UPPER ROOM ULTRAVIOLET (UV) AIR DISINFECTION: Where are we and where are we going?

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WHAT IS UPPER ROOM ULTRAVIOLET GERMICIDAL IRRADIATION (UVGI)?

Upper room UVGI employs fixtures placed at least 8 feet off the floor, which are designed to irradiate and sterilize a large volume of air above the occupants' heads while not exposing room occupants to UV. Room air disinfection depends on the upward movement of warmed, contaminated air from the lower room, heated by occupants and other sources, displacing irradiated air from the upper room zone, thereby disinfecting lower room air. Room air mixing, carrying contaminated air into the irradiated upper zone, can be passive, depending on temperature differences, or augmented by slow paddle fans, ventilation registers, or other air moving devices, which will all improve the performance of the upper room UV/air-mixing system (see Figure 1).

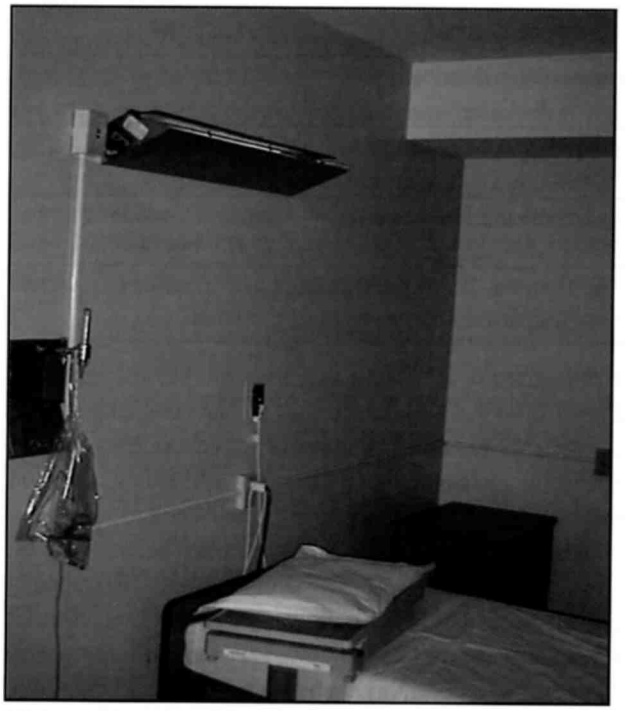

Figure 1. Photo of hospital room with upper room UV.

WHY UPPER ROOM UV AIR DISINFECTION?

Some readers may wonder why anyone would choose to disinfect air in the space above people's heads, when they could be doing the same thing in ventilation ducts, the technology discussed in most of the articles in this special issue. Let me begin this review with a brief comparison of these two approaches to germicidal air treatment. Reasons favoring upper room UV systems include:

1. Most person-to-person transmission of airborne infections is likely to occur between people in the same room, not recirculated through the building's ventilation system, although the latter mechanism occurs. If one is in an examination room with a patient with infectious tuberculosis, or an airborne viral infection, there is little comfort knowing that the air will be disinfected only after it leaves the room. To lower the risk of infection within that room requires dilutional ventilation, but the protection achieved by ventilation has theoretical limits (Nardell et al. 1991). For extra protection, very large numbers of equivalent air changes are required, and upper room UV air disinfection offers the important advantage of disinfecting large volumes of air at one time. Upper room UVGI also prevents recirculation of infectious agents within buildings, especially if most of the rooms serviced by the ventilation system are treated with UV.
2. The efficacy of upper room UVGI depends on good room air mixing, but not on the number of air changes in the room. In contrast, even if UV in ducts kills every infectious organism, the dilutional air disinfection benefit in occupied rooms is still limited by the number of air changes in that room. In other words, the efficacy of UV in ducts is limited by the ventilation rate, whereas upper room UV is not, providing air disinfection in addition to the room ventilation.
3. In many places in the world and in settings where airborne infections are a problem, central ventilation systems may not exist. Homeless shelters are often converted older buildings and warehouses and often do not have central ventilation. In many developing countries, especially in warm climates, buildings without central ventilation are the norm.

There are also some advantages to UV air disinfection in ventilation ducts over upper room UVGI, as follows: