UV Radiation, a source for “Superbugs”?

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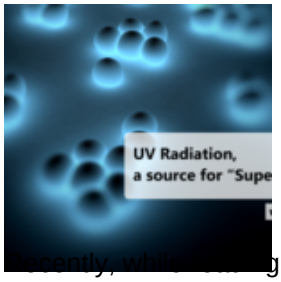

Recently, while reading a report on the opportunities of UV disinfection technologies and the “proclaimed” bright market future (Grand View Research, 2023), I was reminded of the fact that UV light is a source of cancer and actually 90% of skin melanomas are caused by UV light from the sun (Skin Cancer Foundation, 2024). That is a very scary fact, and the way UV radiation does this is by cell damage and mutation.

During and now after the COVID-19 pandemic, we see more and more advertisements for UV products and devices appearing on the market that are being promoted for disinfection and treatment against microbial pathogens. The reason is the fact that UV light can kill and deactivate pathogens by damaging bacteria and viruses, and their effectiveness in water and air treatment is well acknowledged.

That Which Does Not Kill Us Makes Us Stronger

Now, if UV radiation can and will cause mutations, the question arises if UV treatment for disinfection use, for example, in the health care sector, can actually create more dangerous pathogens, similar to the saying of German philosopher Friedrich Nietzsche: “*That which does not kill us makes us stronger*.” It should be noted that UV light is intentionally used, for example, to create mutations in bacteria, for scientific studies. The difference in this application is to induce repairable damage without killing the bacteria to study changes. The ability to kill bacteria and deactivate viruses by using UV light directly depends on the dose of UV light used on the target pathogen(s). Unfortunately, many times, based on different circumstances and applications (e.g., type of UV radiation, treated environment), that dose is not sufficient enough to have a lethal punch. This brings us to a new concept: The non-lethal UV treatment!

The non-lethal UV treatment!

Non-lethal UV treatment might be enough to cause DNA and RNA mutations in the affected organism. A similar situation happens because of partial and insufficient antibiotic treatment against bacterial pathogens. It can cause the creation of more dangerous pathogens, which is well-known and sufficiently published. There is a reason why the physician tells the patient to use all of the antibiotic medication and not stop even if they feel better (Mayo Clinic, 2023). In general terms, it needs the “lethal” punch to be effective!

What is the effect of non-lethal UV treatment?

How does that relate to UV treatment and the potential for generating potentially more dangerous organisms? We can look, for example, at two factors and their combination to address this question. One factor would be increased UV resistance against the radiation itself (less effective treatment), and the other would be the UV impact on antimicrobial

resistance.

The development of UV resistance in microorganisms is well known and is not only expressed in UV resistance but also in resistance to ionizing radiation (Feng Liu et al., 2023). Over time (many growth cycles), it is anticipated that microbes can develop a certain resistance to UV light, especially if they are exposed for a long enough time with no lethal dose. It is worthwhile noting that UV radiation-resistant microbial communities are already found in hospitals (PubMed, 2023). Consequently, UV light used for disinfection purposes will be less and less effective.

A quick look at recent scientific publications revealed that UV can affect antimicrobial resistance. A study by Caldwell et al. (2019) showed increased antibiotic resistance in *E. coli* caused by UV radiation. In other studies, UV radiation (non-lethal) caused an increase in risk for selecting and promoting *E. coli* strains with already established antibiotic resistance (Pang et al., 2016). Non-lethal UV radiation appears to benefit antibiotic-resistant bacteria's growth and proliferation by eliminating those bacteria with less antimicrobial resistance. Work by Li et al. (2021) discovered that UV light might decrease the susceptibility to certain antibiotics like tetracycline, ciprofloxacin, and polymyxin B in *Pseudomonas aeruginosa*.

Results Are Concerning And Require Further Studies

These and many other results are concerning and require further studies to see how non-lethal UV disinfection applications might cause more harm than good. How does that impact current technologies? If we interpret these studies, one of the conclusions is that a lethal punch is essential and non-lethal applications should be avoided. If bacteria are killed and viruses deactivated, there is no further resistance or infectivity. However, prolonged and insufficient UV radiation application for disinfection purposes might cause problems.

UV light technology used for air treatment is normally based on the approach of having air pass by the emitting radiation source in close proximity for a high-dose exposure. A similar approach is normally taken with water treatment. Generally speaking, both technologies bring the pathogens to the source and, as such, can be very effective (lethal). On the other hand, UV light used for room disinfection relies on prolonged exposure and requires that all targeted surfaces are close enough to be sufficiently exposed. Therein lies a potential problem. Static devices that do not bring pathogens to the radiation source are potentially less effective, plus they face the additional problems of shading by equipment, insufficient clean surfaces, human exposure, etc. That will result in some organisms, based on their location to the UV source, being lethally affected while others are not.

However, before a conclusive assessment can be made, if and how UV might help or promote the development of superbugs, especially in the health care setting, will require more conclusive research and studies on the short and long-term effects of non-lethal UV light on infectious agents. In the meantime, be careful how you use UV light for disinfection purposes. It should be lethal, but not to your skin!

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