Interview with Dr. David Brenner of Columbia University on far-UVC 222-nm and the COVID pandemic

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The recognition that respiratory pathogens which cause COVID-19 were transmitted through airborne mechanisms was a critical insight into the nature of the disease and the need to decontaminate airborne spaces to eliminate these pathogens.

However, rather than initiating a major investment in infrastructure and public health, the current official narrative being promoted by the Biden administration and every other government across the world is that the "pandemic is over" and society must "learn to live with the virus," which has by the fifth year of the pandemic led to 30 million excess deaths and hundreds of millions of people debilitated by Long COVID. Recent research is concluding that not only COVID, but many respiratory pathogens may cause long-term health consequences and are not as benign as previously considered.

Despite the advances in our understanding of the social implications for public health of these pathogens, the ruling elites have deemed social protective measures superfluous and wasteful. Indeed, the White House Summit on Improving Indoor Air Quality in October 2022 was just political theater with little to show for it but rhetoric. Last month, the Biden administration offered the Environmental Protection Agency a paltry $32 million to address indoor air pollution in schools as part of "President Biden's Investing in America" agenda, while they have been able to find hundreds of billions more for their war in Ukraine and the Middle East, while bankrolling Israel's genocidal campaign against Palestinians.

The World Socialist Web Site *has been calling for an elimination strategy for the COVID pandemic from the beginning and continues to explain to the working class that the issues surrounding clean air and public health are democratic and social questions which have revolutionary implications insofar as the very governments supposedly charged with their well-being and safety have abandoned all such pretensions.*

From a technological perspective, the work by Dr. David Brenner and colleagues at Columbia University's Center for Radiological Research in recent years is of immense importance in answering the question, "Can the virus that causes COVID be eliminated?" Their work on far-UVC light at lower wavelengths is proving that this technology is quite suited to the task. And while the White House and the financial oligarchs spare no expense in taking advantage of these advances for their own safety, the promises of infrastructure investment have yet to be realized.

Dr. Brenner was kind enough to accept our request for an interview to discuss his work and help bring recognition to this vital technology.

David Brenner (DB): Hi Ben.

Benjamin Mateus (BM): Hello Dr. Brenner. Thank you for agreeing to do the interview.

DB: Before we start, can you give me a one-minute introduction to why you and your publication are interested in far-UVC?

BM: In the context of the pandemic and the acknowledgment that respiratory viruses are airborne, the elimination of pathogens and prevention of these types of disease mean we must clean indoor air. As medical historians have noted, this is analogous to the English physician John Snow's recognition that cholera was a byproduct of sewage-contaminated water, which led to a revolution in sanitizing water consumed by people and the reduction in rates of cholera.

I don't think we can overstate it, but the sanitization of indoor air is really the next public health hurdle we must cross. In this regard, germicidal ultra-violet (UV) light, a proven technology in disinfecting rooms which has been around for more than 100 years, seems ready-made and at-hand for that task. It was for that reason I reached out to Dr. Edward Nardell of Harvard to speak to him about the history of UVC. We were also interested in the work you and your team were conducting with far-UVC 222-nm. The recent science behind 222-nm demonstrates it is safe to use indoors with people around while being quite effective. However, recently, scientists like Dr. Jose Jimenez, aerosol physicists from Colorado have raised concerns about the ozone emissions from these lamps and the secondary volatile organic compounds they produce. I decided to reach out to you to discuss all these issues.

DB: Go ahead.

BM: Maybe we can start by explaining who you are, what you do and how you became interested in UV and infection control? If I understand correctly, you are a radiation physicist?

DB: Yes, I am a radiation biophysicist from Liverpool, England. I study the effects of radiation on human health. I'm the director of the Center for Radiological Research here at Columbia University, which is a very old and venerable institution that was founded just over a hundred years ago by a student of Marie Curie, Gioacchino Failla, who went over to Paris to obtain his PhD. He returned after his studies and opened the center though it had a different name at the time.

Certainly, our day jobs are not with UV, which is a non-ionizing radiation. We work more with ionizing radiations—x-rays, gamma-rays, and neutrons—originally in the context of using these in radiation therapy. Marie Curie had made the claim that she was going to cure all cancers with radium. I still hope that'll be true one day.

Some fraction of our Center works with high-dose radiotherapy while a larger fraction works on the effects of low levels of ionizing radiation, such as understanding the radiation risks associated with routine use of nuclear power and understanding the benefits and risks of computed tomography (CT) and other radiological exams which are used extensively in healthcare.

In more recent times much of our work has to do with countermeasures after a large-scale radiological event, be it an accident or a terrorist-style event, and what one should do after such an event. Our particular area of study is bio-dosimetry, which is trying to figure out very quickly what dose a very large numbers of people might have been exposed to, and then what needs to be done to address this.

[*Dr. Brenner's publications include demonstrating that CT scans can slightly increase the risk of cancer among children, something that should be considered when ordering a CT scan. He was extensively cited by the media and gave many interviews after the tsunami hit Japan's Pacific Coast in March 2011, leading to the Fukushima Daiichi nuclear power plant accident.*]

And then around a decade ago we started thinking about UVC light.

The initial impetus was that I had a good friend back in the UK who passed away. He went into the hospital for a routine hip operation and passed away from a surgical site infection. I began to wonder and raised the issue with my colleagues here if there was anything we as physicists could do to address this problem.

[*According to the Centers for Disease Control and Prevention (CDC), in 2018 there were 157,500 surgical site infections (SSI) in the US with an estimated mortality of 8,205. SSIs contributed to 11 percent of all deaths in intensive care units and an additional 11 days of hospitalization for each SSI. The per annum cost to the health system has been estimated at $3.2 billion.*

In low to middle income countries, the burden of SSI is much higher, with estimates ranging from 8 to 30 percent. In these environments, SSIs are the most common acquired infections that have considerable morbidity, mortality, and economic devastation. Mortality within 30 days of surgery is the third-leading contributor to global death with SSI linked to 38 percent of deaths in patients with SSI.]

DB: We started to think about using far-UVC because we knew that germicidal UVC is very good at killing bacteria and viruses. But we also knew that it's not used very much because of the potential hazards to skin and eyes. We then got the idea of going to even lower UVC wavelengths.

Conventional germicidal UVC typically peaks at a spectrum of 254 nanometers (nm). UV light at that wavelength is comparatively penetrating on the scale of the skin and eyes. It can penetrate through to the basal layers of the skin and to the cornea of the eyes. It was well known that at lower UVC wavelengths the penetration would go down quite considerably because the light is more and more absorbed by proteins. So, its penetration to critical cells in the skin and eyes would be much less.

And given that the very surface of our skin is made of a layer of dead cells called the stratum corneum, our estimate at the time was that the far-UVC light would not penetrate through that layer and therefore couldn't reach the living cells in the epidermis of the skin. Likewise in the eye, there is the tear layer in front of the cornea—it's a liquid layer—that serves the same function as the stratum corneum of the skin, and far-UVC light would be significantly absorbed by the tear layer and injury to the cornea would not occur.

On the other hand, viruses and bacteria, even when they're clustered together, are much smaller, in terms of scale, than the stratum corneum or the tear layer. Our initial hypothesis was that with these lower UVC wavelengths—far-UVC—we could kill these "bugs" without humans sustaining the hazards associated with conventional UVC.

We then started looking around to find sources that emitted wavelengths much less than 254-nm. And what we found there was a technology out there called excimer lamps that could produce 207 or 222-nm wavelengths. [*Excimer lamps emit light in the UV spectral region and have wide applications in industry that involve photo-chemical processes such as curing inks, and manufacturing adhesives and varnishes.*] That's basically how we got started. That was essentially a Russian invention. We contacted the folks in Russia who'd devised these lamps and they sold us a few which we still have and they're incredibly reliable.

And then we started to do some biological studies to test our hypothesis about far-UVC.

[*Although Brenner and colleagues initially worked with Kr-Br excimer lamps that emit UVC wavelengths at 207-nm, they shifted to using Kr-Cl lamps that emit 222-nm UVC light. Brenner explained that these lamps were far more efficient and penetrated aerosols much better. In their 2013 study with methicillin-resistant Staphylococcus aureus (MRSA) bacteria, using 207-nm Kr-Br excimer lamps, demonstrated efficient killing of these pathogens with a 1000-fold less human cell killing than conventional germicidal UVC lamps used in studies of wound irradiation.*]

[*Two other studies conducted by Brenner and colleagues can be viewed here and here. They demonstrated that continuous exposure of hairless mice and 3D human skin models to far-UVC led to very effective killing of antibiotic-resistant bacteria without causing any damage to the associated skin. As the authors wrote, "A central application of our approach is reduction of surgical site infection (SSI), which still represent a major complication of surgical procedures. Current evidence suggests that a majority of SSIs result from bacteria alighting directly onto the surgical wound from the air. Based on our previous studies and on the preclinical results reported here, lamps emitting far-UVC light in the 200 to 222-nm range could potentially be used for continuous low-fluence/low-rate exposures during the course of surgical procedure to inactivate bacteria before they penetrate the interior of the wound."*]

BM: As I understand it, these excimer lamps produce multiple peaks, and therefore the extraneous wavelengths need to be filtered to get the one you require. Maybe you can explain this?

DB: That was basically one of the first things we found out about these lamps. We were interested in wavelengths around 210, 215, 220, and 225-nm. But we don't want wavelengths in the 240s or higher. The two excimer lamps I spoke about—Kr-Br that peaks at 207-nm and Kr-CL that peaks at 222-nm—both have wavelength "tails" that extend to higher wavelengths.

So, we sat down to work on how we could filter these higher wavelengths. And after some engineering work, we found we could filter them although you pay a bit of a price because the peaks that you want are reduced in intensity. But there is still plenty there. And you can, more or less, get rid of all the high wavelengths that you don't want with an appropriately designed filter. Today, essentially all commercial far-UVC lamps, with a couple of notable exceptions, use filters.

BM: Turning back to the issue of reducing surgical site infections with germicidal UV lamps—can you tell us about how effective these were. Does Columbia have data on surgical site infection rates using these devices?

DB: Again, just tracking back into the history—our initial thoughts a decade ago were in terms of reducing surgical site infections and our initial experiments were focused on this. And then we had the idea that if these devices were useful on surfaces, how about targeting microbes that were in the air? Our motivation at the time was to reduce the risk of influenza.

[*In 2018, Brenner and colleagues wrote, "Airborne-mediated microbial diseases represent one of the major challenges to worldwide public health. Common examples are influenza, appearing in seasonal and pandemic forms, and bacterially based airborne-mediated diseases such as tuberculosis, increasingly emerging in multi-drug resistant form."*]

So, our ideas for using far-UVC expanded, meaning that besides the application of UVC in a surgical suite, there was a much more general application where you could put these lamps in rooms where people are getting together and potentially breathing these airborne bugs. The lamps would kill the bugs floating on the air currents and reduce the person-to-person transmission of airborne diseases like influenza and measles. We didn't abandon the work on surgical site infection, but we started to think more about airborne decontamination.

What we did then was we built ourselves a laboratory system whereby we could generate aerosols of any virus we wanted and flow them in front of a far-UVC lamps and look at their efficacy at killing the viruses in the air. Obviously, we had influenza on our mind, and we published our first paper on aerosolized viral particles not long before the COVID pandemic came along.

But when the COVID crisis hit it didn't take long for us to realize the relevance of far-UVC against COVID. That said, at the beginning it wasn't clear at the time that it was transmitted through air as opposed to surface transmission. Remember we were all spraying our groceries and our newspapers and stuff at the time. But, I think within a few months it became clear that COVID was an airborne transmitted phenomenon, making far-UVC relevant.

Naturally, we started extending our airborne influenza studies to airborne coronavirus studies. At the time, it wasn't feasible for us to use SARS-CoV-2 viruses, but there are plenty of other human coronaviruses that can give you flu-like symptoms that we could use and did use.

[*Brenner and colleagues published their study in the journal* Nature *on the efficient and safe use of far-UVC 222-nm to inactivate airborne human coronaviruses which have comparable physical and genomic size to the SARS-CoV-2 virus. In a very short time, using modestly low power levels, 222-nm light rapidly inactivated 99.9 percent of all the aerosolized coronavirus particles. At that time, they wrote, "The severity of the 2020 COVID-19 pandemic warrants the rapid development and deployment of effective countermeasures to reduce indoor person-to-person transmission. We have developed a promising approach using single-wavelength far-UVC light at 222-nm generated by filtered excimer lamps, which inactivates airborne viruses without inducing biological damage in exposed human cells and tissue."*]

BM: Can you give a degree of scale for how effective far-UVC is? I understand the power of these lamps is critical for the order of viral particle inactivation you get. How do these devices compare to HVAC units or HEPA filters?

DB: There is a way of comparing the different approaches, essentially putting them on a level playing field—and that's the concept of equivalent air changes per hour.

If you were trying to clean the air simply with fans and such devices, you can ask how many air changes in the room can I get each hour? With ventilation using fans and air-conditioning units, you can achieve maybe five or six air changes per hour.

We can analyze the results we get with far-UVC and convert our results to equivalent air changes per hour which can then be directly compared with more conventional approaches like ventilation.

We're not moving the air out of the room in the same way, but we are reducing the level of "live" bugs in the room air, and we can convert that to an equivalent air changes per hour. The question then becomes how many air changes would you have to do using conventional techniques to match what you can get with far-UVC? And the answer from our study shows that in a full-scale room we were able to get well over 100 equivalent air changes per hour. Clearly, far-UVC is a very efficient approach at cleaning the air in a room than conventional techniques.

[*In the abstract to the report linked above: For the first time, we show that far-UVC deployed in a room-sized chamber effectively inactivates aerosolized Staphylococcus aureus. At a room ventilation rate of 3 air-changes-per-hour (ACH), with 5 filtered-sources, the steady-state pathogen load was reduced by 98.4 percent providing an additional 184 equivalent air changes (eACH). This reduction was achieved using far-UVC irradiances consistent with current American Conference of Governmental Industrial Hygienists threshold limit values for skin for a continuous 8-h exposure. Our data indicate that far-UVC is likely to be more effective against common airborne viruses, including SARS-CoV-2, than bacteria and should thus be an effective and "hands-off" technology to reduce airborne disease transmission. The findings provide room-scale data to support the design and development of effective far-UVC systems.*]

BM: Being a surgeon myself, I'm still curious as to how effective is germicidal UV at Columbia in preventing SSI? Based on the evidence you have presented, it seems we should have these lamps installed everywhere, especially the healthcare setting.

DB: Far-UVC has not yet been used for preventing surgical site infection. We were going along that path when COVID came along and then our focus shifted to airborne decontamination. With COVID hopefully slowly coming to an end, we are going back and basically restarting from where we left off with surgical site infection prevention.

One example where there is a lot of interest in using far-UVC is in the veterinary world. Surgical vets are very worried about surgical site infections because they have a somewhat less sterile environment than you as a "human" surgeon would, though they do the best they possibly can. But surgical sites infections for vets can be as high as 20 percent, while surgical site infection rates in US hospitals are only a few percentage points these days.

That is still too high, but it does mean that you need quite a large hospital study to convincingly demonstrate a reduction in the risk. But where the prevalence of the disease is high—20 percent—and you want to demonstrate far-UVC can halve the rate of SSIs, then you can do a much smaller study to prove your hypothesis.

It made sense for a couple of reasons to start in the vet world. First, the vets were very interested because they didn't have many techniques available to them to control surgical site infections. And of course, horses are extremely valuable! When we took this idea to the vet community, we got a very positive reception.

The long-term plan is to then do that same study in a human surgical population. But step one, I think, would be to do it in a vet environment.

BM: Has that study been done, or are you in the process of collecting the data?

DB: No. Those projects went into hibernation when COVID hit. We were getting all our approvals to conduct these studies when suddenly everyone realized COVID was going to be this big thing. So, we put it aside and only now it's reasonable to come back to that.

But again, it's now one of two angles that far-UVC is taking. The other one, which is a more general application, is trying to reduce airborne transmission of viruses in public spaces, like a room, an office, or any place where people get together like schools or hospitals. Our bigger focus is on reducing indoor airborne transmission.

BM: Recently, aerosol physicist Dr. Jose Jimenez from the University of Colorado at Boulder raised concerns about the production of ozone with the excimer lamps and the generation of airborne microparticles. Can you speak to this? Is there validity to these concerns?

DB: It is true that as the light from these far-UVC lamps travels through the air it interacts with regular oxygen (O2) and can produce ozone (O3). But the amounts are extremely small. The studies that we and others have done looking at this question show that the level of microparticles produced by ozone would be extremely low in a room with any level of ventilation.

The studies that people quote about these concerns are being done in airtight rooms, a sealed metal box let's say, which isn't real life. Real-life rooms are very leaky and there are carpets and furniture which absorb the ozone. Overall, I don't think in practice it's a concern.

The measurements that we've taken, and others also, some of it now published, show that when you turn on and off the far-UVC lamps, you do see a change in ozone levels, but it's pretty small compared with the effect from outdoor ozone. The typical average outdoor ozone level is 50 parts per billion (ppb). Far-UVC lights don't produce anything like that.

When you try to compare the ozone results between far-UVC lights on and off, what you realize is that the results are actually almost completely dependent on the variation in the outdoor ozone level, and not on the indoor far-UVC lamps.

[*Dr. Brenner wrote in the journal* Photochemistry and Photobiology *a commentary published on November 30, 2023, a response to the concerns raised about indoor ozone and its associated secondary chemistry, by citing the available evidence. He concluded that these lamps in "reasonably well-ventilated rooms compliant with current ACGIH far-UVC dose recommendations would produce ozone levels much less than five ppb, and very much less than 0.5 ppb in scenarios in which current ICNIRP dose limit recommendations are in place. These levels also would not have significant health hazards from the ozone generated or the associated particulate pollutants."*]

BM: Clearly the work you and your team were conducting was fortuitous and timely. The evidence for the use of far-UVC and indoor air decontamination is quite compelling. Yet, we are still waiting to get these lights into public spaces, which has more to do with politics than regulatory or engineering issues.

One of the points you have repeatedly been making in your studies is the need to clean the air and prevent the onward transmission of pathogens. Here we are four years and change into the pandemic and the health economists are telling us we can expect upwards of 220 million COVID infections and 20 million cases of Long COVID every year at an added health cost of $200 billion.

DB: And if you don't mind me interrupting you one moment. To my mind there is also the next COVID. All the conditions are ripe for the next one. We are getting on airplanes all the time and nature does what it does in terms of mutations—there will be another COVID. We know that.

I understand the question you are asking. I don't really know the answers to all of it because it's clearly a very multifaceted issue. Inevitably, there are regulatory issues which are slowly being addressed by UVC lamp manufacturers.

And one of the issues was getting UL approval. UL stands for Underwriters Limited. And no matter what electrical device you buy in a store, you must have a UL sticker on it. Electricians won't install stuff that doesn't have a UL sticker on it. But now the two major far-UVC light manufacturers do have UL approval. So that's one thing which is good.

But I think the major issue is that people don't know about far-UVC. From time to time, I give a talk on far-UVC and always the biggest question is, "I didn't know about this. How come I didn't know about this? Why isn't it like widespread?" And I don't really know how to answer that. We, in our lab, we are biologists, and physicists. What we don't know so much about is "public relations" and whatever is needed to get a technology out into the real world. It's not our expertise!

BM: I raise the issue also because oftentimes people cite the high cost of these far-UVC lamps. But when you compare it to the health problems caused by these respiratory pathogens—deaths, morbidity, hospitalizations, work absenteeism, and so on—and then the added understanding that these infections may produce, and certainly exacerbate, chronic health conditions, there is no real comparison or dollar value you can put against it. These technologies have the potential of reducing much suffering.

DB: In the scheme of things, the cost is not enormous. And, as with basic economics, as these lamps become more commonplace, and get used more and more, and companies sell more, the prices will come down.

The other part of that story is this excimer lamp technology will hopefully, at some point, be replaced by LED technology. Just in the same way that regular light bulbs that we use right now where there has been a gradual evolution from the old-fashioned filament type to LEDs, that same shift will happen in the far-UVC world. And there are several LED companies and universities working on that question.

Right now, it is difficult to build an LED lamp with enough intensity and enough lifetime to go into general use. So, I don't think that's there yet. But I think that in a few years' time, that would be the case. But even without that, if you do any sort of cost-benefit analysis, the cost of the lamps will be pretty small in the scheme of things.

BM: The work you are doing, in the present period in history, seems to be quite transformative. It has tremendous social value. Any final comments?

DB: I think talking to folks like you is one of the things that people like me should be doing. I don't see any other way that far-UVC will evolve. One hopes that a couple of large companies, a hotel chain, a chain of offices, would install it in their facilities. Then they could make the claim, "We have the cleanest office facilities in the world!" Then others could jump on that bandwagon.

BM: That's interesting that you say that. The United States government is using it, the US Air Force is using it, and at Davos, they had UV lights installed everywhere. So, it is being used, but it's not being used in schools and factories; only at the highest echelons to protect the well-fed.

DB: We have it installed in one of the Columbia dental clinics, which have huge rooms. One of the things we hoped to achieve when we installed it there was to see how the general public would respond. We posted signs on the wall saying, "You're protected by far-UVC lamp. If you have any questions, please provide us with your contact information." In two years, we haven't received any complaints. On the other hand, we received many nice compliments.

The point is that I think the general public is very accepting of a technology which would prevent them getting the flu next time and maybe would prevent them getting COVID or prevent the next pandemic.