Carpet: An Important Reservoir That Influences Both Indoor Chemistry and Indoor Microbiology

Sarah Haines; Rachel Adams, Ph.D.; Andrea Ferro, Ph.D.; Karen Dannemiller, Ph.D.

Introduction

In the indoor environment, people move and resuspend dust from the floor. Choice of flooring type has an important influence on exposure to microbes and chemicals in the indoor environment from this dust.[1,2] However, important questions remain about how carpet (broadly defined) compares to solid flooring in influencing indoor microbiology, indoor chemistry, dust resuspension, and human exposure. These interactions between chemicals and microbes also influence the way in which carpet should be cared for and cleaned. Further study could improve the effectiveness around carpet cleaning and understanding between carpet care and occupant health.

A workshop entitled "Implications of Carpet on Indoor Chemistry and Microbiology," was held on July 30–31, 2019 at The Ohio State University. Attendees included representatives from the carpet industry, the cleaning industry, the Centers for Disease Control and Prevention, the U.S. Environmental Protection Agency, and scientists from engineering, public health, chemistry, microbiology, and other diverse fields. At the workshop these different groups identified gaps in research related to carpet as a reservoir for contaminants in the indoor environment. Key findings from this workshop were recently published in a paper in *Building and Environment* titled "Ten Questions Concerning the Implications of Carpet on Indoor Chemistry and Microbiology.[3]" The full text of the paper is available here: https://doi.org/10.1016/j.buildenv.2019.106589.

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SYNOPSIS

In the indoor environment, people move and resuspend dust from the floor. Choice of flooring type has an important influence on exposure to microbes and chemicals in the indoor environment from this dust.

Carpet is a complex textile that is present in many indoor environments. Carpet maintenance and proper cleaning is important when considering the relationship between carpet dust and human exposure.

A workshop in 2019 included representatives from the carpet industry, the cleaning industry, the Centers for Disease Control and Prevention, the U.S. Environmental Protection Agency, and scientists from engineering, public health, chemistry, microbiology, and other diverse fields. Key findings from this workshop were recently published in a paper in *Building and Environment* titled "Ten Questions Concerning the implications of Carpet on Indoor Chemistry and Microbiology".

The workshop fostered important conversations between groups with diverse perspectives on carpet. It was clear that these groups would benefit from continued conversations to move toward shared goals of improving indoor environmental quality.

Carpet is an important source of exposure to microbial and chemical contaminants through the resuspension of floor dust with human activity. Carpet is both a sink (trap) and a source for accumulated dust and chemicals, and therefore acts as a reservoir for environmental contaminants and may increase human exposure if proper maintenance and cleaning is not performed. Under most typical levels of dust in buildings, research presented at the workshop showed that carpet has increased amounts of resuspended dust compared to hard flooring, making carpet cleaning an essential component to research on how carpet influences health.

While the presence of carpet may affect exposure to chemical and biological agents, some of this can be mitigated through proper maintenance. One of the key gaps in knowledge identified in the workshop was that there are few scientific studies evaluating current practices and making recommendations.

Overall, improved understanding of how different carpet cleaning methods influence indoor microbiology, indoor chemistry, and human exposure is needed. This knowledge will lead to better ways to manage carpet.

There are numerous chemicals and microbial components in carpet dust, and procedures involving removal, cleaning, and installation of carpet should be designed to prevent harmful occupational exposures.

The following discussion reviews key findings related to carpet cleaning and maintenance.

The Workshop

One unique aspect of the workshop was fostering conversations between groups with diverse perspectives on carpet. Important information was exchanged among all workshop participants. For instance, the scientists and academics gained important information about current industry trends in carpet manufacturing and maintenance. Similarly, industry participants were interested to learn about fundamental research studies that have been completed in this area. It was clear that both of these groups would benefit from continued conversations to move toward shared goals of improving indoor environmental quality.

Implications for Dust Resuspension and Exposure: Carpet is a Reservoir

Carpet is an important source of exposure to microbial and chemical contaminants through the resuspension of floor dust with human activity, such as walking (Figure 1). Carpet is both a sink (trap) and a source for accumulated dust and chemicals, and therefore acts as a reservoir for environmental contaminants and may increase human exposure if proper maintenance and cleaning is not performed. In other words, carpet both traps indoor dust and also releases it back into the air in the room. Under most typical levels of dust in buildings, carpet has increased amounts of resuspended dust compared to hard flooring, making carpet cleaning an essential component to research on how carpet influences health. Carpet is also a diverse textile with many different types that can influence this resuspension.[4]

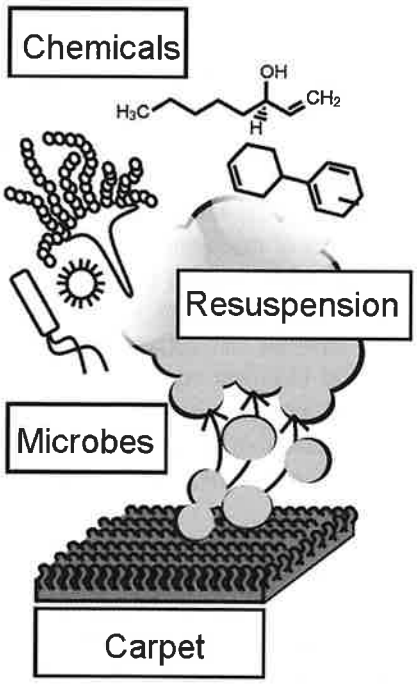

Figure 1: Microbes and chemicals may be resuspended from carpet into the air.

Carpet can emit and retain both volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). Surface chemical reactions can also occur more on carpet than hard-surface flooring because carpet has a higher surface area.

Carpet influences microbial growth indoors by providing a reservoir for dust. Moisture is generally the limiting factor for microbial growth, and this growth occurs if the relative humidity becomes elevated above around 80%.[5] It is critical to maintain appropriate relative humidity levels to prevent microbial growth in carpet dust. The U.S. EPA recommends maintaining indoor relative humidity between 30–50% and definitely below 60%.[6] Floor dust may also contain other biological agents such as allergens. Vacuuming reduces the amount of dust in carpets, but often the vacuuming that occurs in homes is not as rigorous as in academic studies. This is why it is important to sustain proper maintenance of carpet. Further research would be useful to define proper maintenance and what effective cleaning means.

Carpet Maintenance

Carpet can provide important benefits to an indoor space, including increased comfort, sound dampening, and injury prevention. While the presence of carpet may also affect exposure to chemical and biological agents, some of this can be mitigated through proper maintenance. One of the key gaps in knowledge identified in the workshop was that there are few scientific studies evaluating current practices and making recommendations. Plus, many of the existing studies use methods that are unrealistic in most homes; for example, one study found that vacuuming needed to occur for 6 to 45 min/m^2 to remove detectable dust from some older carpets.[7]

Overall, we need improved understanding of how different carpet cleaning methods influence indoor microbiology, indoor chemistry, and human exposure. This level of knowledge will lead to better ways in which to manage carpet. The workshop identified specific areas in which further information is needed.

First, it was suggested that there is a particular need for more standardization of information about vacuuming protocols to meet a threshold of dust loading as to limit resuspension in the air. These levels will likely vary, as different types of carpet and human presence will influence dust loading.

Second, sustainability should also be considered in carpet maintenance, as over four-billion pounds of carpet per year are removed as waste.[8] Thus, improved maintenance strategies through vacuuming and cleaning processes may also promote the longevity of carpet. Sustainability should also include disposal and replacement of carpet due to water damage or smoke exposure that could influence chemical and microbial human exposures. Improvements in standards for carpet maintenance best practices will be key in limiting these human exposures.

Finally, maintenance cost and procedures should also be considered prior to carpet installation. Guidance and best-practices for installation of carpet and maintenance are necessary for all consumers, and costs are particularly important for low-income families. Optimized maintenance procedures are of particular interest to those in the carpet cleaning industry. There are numerous chemicals and microbial components in carpet dust, and procedures involving removal, cleaning, and installation of carpet should be designed to prevent harmful occupational exposures. Proper clothing and personal protective equipment (PPE) should be worn as necessary. The types of PPE required will vary based on the contaminants suspected to be present and the procedures being completed, but the PPE should adequately protect workers from harmful exposure.

Conclusions

Carpet is a complex textile that is present in many indoor environments. Carpet maintenance and proper cleaning is important when considering the relationship between carpet dust and human exposure. Future research is needed to improve cleaning practices and evaluate their efficiency and efficacy. Carpet should be designed with the ability to improve impacts from dust retention, VOC exposure, resuspension and microbial growth. Maintaining a proper relative humidity in the home is also important, as is keeping carpet dry so as not to encourage microbial growth. It is important to utilize this information to improve indoor environmental quality and therefore human health.

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