Reduction of Indoor Airborne Mold Spores in a Hospital Facility by the Genesis Air Photocatalysis System

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Abstract

Genesis Air Photocatalysis (GAP ™) is an advanced, high capacity air purification system designed to remove harmful and allergenic particulate and organic contaminants of air. The present study was a test of the GAP ™ technology to improve indoor air quality in a health-care setting. Indoor and outdoor air levels of non-viable and viable mold spores were measured at a VA hospital. The air handling units of the hospital were then retrofitted with GAP ™ panels and were operated as usual for approximately seven weeks. Post-installation samples demonstrated that despite a significant increase in outdoor mold spore counts, indoor air fungal spores were reduced by an overall average of 66.4 % within the hospital work spaces and patient care areas.

Introduction

Indoor air quality issues are of increasing concern world-wide. While outdoor air pollution issues have received attention for decades, the quality of indoor air has only recently been acknowledged as important in health and well-being. Indoor air pollution is now recognized as being among the top five environmental health risks. (1) It is estimated that in industrialized nations, people spend as much as 80%-90% indoors. Modern buildings are tightly sealed and often poorly ventilated, allowing pollutants to become trapped and concentrate to levels 2-5 times those found outdoors.(2) Indoor air pollutants generally consist of gaseous elements (vehicle exhaust, gas stove emissions, paint and varnish fumes, etc.) and particulate matter (dust, smoke, pollen, bacteria, mold spores, etc.) Of these, fungi and molds have recently been the focus of numerous studies demonstrating their many detrimental effects on human health.

There are over 1000 species of fungi that have evolved to thrive in building environments.(3) (4) While most are not pathogens in healthy individuals, many cause allergic processes such as perennial rhinitis and eye irritation and can exacerbate existing conditions such as asthma. Fungi produce mycotoxins, volatile organic compounds (VOCs), and spores which are largely responsible for many of the adverse health effects caused by molds. Spores of commonly occurring molds such as Alternaria, Cladosporium, Drechslera, and Rhizopus spp. are on the order of greater than 5 microns in diameter and are readily inhaled when airborne. (5) However, this particle size is effectively removed by the use of high efficiency air cleaning systems, such as the Genesis Air Photocatalysis (GAP ™) System.

While there are many types of air purification systems available, not all are effective and some (ozone generators) may actually be harmful. The most advanced and innovative technology combines particulate removal with pollutant destruction. GAP ™ technology is a three-stage germicidal and air-cleaning process that purifies air by trapping particles 3 microns or larger in the first stage, and inactivating them in the second and third stages. The second stage is a powerful UV light and the third stage uses a photocatalytic reaction of the UV light with a titanium dioxide coated pleated membrane to create hydroxyl radicals as the cleaning agents which convert hazardous biological and chemical pollutants into harmless compounds.

This system was initially tested by the U.S. Army in rigorous controlled studies for its ability to remove biological agents from room air. The impressive results from these studies, in which the GAP ™ system removed and destroyed an average of 93.5% of airborne fungal spores in a controlled setting, (6) led to the testing of the system in a more “real-world” situation. GAP ™

technology was tested for its ability to improve indoor air quality in a health-care setting. Indoor and outdoor air levels of non-viable and viable mold spores were measured at a VA hospital. The air handling units of the hospital were then retrofitted with GAP ™ panels and were operated as usual for approximately seven weeks. Post-installation sampling demonstrated that indoor air fungal spores were reduced by an overall average of 66.4 % within the hospital work spaces and patient care areas, even as outdoor spore levels had increased by over 50% to nearly 70% during the same time frame.

Materials and Methods

The Veteran's Administration (VA) Hospital in El Paso, Texas, was the site chosen to test the system. In September of 2007, various sites within and outside the hospital were sampled using spore-trap (non-viable fungi) and culturable (viable fungi) methodologies, and samples submitted to a reference laboratory for analysis. The hospital's 15 air handling units were then retrofitted with 114 Populated Catalyst Panels (PCP) Standard which had 264 Ultraviolet germicidal (UVGI) lights installed. The hospital's air handlers were operated as usual until late October of 2007, at which time sites within and around the hospital were again sampled. Post-installation samples were submitted to the same reference laboratory for analysis. The spore trap data is a measure of total fungal airborne debris (hyphal fragments, spores, etc.) and does not differentiate between viable and non-viable fungal spores. The culturable fungi analysis measured the live fungal spores in colony-forming units (cfu) and allowed for the identification of the fungi recovered.

Results

Non-viable methodology:

Total fungal airborne particles, as measured by the spore trap analysis, were reduced by an overall average of 66.4% across all sites within the hospital. The GAP ™ system was able to significantly reduce the indoor fungal particles despite an apparent increase of 55.3% in outdoor fungal particles in an outdoor site immediately adjacent to the hospital facility (loading dock). The reduction of indoor particles at the various sites ranged from 49.8% (lobby 2nd floor) to 81.8% (HVAC room 4-2) (Fig. 1).

Viable methodology:

The viable fungal airborne particles, as measured by the culture and identification of the molds recovered, were reduced by an average of 63.4% across all sites within the hospital. As two outdoor sites again showed a significant increase (loading dock, 69.1% and main entrance, 75%) in viable fungi, the indoor reduction in mold particles can be attributed to the GAP ™ panels. The reduction of indoor viable fungi ranged from 42.1% (HVAC Room C) to 95.8% (A327 Supply AHU) (Fig 2).

Conclusions

The Genesis Air Photocatalysis (GAP ™) System significantly reduced both viable and total indoor airborne fungal elements in a large VA Hospital Facility in El Paso, Texas. The existing air handlers were easily retrofitted to accommodate the GAP ™ panels, thus allowing the installation of the advanced three-stage germicidal and air-cleaning process. Subsequent normal operation of the facility's air handling units resulted in a dramatic reduction of indoor fungal particles.

As an ever-increasing number of studies indicate that fungal particles and by-products adversely affect the health of building occupants, Genesis Air Photocatalysis (GAP ™) Systems may be used to improve the health and comfort of personnel and patients in a hospital or other type of patient-care setting.

References

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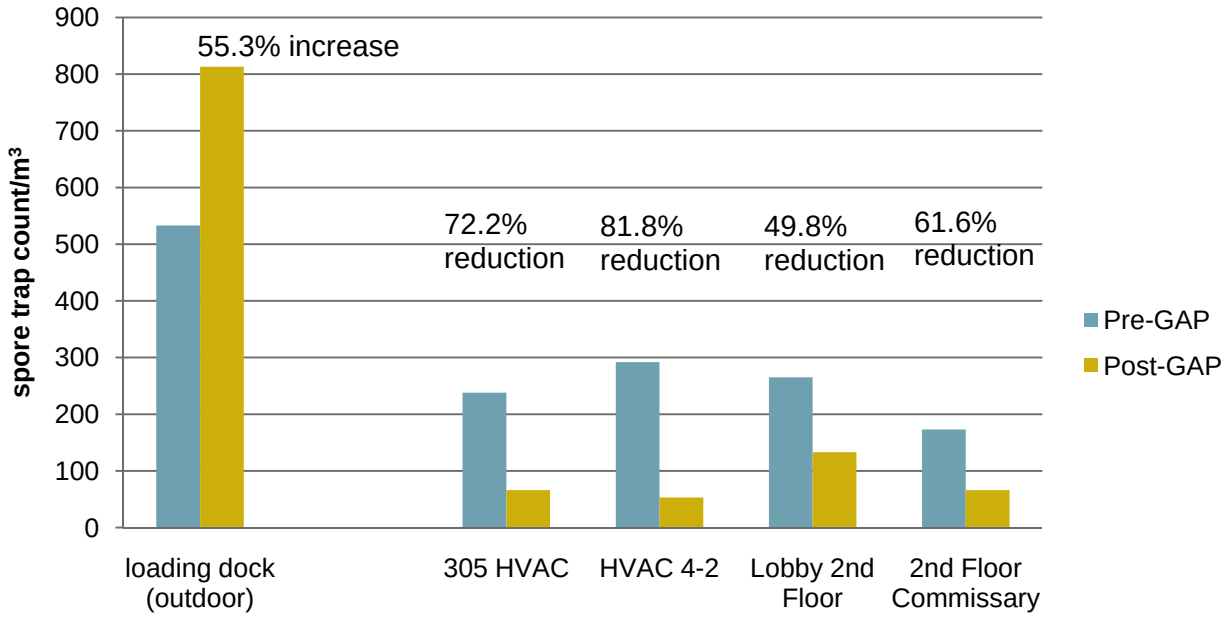
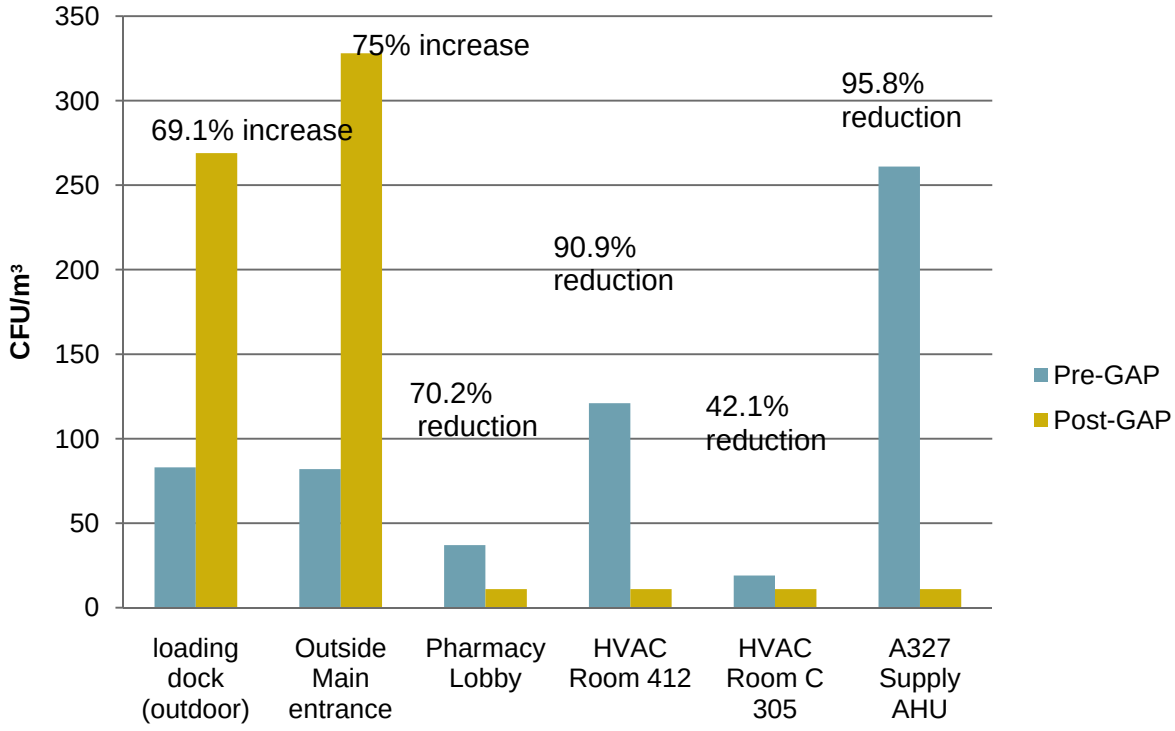
Figure 1 - Non-viable methodology



VA sites sampled before and after GAP™ installation

Figure 2 - Viable methodology



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