THE QUALITY OF AIR IN HEALTHCARE

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Indoor air can become very contaminated, like the murky water in a stagnant pond. Unfortunately, "dirty" indoor air cannot be visually distinguished from clean air. Many of the contaminants in the air are particulates, less than ten microns in size, and the respiratory system acts as a filter to trap these aerosols which often end up in the lungs.

Bioaerosols, (particulates from living organisms), if inhalable or respirable , can be a significant exposure risk for sensitized individuals, including not only patients, but the health care providers who may work long shifts in the self-contained, sometimes "stagnant" building environment. Illnesses associated with environmental exposures include asthma and hypersensitivity pneumonitis.

Building air, whether in a doctor's office or in a large hospital, is impacted by many systems, each making its own contribution of vapors and airborne particulates. Because air, like water, is a fluid and always moves from high pressure to low, contaminants flow passively through the building following the pressure gradients. Mechanical systems also actively transport contaminants from one room and floor to another. Thus, air from underground garages often moves through elevator shafts to spread carbon monoxide (CO) and car soot into the habitable spaces above; fresh air intakes which, due to architectural design, are often located above loading docks, can also distribute CO and truck soot.

Modern medical facilities are air conditioned, and whenever humid air is cooled, moisture condenses. Air conveyance systems (ducts, blowers, cooling coils, etc.) contain biodegradable dust, including skin scales, cellulose lint, corn starch granules, and pollen. When these nutrients become moist, the growth of mold, yeast or bacteria occurs. Air flows through the conveyance system can aerosolize the products of this microbial growth and distribute them throughout the building; these microbes are also the source of the "sweat sock" odor often associated with cooling systems.

Carpeting that has suffered moisture, either from flooding, dew-point condensation, or even foot traffic during damp weather, is another common source of bioaerosol and sour odor. Because all the nutrient dust can never be vacuumed out of a carpet, whenever there is excessive moisture, microbes can proliferate. When the dry carpeting containing this growth is disturbed by foot traffic, potential allergens become airborne. Attempts to clean such carpeting can result in high levels of allergenic bioaerosols if an inefficient, unfiltered vacuum is used.

One surprising bioaerosol that has caused numerous cases of allergy and even anaphylaxis is latex allergen on corn starch granules from surgical gloves. The theory about this exposure is that starch granules (in the range of 8 to 20 microns) acquire latex proteins from direct contact with the glove surface.

I believe that the presence of allergens on surrogate particles is quite common, but unfortunately unrecognized, because it is so difficult to detect. For example, Fel d 1, the protein allergen in cat urine, could easily be found on aerosolized particulates from disturbed, dried kitty litter. Through the use of immuno-labeled colloidal gold adsorption, studies have shown that soot particles (assumed to have resided on the surface of cat dander or pollen) become allergenic as a result of protein adsorption.

Very often, in indoor environments where sensitized individuals are experiencing symptoms, the results of culturable bioaerosol testing for mold or bacteria are negative. In such an environment, it is possible that soot particles that had been adhered to damp microbial colonies (the extent of whose growth within mechanical systems can extend over many square meters) are distributed and present in the air.

In a computing facility with highly purified and humidified air, one individual experienced respiratory symptoms even though the only airborne particulates present were sub-micron rust crystals that originated from the bacteria-contaminated, rusting evaporative tray in the humidifier. Presumably, some allergen from the slimy bacterial broth was present on the surface of the aerosolized rust. (Similar rusting can be found on condensate trays under AC coils.)

Here are some tips for healthcare providers:

- In humid weather, the temperature of concrete in contact with soil is usually close to the dew point (producing high relative humidity at surfaces), so mildew frequently grows on drywall and in carpeting on concrete below grade, especially near foundation walls in confined spaces. Physicians specializing in allergy and asthma should avoid seeing patients in below-grade spaces.
- The purpose of filtration is dual: to trap allergens and microbes, but more importantly, to prevent the accumulation of nutrient dust on the system components. HVAC systems (particularly the cooling coils, condensate trays and fiberglass lining near the coils) in healthcare facilities should be maintained dust, rust and soot free and only be operated with better than 95% efficient arrestance (12 MERV) media filters.
- The required ventilation air should always be introduced, both for general comfort and to reduce the concentration and transmission of infectious droplets.
- Offices often contain copiers, printers or labs, and have widespread use or processing of carbonless, self-copy forms. These can be the source of irritating chemical aerosols. Frequent sources of significant odor or chemical emissions should have local exhausts.
- The use of air fresheners, spray cleaning chemicals, and compounds with strong fragrances should be avoided in healthcare facilities.
- To avoid re-suspending bioaerosols, use only HEPA vacuums.
- To prevent dust, vapors and contaminants from entering areas where patients may be affected, particular care should be taken during renovations. Containment should be carefully planned.