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Respiratory nanoparticle-based vaccines and challenges associated with animal models and translation

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Abstract

Vaccine development has had a huge impact on human health. However, there is a significant need to develop efficacious vaccines for several existing as well as emerging respiratory infectious diseases. Several challenges need to be overcome to develop efficacious vaccines with translational potential. This review focuses on two aspects to overcome some barriers – 1) the development of nanoparticle-based vaccines, and 2) the choice of suitable animal models for respiratory infectious diseases that will allow for translation. Nanoparticle-based vaccines, including subunit vaccines involving synthetic and/or natural polymeric adjuvants and carriers, as well as those based on virus-like particles offer several key advantages to help overcome the barriers to effective vaccine development. These include the ability to deliver combinations of antigens, target the vaccine formulation to specific immune cells, enable cross-protection against divergent strains, act as adjuvants or immunomodulators, allow for sustained release of antigen, enable single dose delivery, and potentially obviate the cold chain. While mouse models have provided several important insights into the mechanisms of infectious diseases, they are often a limiting step in translation of new vaccines to the clinic. An overview of different animal models involved in vaccine research for respiratory infections, with advantages and disadvantages of each model, are discussed. Taken together, advances in nanotechnology, combined with the right animal models for evaluating vaccine efficacy, has the potential to revolutionize vaccine development for respiratory infections.

Keywords: Nanovaccines, animal models, translation, vaccine efficacy