Respiratory Infection Control: Respirators vs. Surgical Masks

By Michael Lore, MS

The recent onset of a novel influenza virus strain has refocused attention on personal respiratory protection. This is of particular interest in hospital settings where controlling the spread of disease is important. The need to understand the limitations and use of respiratory protection devices to minimize exposure of potentially pathogenic laboratory specimens is important for laboratory workers.

Exposure to droplets on hands and environmental surfaces is thought to account for the majority of infections by the influenza virus. However, inhalation is also an important route of pathogen entry into the human body. As a precautionary measure, recommendations are that laboratory personnel reduce their exposure to airborne pathogens through the use of respiratory devices. Respirators are an effective protection measure against airborne particulate exposures when properly selected and worn. However, a common mistake seen in the workplace is the use of the wrong filter mask.

Image 1

In a hospital setting, there are typically two types of disposable respiratory protection devices available: the surgical mask and the filtering facepiece respirator. The surgical mask **(Image 1)** is primarily designed to protect others from the wearer's oral and nasal pathogens. Droplets that can be visually seen are produced through respiratory events such as talking, coughing or sneezing. These droplets are easily captured through the surgical mask's filter barrier. However, this type of mask is not intended to protect the wearer from micro-droplets or from very small particles like viruses.

The second type of respiratory mask typically used in laboratory situations is the filtering facepiece respirator **(Image 2)**. These respirators contain an electrically charged filter medium. This special charge is embedded into the filter medium of the mask and works by attracting very small particles, much like a magnet. These masks have a National Institute for Occupational Safety & Health (NIOSH) certification which means that they have undergone rigorous testing to verify their air-filtering ability. NIOSH approved masks are labeled according to their resistance to oil-based aerosols and particle collection efficiency. The most commonly recommended filtering facepiece respirator in the health care setting is the N95 mask where the "N" means "not resistant to oil aerosols" and "95" means that it will trap 95% of particles 300 nm or larger. Although the N95 filters are not certified at particle sizes smaller than 300 nm, they do provide adequate protection below 300 nm. As a reference, the sizes of airborne pathogens are highly variable but typically, most bacteria are larger than 300 nm while most viruses are smaller.

Image 2

Sneezing or coughing leads to the generation of large droplets (4000+ nm) that can be easily captured by a respiratory mask but what about very small particles? A single influenza virus particle average about 100 nm in size, too small to be trapped by a mask. Or is it? Shown in the figure below is a graph of an N95 filtering facepiece respirator tested in our lab against a polydisperse (broad size range distribution) salt solution. A polydisperse aerosol is used to test the mask's ability to capture particle sizes from 30-400 nm. The graph demonstrates the typical penetration curve of an N95 filter with few particles (300 nm size) passing through the filter mask (0.4%, circle), well below the NIOSH standard of 5%. As the size of the particle increases, fewer were able to pass through the filter. Note, however, that small particles were able to penetrate through the filter; however, they were still well below the 5% limit established by NIOSH.

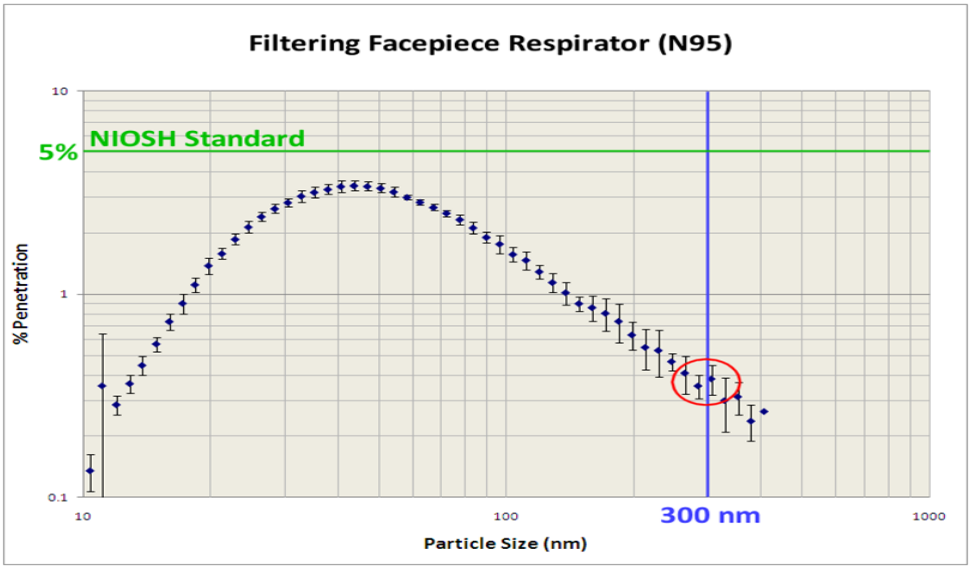

Figure 1. The NIOSH Standard line represents the 95% NIOSH limit for particle penetration at 300 nm. If the particle curve exceeds the line, the filter is less than 95% efficient at capturing particles. If the particle curve remains below the line (as above) the filter is greater than 95% efficient at removing airborne particles.

When fitted properly, the N95 filtering facepiece respirator has been proven to stop 95% of airborne particulates down to the 10nm range. A current research project at UNMC is to investigate whether significant disease can occur from the number of particles that do in fact penetrate the respirator.