and that nearly 78 million people have contracted the infection, making HIV/AIDS one of the biggest health crises facing the world, according to the United Nations Programme on HIV/AIDS (UNAIDS). By the end of 2013, 35.0 million people worldwide were HIV positive [2]. HIV can cause immunodeficiency by infecting a range of immune cells, including CD4+ T cells, macrophages, and microglial cells. It is essentially spherical, with a diameter of about 120 nm.

Keywords: HIV, Gene therapy, AIDS, immunotherapy, and antiretroviral therapy

Introduction

Numerous conventional HIV/AIDS vaccines have shown extremely harmful side effects, poor targeting and selectivity, and trouble penetrating infected cells. Only a small number of vaccine candidates are at various stages of clinical trials, and there is currently no effective HIV vaccine in clinical use.
The issues with conventional HIV vaccinations for HIV/AIDS prevention and treatment can be resolved by nanotechnology [5]. First, a better transmission method made possible by nanotechnology may make it easier for HIV/AIDS medications and vaccines to get through physiological obstacles. Additionally, optimal regulated drug release enhances the half-life and efficacy of HIV/AIDS medications and vaccines. Second, by entering the virus, neutralizing it, and disrupting the virus assembly process, nanoparticles themselves can prevent viral replication. Third, the toxicity of HIV/AIDS medications and vaccines is greatly decreased by nanomaterials. This article outlines the latest developments in the application of nanotechnology to the creation of HIV/AIDS vaccines and talks about how it can significantly enhance the vaccines' pharmacokinetics, stability, permeability, and solubility.
Utilizing nanotechnology and nanomaterials to create an HIV/AIDS vaccine Nanomaterials and nanotechnology have the potential to address the issues with conventional HIV/AIDS vaccinations because of their unique properties. Nanomaterials can serve as a preventive or adjuvant for an HIV/AIDS vaccine. In order to provide multivalent vaccines, nanomaterials can also simultaneously carry multiple antigenic compounds. Nanomaterials may be used to increase the HIV vaccine's biological activity. Currently, researchers have invested 165 million dollars on innovative delivery systems.
Nanomaterials can readily interact with biomolecules at the surface and within cells because of their small size and large surface area. Numerous nanomaterials have been employed as delivery methods, nano-carriers, or vaccine adjuvants to improve protective immune responses. These include polymeric nanoparticles, lipid-based carriers (liposomes/micelles), dendrimers, carbon nanotubes, and gold nanoparticles. The molecular mechanism of action of the majority of adjuvants was investigated by Vono et al. The authors discovered that the viewpoints and conclusion
[14/04, 10:09 pm] ......: HIV infection prevention and treatment are essential. Nevertheless, years of persistent work have not yet resulted in the effective development of an HIV vaccine. It has been shown that nanotechnology has the ability to alter this procedure somewhat. Many nano-architectures and nanomaterials, such as the aforementioned inorganic nanomaterials, liposomes, micelles, and polymers, have currently been studied as possible HIV vaccine carriers or adjuvants.

Symptoms

- Flu like symptoms
- Rashes
- Muscle and joint pain
- Fever
- Fatigue

- Swollen lymph nodes
- Sore throat
- Weight loss
- Diarrhoea
- Shingles
- Cancer

Causes

HIV is brought on by a virus. It can spread by intercourse, sharing needles or injecting illegal drugs, and coming into contact with contaminated blood. Additionally, it can transfer from mother to kid during nursing, giving birth, or during pregnancy. White blood cells known as CD4 T cells are destroyed by HIV. These cells are crucial to the body's ability to combat illness. Your immune system deteriorates when your CD4 T cell count declines.

Treatment

Use of Nanotechnology

Many aspects of the treatment of illness are being altered by the use of nanotechnology platforms to deliver medication to its intended location. Thus far, this shift has benefited cancer patients the most. The last few decades have seen many significant advancements. The FDA has approved a number of nanoscale cancer treatments, and others are undergoing clinical testing. The special characteristics that nanotechnology offers to medication delivery systems enable this enormous accomplishment. Nanotechnology has made it feasible to deliver pharmaceuticals to certain cells or tissues, deliver macromolecules into cells, and enhance the dispersion of drugs that don't dissolve well in water.

Drug delivery technologies based on nanotechnology may offer a similar benefit by systemically delivering antiviral drugs. If they are given using controlled-release methods, they might have extended half-lives in the blood at therapeutic concentrations. This could have far-reaching effects on people's compliance with their prescription schedules. The penetration and transportation of hydrophilic and hydrophobic medications to their target areas are enhanced and controlled using nanoscale delivery systems. The most promising aspect of nanoscale delivery systems for HIV prevention appears to be this attribute. By focusing on CD4+ T cells, macrophages, the brain, and other organs, antiretroviral drugs may be able to guarantee that they reach the latent reservoirs.

A single dosage of the drug, however, released gradually over three months in dogs and three weeks in mice, despite the free medication's short 38-hour half-life. These results demonstrate how nanoscale drug delivery may reduce dosage frequency and improve patient compliance. According to a number of studies by Dou et al., a surfactant system that contains Lipoid E80 may stabilize an indinavir Nano suspension, enabling more even dispersion to different tissues. Indihar Nano suspensions were injected into macrophages, and the drug's absorption was assessed.

The mice were then given intravenous indinavir nanosuspensions laden with macrophages. The drug therefore accumulated to hazardous amounts in the body's organs, including the liver, spleen, and lungs. A single intravenous dose of the nanoparticle-loaded macrophages resulted in substantial antiviral activity in the brain of a mouse model of HIV brain infection, and the drug was detectable in the blood for as long as 14 days after therapy.

CONCLUSION

Nanotechnology may have an impact on potentially innovative methods of HIV/AIDS treatment and prevention. Using nanotechnology platforms to deliver antiviral medications could enhance available treatment choices. Increased patient adherence to specified medication schedules, made possible by controlled and extended pharmacological release, may lead to enhanced therapeutic effectiveness. If many medications are administered concurrently in a nanoparticle delivery method, antiviral reservoirs might be treated more successfully in the future. Our team and another group of researchers have created nanoparticles that may simultaneously deliver hydrophilic and hydrophobic medicines or genes, potentially offering antiviral treatment delivery alternatives. In addition to being used in antiviral medications, nanomaterials have demonstrated the ability to prevent viral replication.

Fullerenes, dendrimers, silver nanoparticles, and gold nanoparticles all have antiviral properties or may enhance the antiviral properties of other substances. Nanotechnology has the potential to enhance current therapeutic approaches, including gene therapy and immunotherapy. The nonviral spread of siRNA is one of the most active nanotechnology research topics. The transport of siRNA to HIV-specific cells is already a reality, but research is still needed to create a safe and efficient nanotechnology for RNA interference (RNAi) that may be utilized to treat HIV/AIDS. Immunotherapy is another crucial field where nanotechnology may have a big impact.

Since government organizations distribute large amounts of vaccinations, developing vaccines enhanced by nanotechnology may be a cost-effective way to fight the global HIV/AIDS epidemic. Governmental or non-governmental organizations may also be required to help distribute nanotechnology-enabled microbicides in economically disadvantaged areas. The rate of scientific advancement has never been higher overall, and this is particularly true in the field of nanotechnology. There is broad consensus that investments in nanotechnology will pay off in the long run for the medical and HIV/AIDS fields.

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