Airborne Transmission of SARS-CoV-2 Prevented by Mucosal COVID-19 Vaccine

Researchers evaluated the impact of mucosal versus intramuscular vaccine immunization on airborne infection and transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in Syrian hamsters.

Study

This study evaluated the effects of mucosal and systemic immunization on SARS-CoV-2 transmission using Syrian hamsters. Hamsters were vaccinated intranasally with chimpanzee adenoviral-vectored vaccine (ChAd-CoV-2-S) or intramuscularly with remnant BNT162b2 (BioNTech and Pfizer COVID-19 vaccine) and then exposed to SARS-CoV-2-infected hamsters.

Viral titers in the upper and lower airways were measured to determine transmission. Primary contact hamsters that remained uninfected were excluded. Hamsters were randomly assigned to vaccination or donor/contact groups.

Vero cells expressing human transmembrane protease serine 2 (TMPRSS2) and angiotensin-converting enzyme 2 (ACE2) were cultured to prepare the virus.

Recombinant SARS-CoV-2 (WA1/2020 D614G) was confirmed by sequencing. All procedures involving SARS-CoV-2 were conducted in Biosafety Level 3 (BSL-3) facilities.

Animal studies followed National Institutes of Health (NIH) guidelines with Institutional Animal Care and Use Committee approval. Male hamsters were inoculated with SARS-CoV-2 and exposed to other hamsters in biocontainment units. Primary and secondary transmission were evaluated by sequential exposure of contact hamsters.

Tissue samples, including nasal washes, lungs, and nasal turbinates, were collected for virological analysis using reverse transcription polymerase chain reaction (RT-qPCR) and plaque assays.

Hamsters were immunized intranasally with ChAd-CoV-2-S or intramuscularly with BNT162b2, with control hamsters receiving phosphate-buffered saline (PBS). Antibody responses were measured post-immunization.

Statistical analysis was performed using GraphPad Prism, with significance at $P < 0.05$. Changes in virus titers, Ribonucleic Acid (RNA) levels, and antibody responses were analyzed using Analysis of Variance (ANOVA) or unpaired t-tests.

Findings

In the study, donor hamsters were inoculated with 105 plaque-forming units (PFU) of the WA1/2020 D614G variant. After 24 hours, primary contact hamsters (C1) were exposed to the donors for 8 hours.

Secondary contact hamsters (C2) were then exposed to the C1 hamsters for 8 hours after one, two, or three days of incubation.

Virological analysis of nasal washes, nasal turbinates, and lungs confirmed efficient primary airborne transmission, except for one nasal wash sample from a C1 animal in the 48-hour incubation group.

In C2 hamsters, a substantial infectious virus was detected in the lungs and nasal turbinates after 24, 48, and 72 hours of primary exposure. This indicates that secondary transmission is most likely 72 hours after primary exposure.

The impact of mucosal and systemic COVID-19 vaccines on airborne infection and transmission was evaluated. Syrian hamsters were immunized intranasally with ChAd-CoV-2-S or intramuscularly with BNT162b2. Twenty-one days post-immunization, serum was collected, and two weeks later, hamsters were exposed to SARS-CoV-2-infected donors.

Virological analysis showed significant reductions in viral titers and RNA levels in the upper and lower respiratory tracts of ChAd-CoV-2-S-immunized hamsters compared to unvaccinated controls.

In contrast, messenger RNA (mRNA)-immunized hamsters showed less reduction in virus titers and RNA levels, with only a small percentage of animals remaining SARS-CoV-2 negative. Mucosal immunization provided superior protection against airborne infection and transmission.

To evaluate the impact on secondary transmission, vaccinated and unvaccinated C2 hamsters were exposed to ChAd-CoV-2-S- and mRNA-vaccinated contact one hamster 72 hours after the initial exposure. In unvaccinated controls, secondary airborne transmission resulted in high virus titers in the nasal turbinates, nasal washes, and lungs.

However, ChAd-CoV-2-S-immunized contact 2 hamsters showed no measurable infectious virus or viral RNA, with 100% protection from secondary transmission. In contrast, mRNA immunization did not eliminate secondary transmission.

Serum antibody responses correlated with virus titers in ChAd-CoV-2-S- but not mRNA-immunized hamsters. ChAd-CoV-2-S vaccination induced stronger mucosal Immunoglobulin G (IgG) and IgA antibody responses compared to mRNA vaccines.

Next-generation sequencing of the S gene in C1 and C2 animals showed no significant amino acid changes, indicating that sequential airborne transmission did not induce the selection of viral variants.

Conclusion

To summarize, intranasal immunization with ChAd-CoV-2-S, prevented primary transmission and lung infection, and blocked sequential transmission to vaccinated and unvaccinated hamsters.

In contrast, systemic immunization with an mRNA vaccine did not prevent virus replication in the lungs or sequential transmission.

These findings suggest that mucosal vaccines can significantly reduce lower respiratory tract infections and community spread of SARS-CoV-2 by blocking sequential transmission cycles.

Source:

https://www.news-medical.net/news/20240805/Mucosal-COVID-19-vaccine-prevents-airborne-transmission-of-SARS-CoV-2.aspx