Radium
Die Lichtmarke

Whitepaper.

Reduce the risk of infection with the Corona virus by air disinfection using UVC radiation.

Scientific background on the mode of action of UVC radiation with regard to disinfection and specifically in treating and inactivating SARS-CoV-2 pathogens.

Introduction

SARS-CoV-2 is the virus that causes the disease COVID-19 and is spreading rapidly throughout the world in all populations. Coronaviruses can infect both humans and various animals, including birds and mammals. They cause common colds as well as the potentially fatal diseases MERS and SARS[1].

In 2003, a clinical study conducted in Hong Kong identified coronaviruses as the cause for the occurrence of pneumonia with an atypical progress. This new disease first appeared the year before in the neighbouring Chinese province of Guangdong and was named Severe Acute Respiratory Syndrome (SARS).[2] The initially flu-like symptoms include fever, headache and shivering fits. Later, coughing, shortness of breath and diarrhoea may be added. The mortality rate of patients is estimated to be around 11%, varying considerably, depending on the age group affected (0% to 50%).[3]

COVID-19 - the coronavirus disease

On December 31st 2019, WHO was informed of cases of pneumonia with unknown cause in the Chinese city of Wuhan. Subsequently, on January 7th 2020, the Chinese authorities identified a novel coronavirus as the trigger of the disease.[4] Since February 11th 2020, the virus has been named SARS-CoV-2 (Severe acute respiratory syndrome coronavirus 2). The disease that the virus triggers is called Covid-19 (Corona Virus Disease 2019).[5]

Although the new virus prefers to attack the respiratory tract, it is a multi-organ virus that can affect numerous organs. After the throat and lungs, the heart, liver, brain and especially the kidneys can be affected.[6]

Viruses are infectious entities that, due to their small size (16 - 300 nm), can only be ultra filtered and cannot be retained by bacteria-proof filters. The disease-causing virus particles consist of proteins and contain either DNA or RNA. Some types are surrounded by an envelope (lipid membrane). Viruses do not reproduce by division like bacteria, but replicate in living cells that they infect. The replication cycle of a virus generally begins when it attaches itself to a host cell and brings its genetic material inside the cell.[7] The genetic material of the virus is then co-processed in the host metabolism, where its nucleic acid component is replicated and its protein components are synthesised based on the genes in the virus genome. In this way, new viruses can be formed in the cell and then released.[8]

Transmission channels

Although the original source of the virus is thought to be animals, it is now spreading from human being to human being. It is currently estimated that, on average, one infected person infects two to three others. Transmission appears to occur mainly by droplet infection, where particles of fluid containing the virus, produced by breathing, talking, coughing or sneezing, enter the respiratory tract of a nearby person (less than one metre away). This can occur by

inhaling the secretion droplets or by touching contaminated surfaces and then touching the eyes, nose or mouth.[9] Investigations have shown that SARS-CoV-2 can still be detected on a plastic and stainless-steel surface even after 72 h.[10]

Infection can occur via droplet transmission (5 - 10 µm) and aerosol transmission (< 5 µm).[11,12]

Larger droplets are usually emitted by coughing and sneezing and can thus be transmitted to people in contact. For this reason, a distance of one to two metres from other persons, wearing a mouth-nose covering and frequent hand washing are recommended as precautionary measures.[13,14]

Less well known is the fact that even speaking loudly can distribute thousands of small droplets per second.[15] As soon as the droplets are exhaled, they begin to evaporate. They can thus become so small that they can travel many metres[16] and remain infectious for hours in enclosed rooms[11]. The spread of those airborne particles is comparable to that of cigarette smoke; it does also consist of micrometre-sized particles and thus follows similar distribution patterns. The distance from a smoker where one can still smell the cigarette smoke roughly indicates how far away from a Corona positive person there is still a risk of infection.[11] **The transmission of viruses by aerosols must be recognised as a key factor in the spread of infectious respiratory diseases. There is evidence that SARS-CoV-2 spreads unnoticed in aerosols exhaled by highly contagious infected persons without symptoms.**[11] In addition, due to their small size, aerosols may lead to a more severe course of the disease as they may ingress deeper into the lungs.[17]

Measures to prevent infection in enclosed spaces

Chains of infection can be interrupted through targeted measures. At personal level, careful hand washing plays a decisive role; touching the eyes, nose and mouth should be avoided; attention should be paid to observing sneezing etiquette (covering the mouth and nose with the crook of the arm). Since it is difficult to determine who is infected, social distancing (minimum distance from people) plays a major role.[4]

In enclosed spaces, environmental measures can also be taken to prevent the spread of SARS-CoV-2. For example, surfaces can be cleaned with disinfectants and access to alcohol-based hand sanitisers can be provided. Frequent air exchange, especially the inflow of outside air, can lead to a reduction in the viral load.[18] However, it is not always possible to provide sufficient air exchange through window ventilation or other measures. Be it because there are no ventilation options, be it because the temperature fluctuations are too great or because there are other impediments. **In this case, the existing risks can be reduced by application of ultraviolet radiation (UV).**

Air disinfection with UVC radiation

Ultraviolet radiation belongs to the field of optical radiation. It covers the wavelength range from 100 to 400 nm. Unlike visible radiation, which spans from 400 to 800 nm in range, it is not visible to the human eye. The International Commission on Illumination (CIE) defines the range between 315 and 400 nm as UVA radiation, between 280 and 315 nm as UVB radiation and between 100 and 280 nm as UVC radiation.[19]

Since the 1930s there have been studies on the successful killing of airborne pathogens. W.F. Wells was the first to ray contaminated aerosols with UVC and observed a rapid death of the bacteria.[20]

The absorption of radiation in the UVC range by the DNA or RNA leads to inactivation or death of the microorganisms. **Low-pressure discharge lamps with an emitted wavelength of 253.7 nm have been shown to be a very effective method of treating bacteria and viruses.**[21]

The application of UVC radiation is now an established method of disinfection and can prevent the spread of diseases. Air disinfection can be achieved by different approaches: Irradiation of the upper room air only, irradiation of the entire room (only when the room is empty or persons may only be present with protective clothing) and irradiation of air which is led past an UVC radiator (air-conditioning systems, air disinfection devices).[22]

The structure of the new coronavirus is similar to that of the SARS-CoV virus, which has been known and researched since 2003. Both virus types are enveloped viruses with single-stranded RNA (ssRNA)[23]. The presence of small spikes in the envelope and the resulting wreath-shaped appearance led to the naming of this family of viruses (corona: Latin for wreath).

Studies on ssRNA viruses have shown that they respond particularly well to inactivation with UVC radiation.[24] At present, only a limited amount of data is available to precisely determine the response of SARS-CoV-2 to UV radiation. However, it is likely that the new coronavirus shows a similar UV dose response behaviour to the SARS virus, although this has not yet been proven. [23]

Experience gained in treating SARS-CoV[25] and the latest investigations on SARS-CoV-2[26] indicate that effective inactivation of the virus in closed rooms can be achieved by relatively moderate irradiation with UVC. For example, A. Bianco et al. showed that at a virus concentration such as that present in the case of an infection, as little as 3.7mJ/cm^2 lead to 99.9% inactivation.[27]

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