

In July and August of 2017, Puro's technology partner Violet Defense engaged a third-party, clinical testing lab to validate the efficacy of their technology against some of the most concerning pathogens, according to the CDC. The following represents the results of that testing.

About Microchem Laboratory

Microchem Laboratory is an EPA and FDA GLP-Compliant, ISO 17025 Accredited Testing Laboratory (Laboratory Accreditation Bureau Certificate Number L2450). Tests were conducted at the Microchem Laboratory, 1304 W. Industrial Blvd, Round Rock, TX 78681. For more information, visit www.microchemlab.com.

Products Tested

Helo F2



The Helo F2 uses Violet Defense's pulsed xenon technology to deploy broad spectrum of UV-C, UV-B, UV-A to kill bacteria and viruses. Each unit includes intelligent control that can be programmed to run autonomously for a pre-defined period.

Helo F1



The Helo F1 uses Violet Defense's pulsed Xenon technology to deploy broad spectrum of UV-C, UV-B, UV-A to kill bacteria and viruses. Each unit includes intelligent control that can be programmed to run autonomously for a pre-defined period.

Test Methods

ASTM International, formerly the American Society for Testing and Materials (ASTM), is an internationally recognized organization that develops and publishes product and testing standards.

Antibacterial Tests (Studies NG9044-A1, NG9045-A1, NG9204-A1, NG9205-A1, NG13050) were conducted utilizing ASTM International Standard Test Method E1153 Modified for Devices Test Method for Efficacy of Sanitizers Recommended for Inanimate Non-Food Contact Surfaces. ASTM E1153 is a quantitative test method designed to evaluate the antimicrobial efficacy of sanitizers on pre-cleaned, inanimate, nonporous environmental surfaces.

Pathogens Tested

Focus Antibacterial Pathogens:

Escherichia coli

This bacteria is a Gram-negative, rod-shaped, facultative anaerobe commonly found in the gastrointestinal tract of mammals. Certain pathogenic groups of *E. coli* such as enterohemorrhagic (EHEC), verocytotoxin producing (VTEC) and Shiga-like toxin producing (STEC) can cause a multitude of illnesses. *E. coli* is relatively susceptible to disinfection when dried on a surface, yet it can be a challenging microorganism to mitigate in solution.

Salmonella enterica

This bacteria is Gram-negative, rod-shaped, facultative anaerobe. Like the closely related *Escherichia* genus, *Salmonella* are common to all parts of the world and share habitats in the digestive systems of cold and warm-blooded animals. *S. enterica* is one of the most common bacteria associated with zoonotic and foodborne illness. Because of its regular occurrence and pathogenicity, *S. enterica* is a common bacteria for measuring disinfectant efficacy.

Staphylococcus aureus (MRSA)

This bacteria is a Gram-positive, cocci shaped, aerobe which is resistant to the penicillin-derivative antibiotic methicillin. MRSA can cause troublesome infections, and their rapid reproduction and resistance to antibiotics make them more difficult to treat. MRSA bacteria are resistant to drying and can therefore survive on surfaces and fabrics for an extended period of time and therefore makes this bacteria an excellent representative for antimicrobial efficacy testing on surfaces.

Focus Antimicrobial Pathogen:

Candida auris AR Bank #0381

This fungus grows as a yeast and is ascomycetous. *C. auris* is an emerging pathogen and the epidemiology for transmission is still under investigation. Infections have most often occurred in hospitalized patients and healthcare facilities. This yeast has developed resistance to commonly used antifungal drugs and specialized laboratory methods are needed to identify *C. auris* infections. Because of this, *C. auris* infections are increasingly difficult to identify and treat.

Antibacterial Activity and Sanitizing Efficacy of Violet Defense's Device (Study ID Number: NG9204-A1)

Product Tested: Helo F2

Contact Time Tested: 15-minutes, 30-minutes, and 45-minutes

Distances Tested: 3 meters (9.8 feet) & 4 meters (13.1 feet)

Study Timeline: 8/2/2017-8/14/2017

Test Microorganism	Test Substance/ Test Conditions	Contact Time	Units Per Carrier	Average % Reduction Infectious Units Per Carrier
<i>E. Coli</i> ATCC 8739	Plate Recovery Control	Initial	4.71E+06	N/A
		Final	4.05E+06	
		Average	4.38E+06	
	3 meters	15 minutes	2.38E+04	99.46%
		30 minutes	6.84E+03	99.84%
		45 minutes	1.30E+03	99.97%
	4 meters	15 minutes	1.00E+05	97.72%
		30 minutes	1.38E+04	99.69%
		45 minutes	6.70E+03	99.85%

Test Microorganism	Test Substance/ Test Conditions	Contact Time	Units Per Carrier	Average % Reduction Infectious Units Per Carrier
<i>S. enterica</i> ATCC 10708	Plate Recovery Control	Initial	2.46E+06	N/A
		Final	5.43E+05	
		Average	1.50E+06	
	3 meters	15 minutes	3.38E+04	97.75%
		30 minutes	2.68E+03	99.82%
		45 minutes	4.13E+02	99.97%
	4 meters	15 minutes	2.63E+04	98.25%
		30 minutes	9.98E+03	99.34%
		45 minutes	1.85E+03	99.88%

Test Microorganism	Test Substance/ Test Conditions	Contact Time	Units Per Carrier	Average % Reduction Infectious Units Per Carrier
<i>S. aureus</i> ATCC 33592	Plate Recovery Control	Initial	1.46E+06	N/A
		Final	1.71E+06	
		Average	1.59E+06	
	3 meters	15 minutes	3.25E+04	97.95%
		30 minutes	6.25E+03	99.61%
		45 minutes	2.25E+03	99.86%
	4 meters	15 minutes	7.75E+04	95.12%
		30 minutes	2.13E+04	98.66%
		45 minutes	5.35E+03	99.66%

Antibacterial Activity and Sanitizing Efficacy of Violet Defense's Device (Study ID Number: NG9205-A1)

Product Tested: Helo F1
Contact Time Tested: 30-minutes and 45-minutes
Distances Tested: 2 meters (6.6 feet) & 3 meters (9.8 feet)
Study Timeline: 8/2/2017-8/14/2017

Test Microorganism	Test Substance/ Test Conditions	Contact Time	Units Per Carrier	Average % Reduction Infectious Units Per Carrier
<i>E. Coli</i> ATCC 8739	Plate Recovery Control	Initial	5.39E+06	N/A
		Final	1.68E+06	
		Average	3.53E+06	
	2 meters	30 minutes	5.00E+04	98.58%
		45 minutes	6.86E+03	99.81%
	3 meters	30 minutes	2.05E+05	94.19%
45 minutes		1.50E+04	99.58%	

Test Microorganism	Test Substance/ Test Conditions	Contact Time	Units Per Carrier	Average % Reduction Infectious Units Per Carrier
<i>S. enterica</i> ATCC 10708	Plate Recovery Control	Initial	4.00E+05	N/A
		Final	2.05E+05	
		Average	3.03E+05	
	2 meters	30 minutes	5.00E+03	98.35%
		45 minutes	8.75E+03	97.11%
	3 meters	30 minutes	6.25E+03	97.93%
45 minutes		6.25E+03	97.93%	

Test Microorganism	Test Substance/ Test Conditions	Contact Time	Units Per Carrier	Average % Reduction Infectious Units Per Carrier
<i>S. aureus</i> ATCC 33592	Plate Recovery Control	Initial	1.69E+06	N/A
		Final	1.50E+06	
		Average	1.59E+06	
	2 meters	30 minutes	3.00E+04	98.12%
		45 minutes	9.85E+03	99.38%
	3 meters	30 minutes	1.01E+05	93.65%
45 minutes		3.63E+04	97.73%	

Determination of the Antiviral Effectiveness of Test Device Against Feline Calicivirus (Study ID Number: NG9046-A1)

Product Tested: Helo F1
Contact Time Tested: 45-minutes
Distances Tested: 2 meters (6.6 feet)
Study Timeline: 6/30/2017-7/6/2017

Test Microorganism	Test Substance/ Test Conditions	Contact Time	Units Per Carrier	Average % Reduction Infectious Units Per Carrier
<i>Feline Calicivirus</i> (EPA-approved human norovirus surrogate), ATCC VR-782	Plate Recovery Control	Initial	7.08E+05	N/A
		Final	1.26E+04	
		Average	3.60E+05	
	2 meters	4 Hour Cycle (36 min. run time)	2.24E+02	99.77%

Determination of the Antiviral Effectiveness of Test Device Against Feline Calicivirus (Study ID Number: NG9047-A1)

Product Tested: Helo F2
Operational Modes Tested: 45-minutes
Distances Tested: 2 meters (6.6 feet) & 3 meters (9.8 feet)
Study Timeline: 6/29/2017-7/6/2017

Test Microorganism	Test Substance/ Test Conditions	Contact Time	Units Per Carrier	Average % Reduction Infectious Units Per Carrier
<i>Feline Calicivirus</i> (EPA-approved human norovirus surrogate), ATCC VR-782	Plate Recovery Control	Initial	7.08E+06	N/A
		Final	1.26E+05	
		Average	3.60E+06	
	2 meters	4 Hour Cycle (36 min. run time)	7.08E+01	99.993%
	3 meters	4 Hour Cycle (36 min. run time)	2.24E+02	99.98%

Feline calicivirus (FCV), ATCC VR-782, surrogate for human norovirus

This virus is a non-enveloped, positive-stranded RNA member of the genus. As a member of the *Caliciviridae* viral family, FCV is closely related to human noroviruses, which cause acute gastroenteritis marked by nausea, vomiting and diarrhea. Unlike human norovirus, however, a simple cell culture assay system is available for FCV. Therefore, feline calicivirus is the US EPA-approved surrogate microorganism for human norovirus label claims. Both FCV and human norovirus are able to remain viable on environmental surfaces for extended periods of time and are resistant to a number of disinfectant actives.

In June 2019, Violet Defense engaged a third-party, clinical testing lab to validate the efficacy of its technology against *C. auris*. The following represents the results of that testing.

Study Results

Antimicrobial Activity and Sanitizing Efficacy of Violet Defense's Device (Study ID Number: NG13050)

Product Tested: Helo F2

Contact Time Tested: 1 hour, 2 hours, and 3 hours

Distances Tested: 1 meter (3.3 feet) & 2 meters (6.6 feet)

Study Timeline: 6/3/2019-6/19/2019

Test Microorganism	Distance	Contact Time	Average % Reduction
<i>C. auris</i> CDC AR Bank #0381	1 meter	1 hour	99.96%
		2 hours	99.97%
		3 hours	>99.98%
	2 meters	1 hour	96.66%
		2 hours	99.79%
		3 hours	99.82%



C. diff CLINICAL TRIAL (UV COMPARISON TRIAL)

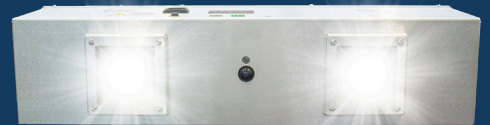
One of Violet Defense's partners conducted a UV Comparison Trial to evaluate and compare the antimicrobial efficacies of several disinfection machines. Violet Defense agreed to provide technology to be a part of this independent assessment. Each product was tested against *C. diff* spores in different test locations in a laboratory-controlled mock hospital room.

Percentage Reduction vs. Control

	Percentage Reduction vs. Control
Bedrail (right)	99.9707%
Bedrail (left)	99.9560%
Under Bed	99.9937%
Call Button	99.9681%
Guest Chair Armrest	99.9954%
Floor (near)	99.9918%
Table (top)	99.9881%
Table (bottom)	99.9842%
Floor (far)	99.9525%
Toilet Seat	99.9928%
Sink Handle	99.9285%
Grab Bar	99.9661%
AVERAGE	99.9740%

PRODUCTS TESTED

Helo F2



OPERATIONAL MODE TESTED

The testing protocol utilized 4 *Helo F2*'s in a layout designed to replicate a fully installed deployment in a mock hospital patient room and bathroom. The units were positioned in a corner pattern at a distance of ~1.5 meters from the patient bed.

Units ran for 2 hours to approximate anticipated disinfection time over the course of a typical 24-hour period for an installed solution.