

## **Final Report**

# **Efficacy of Point-of-Use Nephros-Point in Removing Enteroviruses in a Laboratory Water System**

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## **Background**

The presence of enteroviruses in drinking water, even in very low numbers, poses a high risk to the consumers (Haas et al. 1993). According to the World Health Organization (WHO), four billion cases of diarrheal disease occur worldwide every year, resulting in 1.8 million deaths, primarily infants and children in developing countries (Organization 2006). Around 80% of this disease is attributed to unsafe water supplies, inadequate sanitation and hygiene. In the USA, viruses are the target pathogens in the Ground Water Rule under the EPA's Safe Drinking Water Act, which came into effect in January 2007. However, viruses are difficult to eliminate in drinking water because viruses are smaller than bacteria and resistant to chlorination.

Enteroviruses have been shown to occur in treated drinking-water supplies. Drinking-water represents a likely source of enterovirus infection. Enteroviruses have been detected in drinking-water supplies that met accepted specifications for treatment, disinfection and conventional indicator organisms. Currently, the best available technology for removal of viruses is enhanced coagulation follow up microfiltration (MF) or ultrafiltration (UF). However, it is primarily for large treatment facility in domestic drinking water treatment. No point-of-use (POU) filtration technology can remove virus except using reverse osmosis.

The Nephros Inc. has a new POU filter using a dual stage ultra-filter which increase the usage life to 3 months or longer. The company manufactures the filter with pore size of 0.005  $\mu\text{m}$  membrane offering additional filtration capability including viruses. The objective of this study is to evaluate the efficacy of this new water filter for removing enterovirus in a laboratory model plumbing system.

## Hypotheses

Nephros water filter can remove enterovirus from a laboratory model plumbing system.

## Materials and Methods

### A. Model Fixture

Test and control faucets were attached to a laboratory water system located in the microbiology laboratory at National Kaohsiung Normal University. Two counter-top goose neck faucets were installed at a sink (Figures 1 and 2). A Nephros filter was installed at the test faucet under the counter for treatment of water from the sink. A clear PVC baffle was installed to separate the two faucets so there was no interference between the two faucets. In addition, a baffle was placed under the water stream to prevent the splashes; a potential retrograde contamination. The flow rate was controlled at 3L/min on both systems.

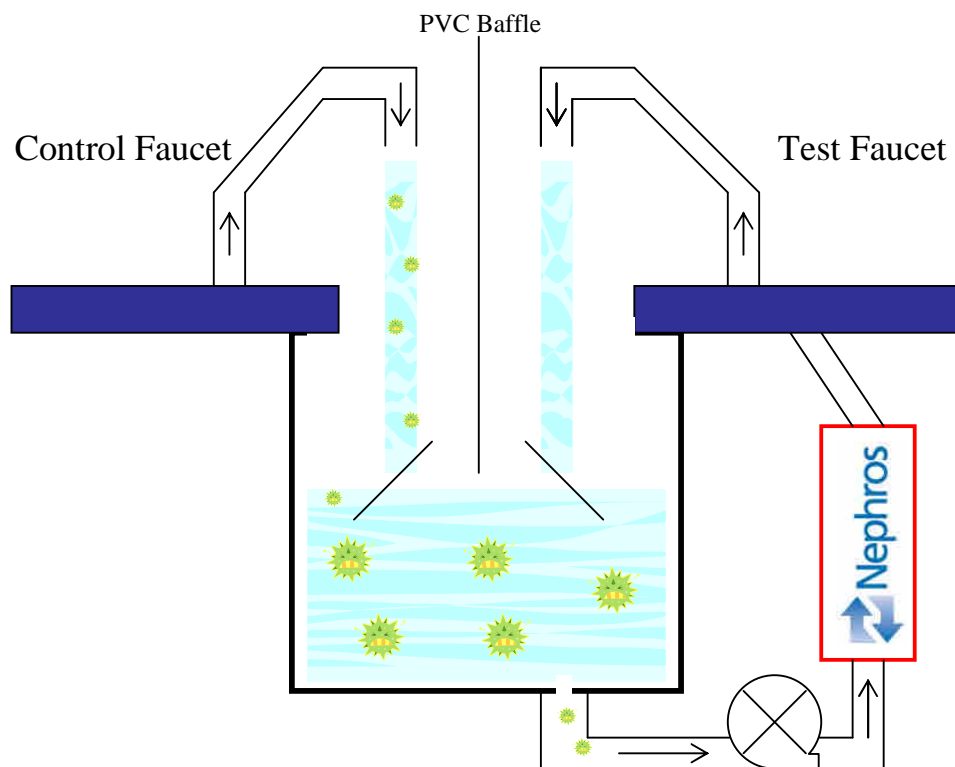


Figure 1. A laboratory water system with a goose neck faucet and Nephros filter.



Figure 2. A model plumbing system with two goose neck faucets and a Nephros filter.

#### B. System Operation:

The experiment was conducted in two conditions:

Experiment I. The Nephros filter was tested for 24 hours at total water volume of 4,320 liters ( $3 \text{ (L/min)} \times 60 \text{ (min/hr)} \times 24 \text{ (hr/day)}$ ).

Experiment II. The Nephros filter was tested for 7 days at total volume of 9,475.2 liters ( $2.256_{\text{avg}} \text{ (L/min)} \times 60 \text{ (min/hr)} \times 10 \text{ (hr/day)} \times 7 \text{ (day)}$ ).

#### C. Test Organisms

A clinical isolate of enterovirus (Coxsackie A16 virus, strain G10) was selected as the test organism.

#### D. Sample Withdrawn and Analysis

Experiment I. 10mL of water sample was withdrawn at T = 0, 1, 2, 4, 6, 24 hr from the both test faucet (after Nephros filtration) and control faucet (no filtration). Total of 12 water samples were tested in each experiment.

Experiment II. 10mL of water sample was withdrawn at T = 0, 1, 2, 3, 7 days from the test faucet, (after Nephros filtration) control faucet (no filtration), and the bulk water. Total of 15 water samples were tested in each experiment.

For culture of Coxsackie virus, a standard microbiological method for sample processing was followed (Manual of Clinical Microbiology, 2003).

#### **Results**

Experiment I : No enterovirus was recovered from the test faucet for 24 hr which the water was filtered by Nephros filter (Table 1). Enterovirus was detected in the samples from the control faucet.

Experiment II : No enterovirus was recovered from the test faucet for 7 days which the water was filtered by Nephros filter (Table 2). Enterovirus was detected in the samples from the control faucet and the bulk water (Table 2).

#### **V. Conclusion**

Nephros filter demonstrate 100% removal of the test enterovirus from a contaminated tap water in a laboratory water system.

Table 1. Efficacy of Nephros Filter in Removing Virus from a Laboratory Water System –

Experiment I (24 hr)

Time (hr)	Test Faucet (w/Filter)	Control Faucet (w/o Filter)
0	Negative	Positive
1	Negative	Positive
2	NA*	NA*
4	NA*	NA*
6	Negative	Positive
24	Negative	Positive

\*: Samples were contaminated and the results were not interpretable.

Table 2. Efficacy of Nephros Filter in Removing Enterovirus from a Laboratory Water System –

Experiment II (7 days)

Time (day)	Test Faucet (w/Filter)	Control Faucet (w/o Filter)	Bulk Water
0	Negative	Positive (1+)*	Positive (1+)
1	Negative	Positive (1+)	Positive (2+)
2	Negative	Positive (2+)	Positive (2+)
3	Negative	Positive (2+)	Positive (2+)
7	Negative	NA**	Positive (1+)

\*: Indication of the fluorescent intensity (negative, 1+, 2+, 3+, 4+) under microscopy.

\*\* : Samples were contaminated and the results were not interpretable.

## **Reference**

Haas, C. N., J. B. Rose, et al. (1993). "Risk assessment of virus in drinking water." Risk Anal **13**(5): 545-52.

Manual of Clinical Microbiology (2003). Washington, D.C., American Society for Microbiology Press.

Organization, W. H. (2006). Guidelines for drinking-water quality. Geneva, World Health Organization.