British Photodermatology Group Position Statement

Ultraviolet C

What is ultraviolet-C?

Ultraviolet-C (UV-C) is a type of ultraviolet (UV) radiation that falls within the short-wavelength range of the electromagnetic spectrum. UV radiation is categorized into three main types based on wavelength: UV-A, UV-B, and UV-C.

While the sun emits UV-C radiation this is absorbed by the Earth's atmosphere and does not reach the surface. UV-C radiation is therefore generated artificially for specific applications. In recent years, there has been growing interest in the use of UV-C technology for disinfecting surfaces and air to combat the spread of infectious diseases, including the COVID-19 pandemic. UV-C devices have been deployed in healthcare facilities, transportation, and public spaces to help reduce the transmission of viruses and bacteria.

UV-C encompasses the wavelength range from 100 to 280 nanometers (nm) and can be subdivided into multiple sections.

- Vacuum UV (VUV): Vacuum UV, also known as VUV-C, refers to the extreme short-wavelength end of the UV-C spectrum, typically below 200 nm. As the name suggests, VUV cannot travel through the air but is used in analytical instruments, such as mass spectrometers and spectrographs, for various scientific and industrial applications.
- Conventional Germicidal UV-C (GUV): includes wavelengths from 240 to 280 nm and is widely used for germicidal purposes and disinfection applications. The most common source of Germicidal UV-C is the low-pressure mercury lamp, with a sharp emission peak of 254 nm. Conventional GUV is hazardous to skin and eyes and should not be incident on unprotected humans.
- Far-UVC: Far-UVC refers to the portion of the UV-C spectrum with wavelengths ranging from approximately 200 to 235 nm. Currently the most common source of Far-UVC is the Krypton-Chloride excimer lamp with peak emission at 222 nm, which typically has an optical filter to reduce non-Far-UVC emissions. Far-UVC has gained attention for its potential to effectively kill microorganisms, including viruses and bacteria, while being less harmful to human skin and eyes compared to longer-wavelength UV-C. This makes it a promising technology for continuous disinfection in occupied spaces, such as public areas and healthcare settings.

Here are some key characteristics of UV-C:

1. Germicidal Properties: UV-C radiation is known for its germicidal properties. It is highly effective at disinfecting air, water, and surfaces by destroying the DNA and RNA of microorganisms such as bacteria, viruses, and mould spores. This makes UV-C a valuable tool in sterilization and disinfection processes.
2. Limited Penetration: UV-C radiation has limited penetration ability, meaning it primarily affects the surface it directly contacts. This is why it is effective for disinfecting surfaces and air in enclosed spaces but may not reach pathogens hidden in crevices or within materials.

With Far-UVC there is even less penetration in tissue, which is why it does not cause acute reactions in the skin or eye until exposure are much higher than defined limits.

3. Safety Considerations: UV-C radiation can be harmful to human skin and eyes if over-exposed. Human exposure should be kept As Low As Reasonably Practicable (ALARP) and within exposure limits as laid out in the Control of Artificial Optical Radiation at Work Regulations 2010. A risk assessment is necessary when working with UV-C sources to ensure compliance with Health and Safety Legislation.
4. Ozone Production: Some UV-C lamps can produce ozone (O3) as a byproduct. Ozone can have both beneficial and harmful effects, so it's important to consider this when using UV-C devices that generate ozone.
5. UV-C LEDs: Advancements in technology have led to the development of UV-C light-emitting diodes (LEDs), which are more energy-efficient and compact than traditional UV-C lamps. UV-C LEDs are being increasingly used in various applications, including water purification, air disinfection, and consumer products.

UV-C (Ultraviolet-C) technology has several applications in healthcare settings due to its germicidal properties, including:

1. Surface Disinfection: UV-C lamps and devices are used to disinfect surfaces in healthcare facilities. These devices emit UV-C light that can kill or deactivate pathogens on surfaces such as countertops, bedrails, doorknobs, and medical equipment. This helps reduce the risk of healthcare-associated infections (HAIs). Sometimes this type of surface disinfection is performed by UV-C Robots. These UV-C robots are equipped with UV-C lamps to autonomously disinfect patient rooms and other high-touch areas. They can navigate through rooms and use UV-C light to kill pathogens on surfaces. Importantly they can only operate in rooms that are not occupied as the quantity of UV-C is hazardous to humans.
2. Air Disinfection: UV-C air disinfection systems are employed in hospitals and other healthcare environments to purify the air and reduce the transmission of airborne pathogens. These disinfection systems may be contained within Heating, Ventilation and Air Conditioning (HVAC) systems or may be within the healthcare facility. If present in a room, the UV-C system will either be contained within a portable air cleaner, be located over-head disinfecting the air in the upper-room or, in the case of Far-UVC, be illuminating the occupied space to disinfect air as it passes between people.
3. Water Treatment: UV-C is used for water purification and disinfection and can be installed in water treatment systems to kill bacteria and other microorganisms in drinking water, as well as in the water used for medical procedures and equipment sterilization.
4. Instrument and Personal Protective Equipment (PPE) Disinfection: UV-C can be used for the disinfecting PPE, medical instruments and equipment. Specialized UV-C chambers or cabinets are designed to disinfect items such as surgical instruments, endoscopes, reusable face shields and dental equipment.
5. Laboratory and Biosafety Cabinet Sterilization: UV-C is used to sterilize laboratory equipment, biosafety cabinets, and other critical research and diagnostic tools to prevent cross-contamination and ensure the integrity of experiments and diagnostic tests.

It's important to note that while UV-C technology is effective at disinfection, safety precautions are crucial when working with UV-C devices to protect healthcare workers and patients from potential exposure.

UV-C (Ultraviolet-C) radiation can have harmful effects such as:

1. Erythema (Skin Redness): Over-exposure to UV-C radiation can lead to erythema, which is the reddening of the skin, often referred to as a "sunburn." The severity of erythema depends on the intensity and duration of UV-C exposure. UV-C-induced erythema can be painful and uncomfortable.
2. Skin Damage: Prolonged or intense exposure to UV-C radiation can cause damage to the skin's DNA and other cellular components.
3. Skin Cancer Risk: There is no direct evidence of skin cancer risk from UV-C exposure although at a population level there has not been chronic long-term exposure.
4. Eye Irritation: Over-exposure to UV-C radiation can also irritate the eyes, causing symptoms like redness, tearing, and discomfort. Proper eye protection may be needed when working with UV-C sources to prevent eye damage.

The risk of UV-C exposure from artificial sources in healthcare settings, where UV-C is commonly used for disinfection and sterilization, is typically managed through risk assessment, strict safety protocols, engineering controls and protective gear to minimize the risk of harm to healthcare workers and patients. However, it is important to let the Medical Physics Department know about UV-C sources in the hospital as they are not always notified and they need to assess the risk posed.

Far-UVC (Ultraviolet-C) is considered to be safer for human exposure compared to other forms of UV-C radiation, primarily because it has a shorter wavelength and reduced penetration depth in biological tissues, with limited penetration beyond the outermost layer of the skin (the stratum corneum). This means that it is less likely to cause damage to living skin cells or the eye's sensitive structures, reducing the risk of skin burns and eye injuries. It has been explored for use in occupied spaces, such as public areas and healthcare settings, as a continuous air disinfection technology. Its reduced risk to humans makes it a promising tool for reducing the spread of pathogens without harming people in the environment.

However, it's essential to note that safety precautions are still necessary with Far-UVC, and compliance with the Artificial Optical Radiation Regulations at Work 2010 in the United Kingdom is essential. As research continues in the field of far-UVC technology, safety standards and best practices for its use are being developed to ensure its safe and effective application in various settings.