Executive Summary

Respiratory protection advisable for workers in close proximity to wastewater systems capable of producing infectious pathogen aerosols

Potential for Exposure to Ebola Virus Surrogates Aerosolized from Wastewater Systems (WERF2C15)

The Central Issue

The Ebola virus disease outbreak in West Africa that began in 2014 is the largest in history. It caused 11,310 deaths as of June 2016 with a fatality rate of 53%. It is widely accepted that the primary route of Ebola virus transmission is direct contact with the patient or infectious body fluids. However, given that 1) aerosol transmission of Ebola virus disease has been demonstrated in animal models, 2) the virus is present in high concentrations in diarrhea, 3) the virus can survive in wastewater, and 4) bioaerosols can be generated by wastewater systems, the potential for transmission via inhalation exposure to the virus in wastewater systems cannot be dismissed. This research on Ebola could be applicable to transmission of other infectious pathogens as a result of extreme events or changes in prevailing weather conditions.

Context and Background

The overall goal of this project was to assess the potential for aerosolization of Ebola virus surrogates from wastewater systems. The researchers evaluated partitioning of surrogate viruses, MS2 and Phi6, between the liquid, solids, and material surfaces of porcelain, concrete, polyvinyl chloride (PVC), and polypropylene. The researchers then considered risk for three wastewater systems: toilets, a lab-scale model of an aeration basin, and a lab-scale model of converging sewer pipes. The researchers measured the aerosol size distribution generated by each system, spiked viruses into each system, collected aerosol samples for analysis by plaque assay, and determined the emission rate of viruses into the air.

Findings and Conclusions

The approach used quantitative polymerase chain reaction (qPCR) to detect viruses. Results reflected the presence of genomic material of the viruses, but not every virus was necessarily infectious. In all cases, at least 94% of the virus particles, or virions, partitioned into the liquid fraction. In real sludge, no more than 0.8% of virions partitioned to the solids and no more than 6% to the material surface.

Management and Policy Implications

The viruses used in this study are considered reasonable surrogates for Ebola virus, but due to uncertainties about aerosolization and persistence of actual Ebola virus – although results should be applied with caution – they can be used to inform risk assessment of inhalation exposure to Ebola virus found in wastewater.
Viruses were readily aerosolized from lab-scale models of an aeration basin and converging sewer pipes. The airborne concentrations may be sufficient to lead to infection. While the risk of transmission via this route is expected to be extremely low compared to contact transmission, the results suggest that respiratory protection is advisable for workers who work in close proximity to wastewater systems that can produce aerosols.

The effects of flow rate, pipe size, and wastewater composition on aerosol generation are not yet known. Another concern not addressed by this study is high-pressure cleaning, which is likely to generate aerosols (Haas et al., 2010), although such activity can be postponed until after an Ebola threat has passed.

Experimental setup for measurement of toilet-generated aerosols.