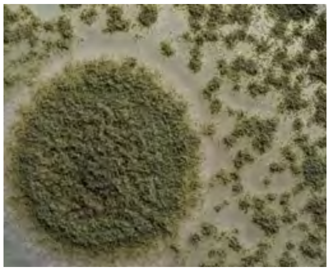
Research Brief

Daylight through Smart Windows Sterilizes Harmful Pathogens

EXECUTIVE SUMMARY

Nearly 150 years ago, a pair of pathologists made an incredible discovery: sunlight inhibits the growth of bacteria. This breakthrough discovery led to many advancements in the treatment and prevention of bacterial diseases, such as the Nobel Prize-winning treatment of skin tuberculosis using the Finsen lamp in 1903. We now know that daylight inactivates not just bacteria but also many viruses and fungi including SARS-CoV-2. UV light technologies have been adapted to sterilize everything from water to surgical rooms to escalator railings. However, UV comes with the downside of discoloring fabrics, degrading certain mechanical equipment, increasing the risk of skin cancer and bringing in excessive heat indoors. As a result, modern windows block UV light, begging the question: what is the effect of daylight on pathogens indoors



Methods

Dr. Sepideh Pakpour, Director of the Pakpour Microbiome Laboratory at the University of British Columbia, designed a highly controlled chamber to test the effect daylight on bacterial and fungal growth:

- View Smart Windows, in their clear state (Tint 1; 60% light transmittance)
- View Smart Windows, in their tinted state (Tint 4; 1% light transmittance)
- Blinds, with windows in their clear state (1% openness factor; 1% light transmittance)

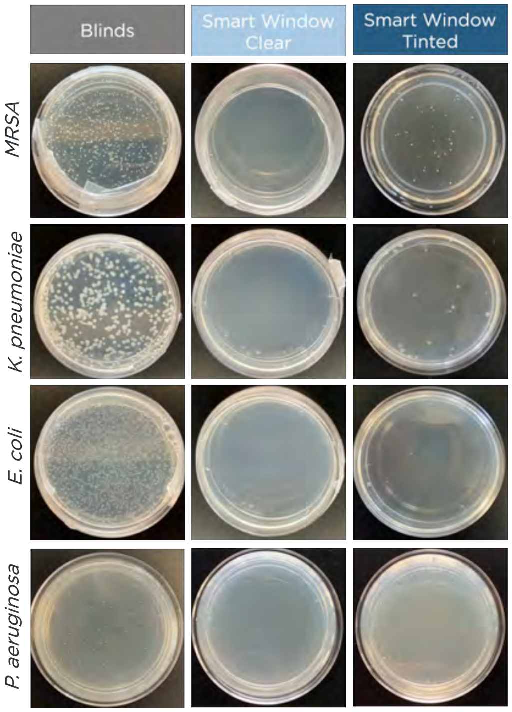
The chamber allowed the researchers to control other factors such as temperature, humidity and airflow. Cultures of pathogenic bacteria and fungi were placed into the chamber and their viability and growth under these daylight conditions were measured.

Key Findings

Smart windows caused a complete 100% reduction of bacteria and fungi in their clear state compared to traditional windows with blinds. When in their darkest tint state, bacteria were reduced by 41-100% and fungi by 26-42% depending on the level of nutrients available and surface material.

Conclusions

Harnessing daylight as a natural disinfectant is a powerful strategy to reduce contamination – and thus reduce the risk of disease transmission – in indoor spaces. This can have particularly important consequences in spaces where providing a contaminant-free space is paramount: In a hospital, reducing surface contamination is key to mitigating the risk of healthcare-associated infections, which can cost millions of dollars and thousands of preventable deaths per year; in a laboratory setting, it is a critical consideration for quality assurance and regulatory compliance.



View Smart Windows cause nearly complete disinfection of harmful bacteria, as evidenced by the number of colonies formed.

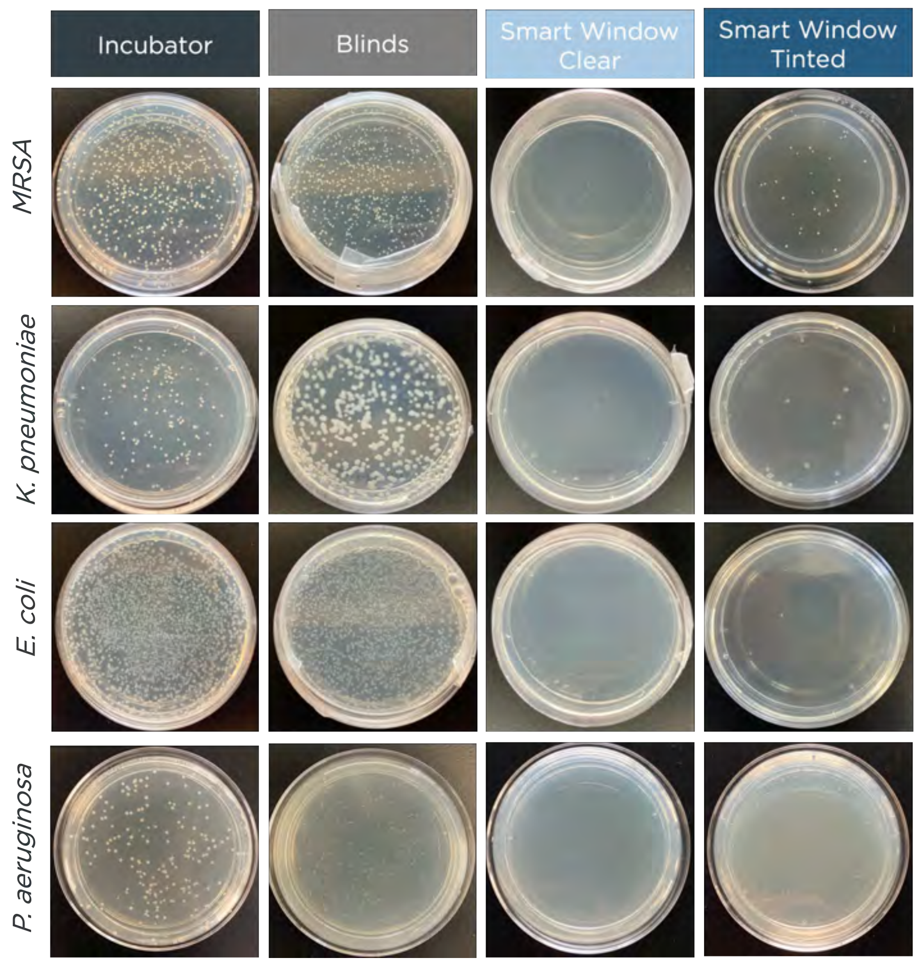
THE UNIVERSITY OF BRITISH COLUMBIA

BMR The Pakpour Laboratory Biomedical Microbiome Research

RESULTS

Smart windows let in more higher energy, shorter wavelength light – the range of visible light with antimicrobial effects – compared to traditional blinds, significantly reducing the growth rate and viability of surface pathogens.

Bacteria

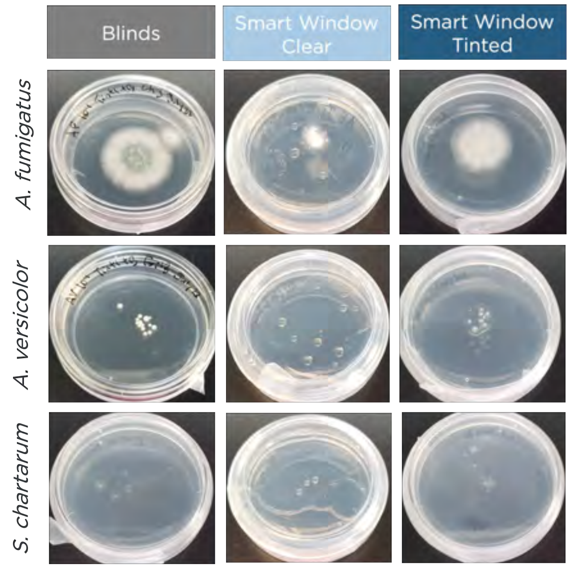


Daylight passing through smart windows in their clear state significantly reduced the viability of all tested bacteria when colonized in a nutrient-rich environment (i.e., food), with all tested bacteria demonstrating a >98% reduction relative to blinds. Daylight passing through the smart windows in their tinted state led to a 41-100% reduction in bacteria viability over 24 hours, relative to blinds. The highest reduction was observed in E. coli and MRSA, in which viabilities were reduced by 100% in both smart window conditions relative to blinds. Conversely, the Blinds condition was not statistically different than the incubator condition.

When the pathogens were cultured on different surface materials (plastic, glass, and PVC fabric), the results varied across material type but generally demonstrated the antimicrobial effects of daylight through smart windows relative to blinds. For example, daylight passing through smart windows in their tinted state reduced the viability of MRSA on PVC fabric by 100% and on glass by 78%, relative to blinds. The disinfection potential of PVC fabric, which is found in blinds and other furnishings, is particularly interesting as these are often the most difficult – and thus least frequently – cleaned surfaces with traditional cleaning agents yet are still frequently touched.

Fungi

Daylight passing through smart windows in their clear state significantly reduced the growth of all tested fungal species, demonstrating a >86% reduction relative to blinds. Daylight passing through the smart windows in their tinted state led to a 26-42% reduction in fungal growth relative to the blinds condition with S. chartarum observing the highest reduction (42%).



IMPLICATIONS

Laboratory Environments

Microbial contamination is a major concern for life science companies - previous studies report that it is responsible for 11-15% of product recalls. In addition to the lost revenue and legal exposure, life science companies spend on average $3.1M annually to remediate contamination events.

Passive surface disinfection with daylight can support laboratory environments to comply with Current Good Manufacturing Practices (cGMP) regulations to maintain a sterile laboratory environment, avoid remediation costs, and reduce the regulatory risk of FDA audits.

Healthcare Environments

Healthcare associated infections (HAIs) lead to nearly 100,000 deaths each year in the US and are commonly attributed to contamination of the patient's surroundings. Not only does a clean environment support healing and recovery – the primary role of the hospital – it can cost a hospital millions of dollars annually in CMS reimbursements. Hospitals that rank in the bottom quartile for the rate of HAIs face a 1% penalty on their CMS reimbursements.

With antimicrobial resistance increasing, treating patients post-infection is no longer a silver bullet. As these pathogens get harder to treat in the patient, the importance of treating them in the environment grows. Current approaches are burdensome and imperfect: for example, one study shows that 92% of blinds become recontaminated with MRSA within one week of cleaning. Cleaning agents also pose a risk to patients and cleaning staff by releasing volatile organic compounds that can be irritants, allergens or asthmagens. Cleaning staff are 70% more likely to suffer from asthma due to chronic exposures to cleaning agents.

CONCLUSIONS

Harnessing daylight as a natural disinfectant is a powerful strategy to reduce contamination – and thus reduce the risk of disease transmission – in indoor spaces. This research shows that electrochromic windows bring in all the elements of daylight that can disinfect with none of the consequences of harmful UV light. In comparison, traditional windows with blinds had a negligible effect with bacteria levels similar to the incubator. This can have particularly important consequences in spaces where providing a contaminant-free space is paramount: In a hospital, reducing surface contamination is key to mitigating the risk of healthcare-associated infections, which can cost millions of dollars and thousands of preventable deaths per year; in a laboratory setting, it is a critical consideration for quality assurance and regulatory compliance.

