

# A Novel Method of Applying UVC to Eliminate the 'Canyon Wall Effect' of Textured Surfaces in Healthcare Environments

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# **Outline**

- 1. Textured Surfaces in Healthcare
- 2. The 'Canyon Wall Effect'
- 3. Experimental Design and Results
- 4. Recommendations

### Characterizing Hospital Environments/ Surfaces



## **Hospital Room Disinfection**



- Hospital Acquired Infections (HAIs)
  - Clostridium difficile (C. diff)
  - Staphylococcus aureus (MRSA)
- Chemical and UVC
- UV Advantages
  - Efficiency
  - Safety
  - Effectiveness

# **UV Disinfection Considerations**

3 aspects to consider when placing lamp:









2. Surface Roughness 3. In (Texture)

3. Incident Angle





Stainless steel under microscope with different finishes.



Enlarged view of typical textured surface found in healthcare settings.



# The 'Canyon Wall **Effect'**



9am canyon - 2m deep



12pm canyon - 2m deep

### The 'Canyon Wall Effect' on a Submillimeter Scale





# Is the 'Canyon Wall Effect' real?

## **Problem Statement**

<u>Problem statement:</u> Most healthcare surfaces are horizontal and textured. Most UV emitters use only vertical UVC sources, meaning that bacteria on surfaces experience the 'canyon wall effect.'

# Hypothesis

<u>Hypothesis 1:</u> UV lamps positioned parallel to the surface will have greater germicidal effectiveness than UV lamps placed perpendicular to the surface.

<u>Hypothesis 2:</u> This importance of where you place the UV lamp is more pronounced with textured surfaces than a smooth surface.

# Testing the 'Canyon Wall Effect'

- 2 independent variables:
  - UV orientation relative to surface (parallel vs. perpendicular)
  - Surface texture (smooth vs. textured)

#### **Experimental conditions**

## Parallel:

- UV applied parallel to smooth surfaces
- UV applied parallel to *textured* surfaces

## **Perpendicular:**

- UV applied perpendicularly to smooth surfaces
- UV applied perpendicularly to *texture* surfaces

# Definitions



## Materials for the Experiments

- 8cm by 8cm disinfected ABS plastic tiles
  - Common in hospital rooms
  - Smooth and textured (shown to the left)
  - Low UVC reflection
  - Uniform and random texturing
    - 1mm peak-valley height
- S. aureus solution
- UVC meter
- UVC light → UV Hammer Device
- Baird Parker contact plates





# Methods: **Parallel** Lamps on Smooth vs. Textured Surface



UVC applied parallel to smooth and textured tiles.

### Methods: **Parallel** Lamps on Smooth vs. Textured Surfaces

- S. *aureus* prepared through culture and incubation.
- 1.1 m from light source
- Lamp length: 505 mm
- Smooth tiles and textured tiles.
- Lamps powered until meter read 5, 10, 20 mJ/cm<sup>2</sup>

Stationary



UV Meter

#### Methods: **Parallel** Lamps on Smooth vs. Textured Surfaces



Quantitative Baird Parker contact plates contacted to the tiles.

Incubated at 35-39 C for 36 hours.

Photographs taken of plates.

Bacteria on each plate counted.

Statistical and data analysis on plate counts.

## Methods: **Perpendicular** Lamps on Smooth vs. Textured Surfaces

#### UVC applied perpendicularly or to the side of smooth and textured tiles.



### Methods: **Perpendicular** Lamps on Smooth vs. Textured Surfaces

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Smooth tiles and textured tiles.

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### Methods: **Perpendicular** Lamps on Smooth vs. Textured Surfaces



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# Results

## **Smooth Surfaces**



cm

150x difference

## **Textured Surfaces**



## Perpendicular









# Conclusions

- **150x reduction** for smooth tiles when lamps placed parallel vs. perpendicularly
- **500x reduction** for textured tiles with lamps placed parallel vs. perpendicularly
- Significant difference between smooth and textured surfaces when UV applied perpendicularly
- No significant difference between smooth and textured surfaces when UV applied parallel

UV Applied parallel eliminates the canyon wall effect!

# Summary

- UV is a practical room disinfection method
- 'Canyon wall effect' is real
  - Shadowing happens on a submillimeter scale
- When disinfecting, must consider:
  - Angle of incidence
  - Degree of texture/smoothness
- Texture cannot be ignored!
- UV applied parallel eliminates the 'Canyon Wall Effect'