Research Q&A: Far UVC light for reducing airborne transmission of bacteria and viruses

**Dr Kenneth Wood**



# NHSScotland Assure Research Service

NHSScotland Assure is adding to the knowledge base available to built environment projects. Building on this existing knowledge will reduce risks, increase quality and promote sharing research with key stakeholders.

Through working with external stakeholders and other NHSScotland Assure services the research service will ensure information is based not only on best practice but best evidence and will benefit those who need it. The service will seek to ensure that the most up to date and robust research is translated into practice as new and emerging evidence become available.

Throughout 2020 and 2021 the NHSScotland Assure Research service commissioned a number of research projects which address gaps in current evidence. These research topics relate to previous issues and lessons learned within previous NHSScotland projects and are in line with the key themes identified by NHSScotland Assure stakeholders.

# Research Q&As

Our research Q&As are designed to talk about these research projects – why the research is needed, what it set out to achieve, what impact it will have on existing guidance and more.

Full research reports are also available by contacting:

* Dr Kenny Wood at kw25@st-andrews.ac.uk
* Dr Ewan Eadie at ewan.eadie@nhs.scot
* Professor Cath Noakes at C.J.Noakes@leeds.ac.uk

## Research Q&A with Research Team – Dr Kenneth Wood

### 1. What is the research that was carried out?

The research has investigated Far-UVC (FUVC) light for reducing airborne transmission of bacteria and viruses.

### 2. Why is this research needed?

FUVC uses ultraviolet-C (UVC) light at 222nm (nanometres) wavelength to inactivate pathogens (‘inactivated’ pathogens are where the DNA/RNA is damaged, meaning the pathogen can’t replicate and cause infections) and reduce the risk of transmitting infection in indoor environments.

FUVC has been shown in small-scale lab tests to be safe and effective against a range of pathogens including SARS-CoV-2 (the virus that caused the COVID-19 pandemic), influenza, and various bacteria responsible for hospital acquired infections.

However, there is neither data to show performance in realistic room environments, nor design guidance for the technology.

This research set out to conduct a series of room-scale chamber experiments to investigate the efficacy of FUVC at reducing the pathogen load in a room. It also aimed to develop computational models to assess the potential for applying FUVC technology in clinical settings.

The research will build on pilot data which shows very promising performance and will consider the effect of FUVC technology on airborne and surface microorganisms with different room layouts and ventilation conditions. It will provide performance data and initial guidance on where and how the technology could be used to improve hospital infection control.

### 3. Who were the team behind the research?

* Dr Kenneth Wood, University of St Andrews
* Dr Catherine Adamson, University of St Andrews
* Professor Cath Noakes, University of Leeds
* Dr Louise Fletcher, University of Leeds

Supporting but unfunded:

* Dr Ewan Eadie, Photobiology Unit, Ninewells Hospital, Dundee

Professor David Brenner, Center for Radiological Research (CRR), Columbia University

### 4. What did the research set out to achieve?

The research goals were to:

* test the efficacy of germicidal ultraviolet Far-UVC light to inactivate airborne pathogens under a range of different ventilation rates
* perform computer simulations of airflow, pathogen spread, and inactivation by Far-UVC lights.

### 5. How was the research carried out?

The experiments were conducted at the University of Leeds bioaerosol chamber. This is a sealed room which is 32m3 (cubic-meters), about the size of a single-occupancy hospital room or small office.

Mechanical ventilation can be set at different rates within the room ranging from very low rates of 1.5 air changes per hour (ACH), up to 9ACH, which is typical of hospital operating theatres. Pathogens were continually introduced to the room in aerosolised form, so the concentration built up to a steady state as measured by an air sampler. This is like having an infected person continually shedding pathogen into a room.

With the aerosolising continuing, the Far-UVC lights were turned on and the air sampling showed a rapid and sustained decrease in the concentration of active pathogen. For our experiments we used staphylococcus aureus and pseudomonas aeruginosa, which are known to be more resilient to Far-UVC lights than influenza and coronaviruses.

For the computer simulations we used computer codes that simulate airflow and particle spread along with a code that simulates the Far-UVC intensity pattern within the chamber. We set the conditions in the simulations to be the same as measured in the chamber, namely the airflow pattern at the ventilation inlet, the location and intensity of the Far-UVC lights, and the release location of the aerosolised pathogen.

### 6. What challenges did you encounter?

Overall, the experiments ran very smoothly, but the project was delayed starting due to accidental flooding of the chamber before the start of the project.

We used concentrations of aerosolised pathogen that are much higher than would be found in real life settings, but this was done to get good statistics for the reduction in active pathogen when the Far-UVC lights were turned on.

### 7. What were your main findings?

Under all ventilation regimes we found that the Far-UVC lights led to a large decrease in the overall airborne active pathogen load within the chamber – in many cases over 90% reduction.

While the lights do not remove the pathogen, they do damage the DNA/RNA and thus render it ‘inactive’, meaning that it cannot replicate and cause infections.

Comparing these results to ventilation, the reduction due to Far-UVC lights would be like increasing the ventilation rate to over 20ACH, which is not easily achievable with mechanical air cleaners.

The computer simulations successfully reproduced the chamber experiments, which gives us confidence that we can use computer modelling to estimate the performance of Far-UVC lights in different indoor settings – this can inform Far-UVC installation guidelines

### 8. How will the research be used?

Our research provides new data on the potential of Far-UVC lights to be used as part of a layered approach to minimise infection transmission in indoor environments.

The large reductions in the concentrations of airborne pathogen demonstrate that Far-UVC is a very promising technology.

### 9. What are the next steps for study in this field?

There are several next steps for study in this field:

1. More chamber experiments using different pathogens such as influenza.
2. Different liquids for generating the aerosols – our experiments to date used distilled water for generating the aerosols, so next steps are to use liquid that is closer to the properties of human saliva. Human saliva contains proteins which may protect the pathogen from the Far-UVC and therefore we wish to investigate the impact this may have on Far-UVC efficacy.
3. Repeating our chamber experiments with more complex airflow and shadowing caused by furniture.
4. We have separate projects studying the safety of Far-UVC light to skin and eyes and we would like to augment this with chamber experiments to study whether the Far-UVC lights produce ozone or particulate matter that could cause human respiratory problems.
5. The success of our chamber experiments and the good safety profile that we are finding for Far-UVC means that next steps would ideally be a real-world trial, perhaps in hospital waiting rooms, wards, and public toilets.
6. On the computer modelling side, the next steps are to scale up the models to larger venues typical to hospitals such as large wards, shops, and dining spaces.

### 10. Will this research have an impact on current guidance?

Yes, our research has demonstrated that very large reductions in active pathogen can be achieved with Far-UVC lights, operating within current UK guidelines for UVC exposure.