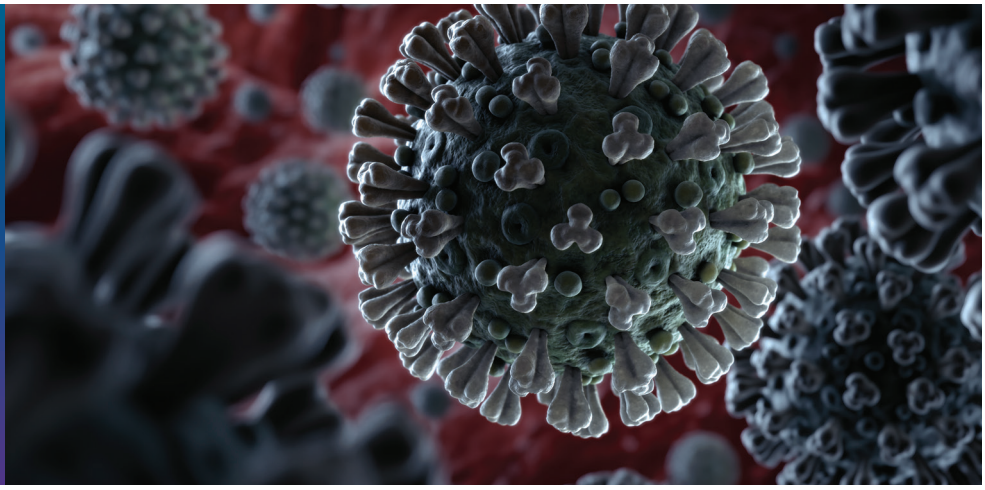
Chemfort®
Keeps you safe. Simply click

TOXIGUARD® Protection Against Virus Penetration into Drug Vials



Transmission of Viruses

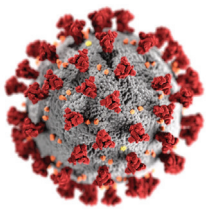
Transmission of influenza and other viruses between humans may occur by three routes:

1. Direct or indirect contact between an infected and a susceptible person, usually resulting in contamination of a susceptible person's hands followed by hand to respiratory mucosa contact
2. Large droplet spray of respiratory fluid
3. Aerosols generated by release of smaller, virus-containing droplets, as may occur during breathing and coughing [1]

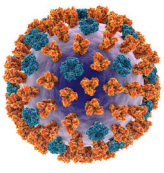
Thus, viruses are carried in the air in aerosol droplets or other particles.
Standard tests were developed to evaluate the ability of the activated carbon matrix or hydrophobic membrane deactivate or lock out viruses aerosolized in an air stream.

Virus Sizes

Viruses are much smaller than bacteria. Therefore, there is a risk of their escape through "sterilizing" membranes that are designed for bacterial protection. Example of virus diameters:
Coronavirus -125 nm [2]
Influenza virus - 80-120 nm [3]
Adenovirus - 70-100 nm [4]
Polio virus - 30 nm [5]
Bacteriophage Phi X174 - 31 nm [6]
MS-2 coliphage - 27 nm [7]



Coronavirus
125 nm



Influenza virus
80-120 nm

Adenovirus
70-100 nm

Bacteriophage Phi X174
31 nm

TOXIGUARD® drug-binding mechanical barrier technology is composed of a hydrophobic membrane (Versapor®; 0.2 µm pores) and a 100% activated carbon matrix (Flexzorb™)

Protective Effect of the Membrane [8]

The viral filtration efficiency (VFE) of the Versapor® membrane family was tested by Nelson Labs US. An aerosol of a challenge virus, bacteriophage phi 164, was used. The droplet size of the aerosol was strictly controlled and had a mean particle size of 2.9 µm. The flow rate of the aerosol through the membrane test sample was 28.3 liters per minute.

It was found that the membrane prevents viruses from passing through at an efficiency greater than 99.9%. Practically, no virus passed the membrane in this study.

Protective Effect of the Activated Carbon Cloth [9]

The **carbon layer** was shown to **have a unique ability to deactivate a virus without chemical intervention. A deactivation rate of up to 93% was achieved by Flexzorb™.** These protective effects of the activated carbon layer are added to the efficient viral filtration ability of the 0.2 µm membrane.

TOXIGUARD® Prevents Viral Contamination of Sterile Drugs [10]

Aim

To evaluate, by qPCR assay, the protective effect of Chemfort® Closed System Transfer Device (CSTD), which contains the ToxiGuard®, against virus penetration, when used in a human coronavirus OC43 (HCoV-OC43) aerosolized environment.

Method

The test was conducted inside a sealed glove box placed inside a biological safety laminar flow cabinet. The glove box environment was aerosolized using a nebulizer with either sterile growth medium as a negative control or human coronavirus (HCoV-OC43) stock solution of known titer.

Chemfort® sets consisting of a Vial Adaptor (VA), a Syringe Adaptor (SA) and a Bag Adaptor SP (BASP) were tested. The Vial Adaptors were either standard (with ToxiGuard®) or positive controls (without ToxiGuard®).

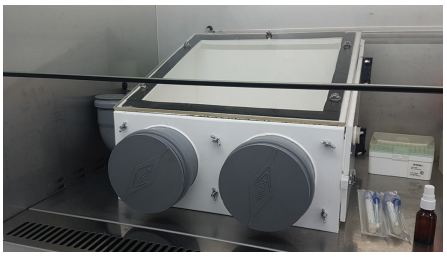
In each test the following activities were conducted:

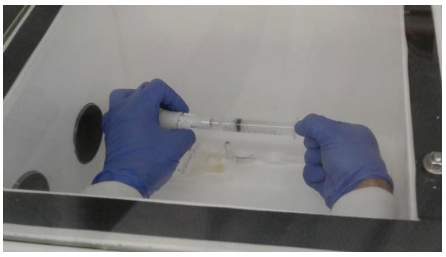
1. Withdraw 10 ml of saline out of a 50 ml IV bag, using a 10 ml syringe + SA
2. Transfer the saline to a vial attached to a VA
3. Shake the vial
4. Withdraw 10 ml of saline from the vial using the syringe + SA and transfer back to the IV bag
5. Take a saline sample from the IV bag for qPCR testing

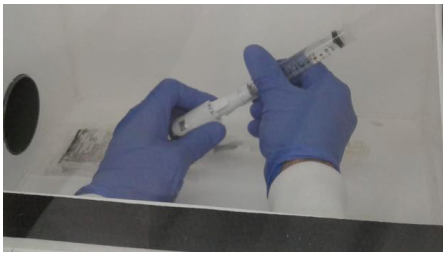
Test groups (triplicates) - using VAs with the complete ToxiGuard®:

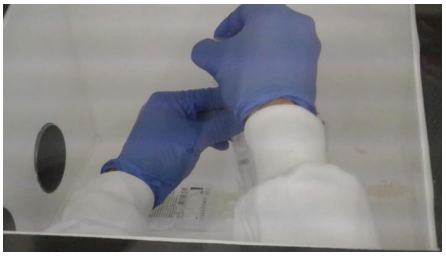
A. Used as is inside the virus-loaded aerosol environment.
B. First challenged by spraying with extra virus-loaded suspension directly on the outer surfaces near the ToxiGuard®, and then used according to the procedure described previously.

As a positive control, 6 sets that included VAs without ToxiGuard® that were sprayed with virus-loaded suspension were used according to the qPCR results (Table 1).









Chemfort®
Keeps you safe. Simply click

Results

When liquid samples were transferred using the standard VAs (containing the ToxiGuard® system), there was no evidence of viral RNA traces, even when the Vial Adaptors were directly sprayed with extra HCoV-OC43 stock solution (Table 1: sampling groups 1 and 2). Contrarily, some of the liquid samples that were transferred by the same procedure using the VAs in which ToxiGuard® was removed and were also challenged by spraying of extra HCoV-OC43 stock solution were found to be positive for viral RNA.

In summary, the results of this study indicate that the Chemfort® CSTD, and more specifically its ToxiGuard® dual action mechanical barrier, play a key role in preventing outer environment viral contamination of liquids transferred by the device.

Table 1.

Sampling group	Sample description	Biological Repeat	PFU/ml		
			Rep. 1	Rep. 2	Rep. 3
1	Standard Vial Adaptor	1	NA	NA	NA
		2	NA	NA	NA
		3	NA	NA	NA
2	Standard Vial Adaptor, sprayed with viruses	1	NA	NA	NA
		2	NA	NA	NA
		3	NA	NA	NA
3	Positive Control: Vial Adaptor without ToxiGuard®, and sprayed with viruses	1	NA	**1.0**	NA
		2	**7.5**	**8.6**	**8.0**
		3	NA	NA	**1.6**
		4	NA	NA	**1.7**
		5	NA	NA	NA
		6	**0.9**	**6.4**	**3.2**

Conclusion

Both protective layers of the TOXIGUARD® dual action barrier system are active against airborne viruses, and prevent the risk of virus penetration into the vial.

References

1. Milton DK, Fabian MP, Cowling BJ, Grantham ML, McDevitt JJ (2013) Influenza Virus Aerosols in Human Exhaled Breath: Particle Size, Culturability, and Effect of Surgical Masks. PLoS Pathog 9(3): e1003205. doi:10.1371/journal.ppat.1003205
2. Fehr AR & Perlman S (2015) Coronaviruses: An Overview of Their Replication and Pathogenesis, Methods Mol Biol. 2015 ; 1282: 1–23. doi:10.1007/978-1-4939-2438-7_1.
3. Spackman E (2008) A brief introduction to the avian influenza virus, Methods Mol Biol. 2008;436:1-6. doi: 10.1007/978-1-59745-279-3_1.
4. Kennedy MA & Parks RJ (2009) Adenovirus Virion Stability and the Viral Genome: Size Matters, Molecular Therapy 17(10):1664-1666
5. Dowdle WR & . Birmingham ME (1997) The Biologic Principles of Poliovirus Eradication, J. Infectious Diseases 175(Suppl 1):S286-92
6. Bayer ME, DeBlois RW., Diffusion constant and dimension of bacteriophage phi X174 as determined by self-beat laser light spectroscopy and electron microscopy. J Virol. 1974 Oct;14(4):975-80
7. Kuzmanovic DA et al (2003) Structure 11:1339-1348, DOI 10.1016/j.str.2003.09.021
8. Nelson Labs, Report No. 238280, Data on File
9. ANTIVIRAL TESTING OF FLEXZORB™ Carried Out by the Health Protection Agency (2009) - Data on File
10. Evaluation of Chemfort® CSTD ToxiGuard Filter for its Ability to Prevent Liquid Contamination by Human Coronavirus OC43 From the Environment (2021) - Data on File

Coronavirus photo by CDC on Unsplash