

SURFACE DISINFECTION BY EXPOSURE TO GERMICIDAL UV LIGHT

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Abstract

The present study was aimed to design a simple model to check efficacy of germicidal UV tube, to standardise the position, distance and time for UV light and also to find out its efficacy against medically important bacteria, the bacterial spores and fungi. The microbial cultures tested included gram positive and gram negative bacteria, bacterial spores and fungal spores. The microbes streaked on solid media were exposed to UV light. The inactivation of the order of four logs was observed for bacteria. UV light can have efficient inactivation of bacteria up to a distance of eight feet on either side and exposure time of 30 minutes is adequate.

Key words: Germicidal, micro-organism, UV light

The medical profession was the first to endorse germicidal effect of UV lamps^[1] and it has been used traditionally to disinfect operation theaters.^[2,3] Absence of any residual effect is the greatest advantage of UV disinfection. In spite of its usage for over 50 years, the guidelines for the position of the fixtures, the effective distance, exposure time required etc. are not well-documented in hospital practice. Our preliminary study indicated that efficient and uniform microbial inactivation is achieved when the UV tubes are hung from the ceiling at seven feet height rather than fitted over the side wall (unpublished data). The aim of the present study was to design a simple experimental model for checking surface disinfection using bacterial challenge and to standardise the position, distance and time for UV light exposure. It was also aimed to find out efficacy of UV light against wide range of medically important bacteria, the bacterial spores and fungi under the defined experimental conditions.

Materials and Methods

Germicidal UV tubes four feet length and of 40 Watt power (Phillips, Holland) were used for the study.

The organisms used in the study are listed in the figure. The bacteria were subcultured on nutrient agar (Hi-Media, India). *Candida albicans* and *Aspergillus niger* were subcultured on Sabouraud dextrose agar (Hi-Media, India). *Aspergillus niger* was allowed to grow for seven days and the spores were scraped and suspended in sterile phosphate buffered saline (PBS). *Bacillus subtilis* was sporulated and the spore suspension heated at 70°C for 30 minutes

to inactivate vegetative forms. *Clostridium perfringens* grown in Robertson's cooked meat medium for seven days and the spores were heated at 70°C for 30 minutes to inactivate vegetative forms. The wild isolate of *Clostridium perfringens* was selected because of its ability to form large number of spores. *Mycobacterium fortuitum* was sub cultured on Lowenstein Jensen medium and incubated at 37°C for 48hours.

Experiment to determine the optimal distance from UV light

Overnight growth of *E.coli* on nutrient agar slant was harvested in normal saline and the opacity was adjusted to 0.5 McFarland standard. Ten microliter suspension was spread over the nutrient agar plates. UV light tube was placed as a horizontal up assembly on a table and the plates were exposed for 20 minutes at varied distance of two feet to 16 feet at increment of two feet each. The *E. coli* suspension (McFarland standard 0.5) was subjected to viable count using ten log dilutions to confirm the count. Reduction in viable count was expressed as ratio of initial viable count to viable count after exposure to UV light.

Experiment to standardize the exposure time

The *E.coli* inoculated plates were exposed to UV light at a fixed distance of eight feet and time of exposure varied from 5 minutes to 40 minutes at an increment of 5 minutes each.

Effect of UV light exposure on different organisms

The distance from the UV source was kept at eight feet and time of exposure was kept at 30 minutes. The suspensions of various organisms were subjected to viable count. *Clostridium perfringens* inoculated blood agar plates were incubated at 37°C for 48 hours in anaerobic condition using Difco - Oxoid Gas Pack System. *M. fortuitum* inoculated nutrient agar plates were incubated for 48 hours at 37°C. *Aspergillus niger* and *Candida* inoculated Sabouraud dextrose agar plates were incubated at room temperature for 48 hours. For the rest of the organisms nutrient agar plates inoculated with bacteria

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were incubated at 37°C for 24 hours. All the experiments were repeated thrice and observations and interpretations were as in experiment one.

Results

The reduction in the viable count of *E.coli* (experiment 1) was 1.8×10^4 up to the distance of six feet, 0.97×10^4 at eight feet, 0.83×10^4 at 10 feet and dropped to 0.36×10^4 at 12 feet distance from UV light. The result suggested four log reductions of bacteria up to eight feet and hence was considered as the maximum distance for disinfection coverage.

In the second experiment, the distance was fixed at eight feet and time of exposure varied. After UV exposure for 10 minutes viable count reduced by 0.2×10^4 , at 15 minutes by 2.6×10^4 and after 20 minutes reduced by 3.5×10^4 . Further time increment showed only marginal increase in bacterial inactivation. Thus, 20-25 minutes exposure to UV light seemed adequate for disinfection and 30 minute exposure time is recommended for UV disinfection.

The efficacy of inactivation of various organisms at the distance of eight feet from UV source and exposure time of 30 minutes is shown in the figure. Four-log reduction was seen for all the organisms including the bacterial spores and excluding *Candida*, *Aspergillus* spores and *M. fortuitum*. Inactivation of *Candida* and *M. fortuitum* was around three logs while inactivation of *Aspergillus* spores was even lower than three logs. The overall results however, suggest satisfactory inactivation of approx 4 log reduction when the UV source is at ≤ 8 feet and the exposure time is 30 minutes.

Discussion

In the present study, a simple model is described to check the surface inactivation of microbes exposed to UV. Our preliminary observations had suggested the germicidal UV tubes fixed over the side wall to be inefficient for disinfection of room and the tubes hanging from the central area of the ceiling of seven feet height were found

to be more efficient. The present observations indicate that disinfection efficiency is good up to a distance of eight feet on either side of the tube and an exposure time of 30 minutes is adequate. Using these optimized conditions, the inactivation of common pathogenic bacteria like all aerobic, anaerobic bacteria and also spore bearers like *Clostridium* was in the order of four log.

The inactivation was almost one log less efficient for *Candida* and *Mycobacterium fortuitum* while for *B. subtilis* and *Aspergillus* spores a reduction of approx 3 and 2.5 logs was observed.

The maximum advantage of UV light disinfection is for areas like operation theater, and biosafety hoods.^[4] While recommending the use of UV light at appropriate distance and for appropriate time we wish to emphasize that standard safety guidelines^[5] need to be observed during usage of UV light.

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