Global Implementation of Effective Upper Room UV Air Disinfection – A Way Forward

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Upper room UVGI with air mixing is an evidence-based intervention that can be an effective part of airborne transmission control, together with administrative controls, personal respiratory protection, and the other environmental controls, especially natural ventilation. Given that natural ventilation is often entirely dependent on outside climatic conditions and occupant cooperation, upper room UVGI with air mixing is often a logical complementary, cost-effective environmental intervention.

Barriers to upper room UVGI implementation and possible solutions:

1) Technical expertise and guidelines
2) Availability of effective fixtures and photometers
3) Effective maintenance strategies

Technical expertise and guidelines.

We now have evidence-based guidelines for the implementation of UVGI (with air mixing) based on the South African efficacy study. ASHRAE is basing new international guidelines on these studies. Other studies will undoubtedly follow, but these hospital-based studies are currently our best source of guidance. There are two relatively simple dosing guidelines, but both depend on knowledge of total UV fixture output, and one guideline requires full gonioradiometry of fixtures. So far, few fixtures have been tested either for total fixture output or by full gonioradiometry, and that is a major barrier. The ASHRAE guidelines may stimulate laboratories to make these services available to fixture manufacturers. If any major manufacturers begin to offer fixtures with full output data, they will have a major competitive advantage over companies not providing that information.

Guidelines must include not only dosing formulas, but recommendations for maintenance and regular photometer readings to assure both effectiveness and safety.

Effective Fixtures and Photometers

Based on the published study, effective fixtures should target a total UVGI output of 0.5 W with designs that assure effective distribution in the upper room and safe levels in the lower room. With efficiently designed fixtures (primarily dependent on louver and reflector designs) total fixture output as high as 0.5 W can be achieved with as little as 25 W electrical (wall) input. Very few currently available fixtures approach this output or efficiency, but it is technically possible using commercially available UVGI lamps and reflectors in well-designed fixtures, with or without reflectors, depending on ceiling height. Generally, this performance is harder to achieve with compact fluorescent lamps because of relatively poor optical characteristics. Linear UVGI lamps can more easily be paired with effective parabolic reflectors to achieve similar performance standard. Less efficient fixtures (more electricity with less output) can be used and may be highly effective, but it will simply take more of them to achieve the UVGI dose per cubic meter room volume recommended (20 mW/m3). Smaller rooms may require less than 0.5 total fixture output.

Assuring good UVGI fixture performance requires calibrated photometers designed for UVGI and guidelines on how to make measurements to assure both safety and efficacy. Some meters are highly unreliable and all meters require periodic (annual) calibration to assure proper performance.

Effective maintenance strategies

Maintaining effective UVGI systems (with air mixing) is as critical as achieving them in the first place. Many systems are installed without proper commissioning measurements, so their safety and effectiveness is never established at baseline. Moreover, once installed, many UVGI systems are never metered again, and ongoing effectiveness, if ever present, is not assured. Hospitals, clinics, prisons, and other institutions simply do not have the expertise to properly design, install, or maintain UVGI systems.

UVGI Comprehensive Service Companies: One solution may be the promotion of private sector businesses (public-private partnerships) to provide design, installation, and maintenance services for UVGI on a purchase-maintain or lease-maintain basis. The latter has the advantage of reducing or eliminating the capital cost for institutions, but companies that essentially provide that capital up front for institutions will, of course, need to recover financing costs as well as design, installation, commissioning, and maintenance costs. These are all essential costs for producing and maintaining effective UVGI systems and should be considered acceptable to institutions if based on fair cost plus profit pricing strategies.

A way forward – some unresolved questions:

1) How do we disseminate technical knowledge on effective UVGI systems, including indications, contraindications, and advice on how to obtain proper equipment, proper designs, commissioning, and maintenance.
2) Computer Assisted Design (CAD) is a useful tool for producing effective Upper Room UVGI designs, but requires full gonioradiometric data on fixtures. It is unlikely that hospital engineers will master the CAD approach, but reasonable to expect independent UVGI service companies to acquire (Visual-UV available free) and to invest in training designers in its use.
3) How do we stimulate manufacturers of UVGI equipment to design fixtures to meet current performance guidelines AND provide customers with total fixture output data – at least total fixture output - and ideally total fixture gonioradiometry.
4) Both total fixture output and full gonioradiometry require independent measurements by competent lighting laboratories following published methods. How do with stimulate this practice, or will guidelines following this approach be sufficient.
5) Steve Rudnick has submitted a paper allowing a competent technician with a good UVGI meter to estimate the total UV output of many (not all) wall fixtures in a reproducible way. How should this method be used? By manufactures, by institutions, by UVGI Service companies?
6) Should there be some form of certification in upper room UVGI technology?
7) What is the role of international agencies: WHO, ASHRAE, international lighting societies?