IMPERIAL

EPSRC
Engineering and Physical Sciences Research Council

The impact of environmental conditions on the prevalence and aerosol transmission of *Streptococcus pyogenes*

Phoebe French[1]

[1]School of Public Health, Imperial College, Wood Lane, London, W12 0BZ

Background

Previous studies show that exposure to pollutants significantly increase infection rates, however there is an indication that the structure and viability of airborne bacteria are also being impacted by the presence of pollutants.

- Nitrogen dioxide (NO_2) and ozone (O_3): increased susceptibility to serious infections[1]; compromise epithelial cells in respiratory tract and suppress the immune response[1].
  - NO_2: exposure causes increased viability of airborne bacteria[2].
- $PM_{2.5}$: has the ability to absorb bacterial cells and deposit them within the lungs[1]; bacteria growth pattern changes after exposure[3].

Motivations and Aim

Scarlet fever, a superficial infection caused by *S. pyogenes*, has increased dramatically in the UK in the last 10 years (Fig. 1). $M1_{UK}$, a novel strain, is a concern because it is causing increased scarlet fever and invasive *S. pyogenes* infections within England[4].

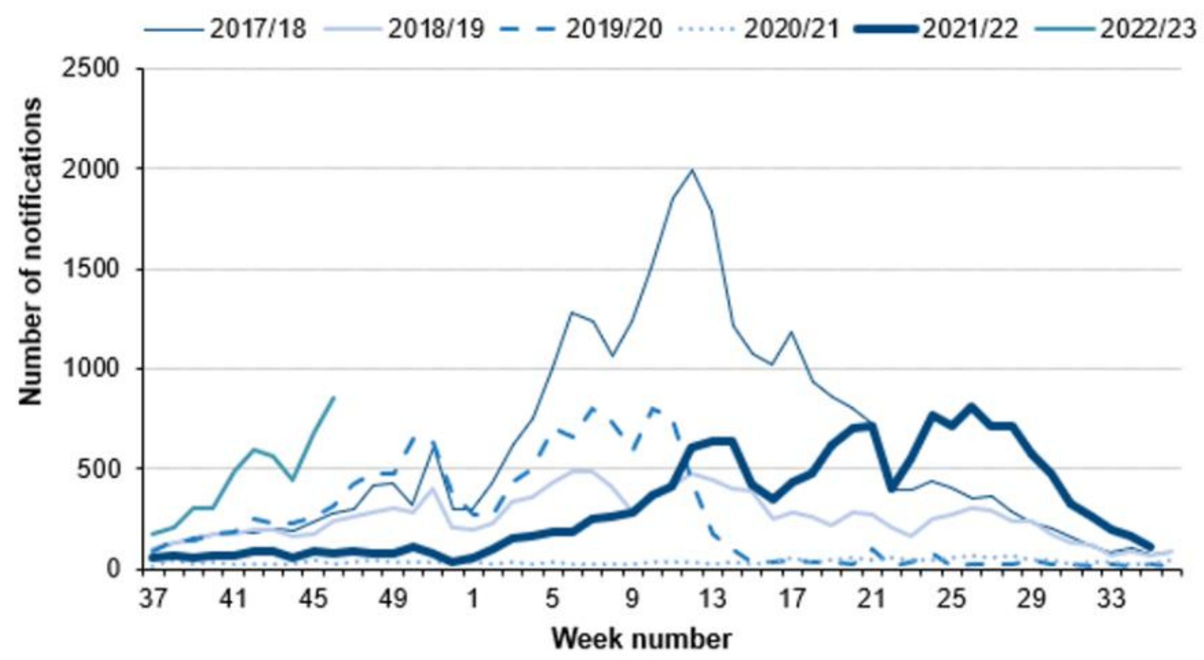

Figure 1. Scarlet fever notifications in England from 2017/2018 season onwards[4].

There is evidence that increased scarlet fever cases may be linked with high concentrations of NO_2, O_3 and $PM_{2.5}$[5], but epidemiology studies are unable to identify exactly how pollutants or certain environmental conditions allow for an increase in *S. pyogenes* infections.

This project aims to determine how the airborne viability of *S. pyogenes* is impacted by ambient conditions, such as gas and aerosol pollutants, temperature and relative humidity.

Proposed Research Strategy

1. Assembly of a CELEBS instrument to allow for: bioaerosol suspension; addition of pollutants; control of temperature and relative humidity
2. Development of methods for evaluating *S. pyogenes* viability with different pollutants and environmental conditions
3. Evaluation of how the viability of different *S. pyogenes* strains changes after exposure to different environmental factors

Experimental Technique

The Controlled Electrodynamic Levitation and Extraction of Bioaerosols into a Substrate (CELEBS) instrument (Fig. 2) is the primary method that will be used in this project because:

- It has a relatively low collection velocity[6]
- There is a 100% sampling efficiency[6]
- External gases can be added into the instrument[6]
- Temperature and relative humidity can be altered[6]

Challenges

The main challenge to overcome in this project is the adaptations of the CELEBS setup as aerosol pollutants have not been added to the instrument before.
This will likely be done with the addition of a nebuliser to the airflow inlet.

Responsible Innovation

As scarlet fever primarily effects children, communication of results need to be done in a clear manner to allow parents and carers to fully understand the findings and avoid misinterpretation.

Policy Implication – Outbreak Management

Guidance for managing scarlet fever within schools and nurseries is based around strict cleaning. This research could highlight the importance of adding face-masks and social distancing to this guidance if the viability of aerosolised *S. pyogenes* is found to be increased.

Policy Implication – ULEZ Zones

The effectiveness of these clean air zones at decreasing the concentration of air pollutants has been demonstrated by the introduction of the Ultra-Low Emission Zone in central London.

This research could show the importance of implementing these clean air zones and demonstrate why more Ultra-Low Emission Zones should be created across the UK.

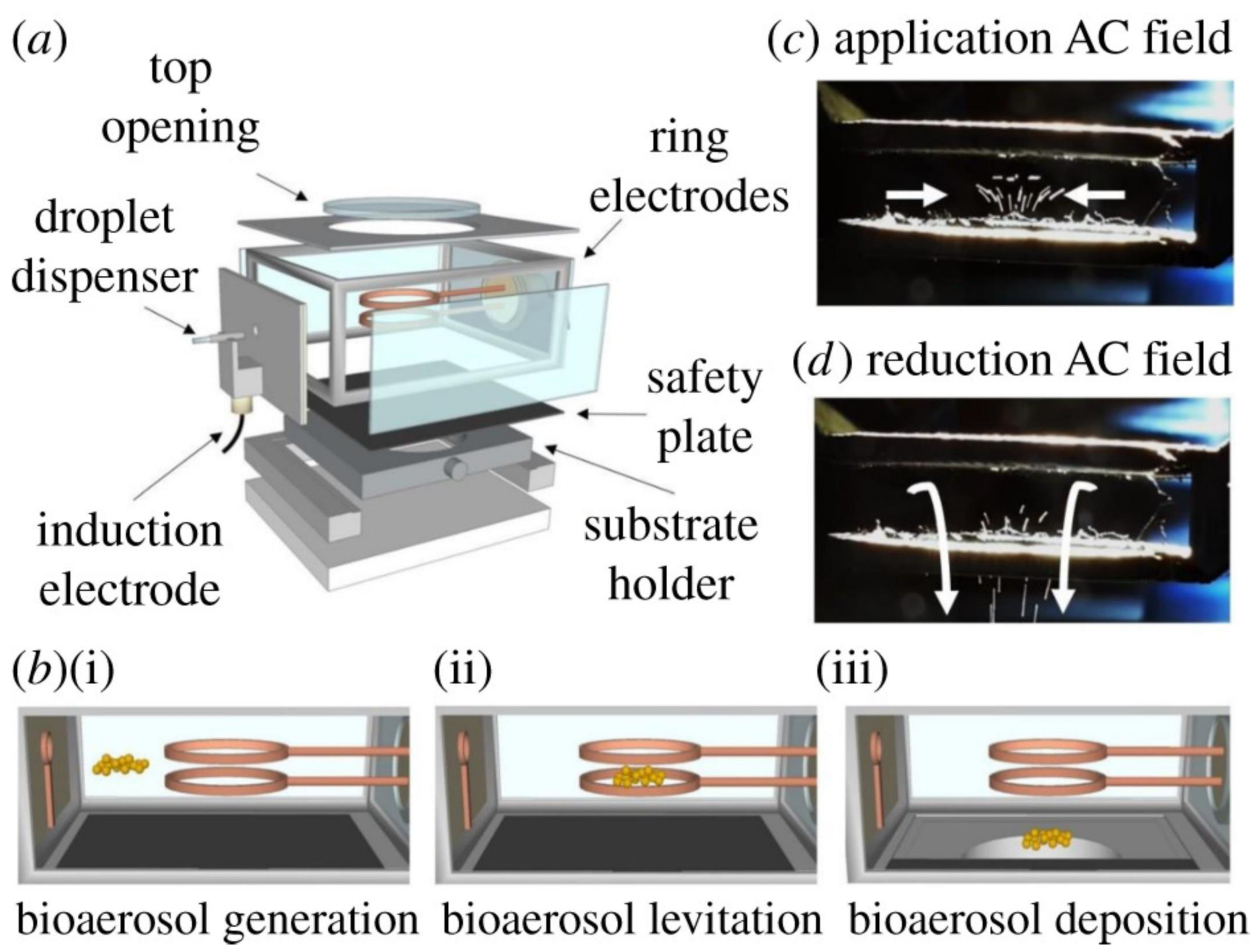

Figure 2. Schematic of the typical CELEBS setup and operating stages (a, b), images showing the levitation (c) and deposition (d) of a bioaerosol[6].

References

1. Pompilio, A. & Di Bonaventura, G. (2020). *Crit. Rev. Microbiol.* 46 (5), 600-630.
2. Mancinelli, R. L. & Shulls, W. A. (1978). *Appl. Environ. Microbiol.* 35 (6), 1095-1101.
3. White, J. K et al. (2020) *Int. J. Hyg. Environ. Health.* 230, 113608.
4. UK Health Security Agency (2023). Group A streptococcal infections: report on seasonal activity in England, 2022 to 2023 [Accessed 26/01/2024].
5. Liu, Y. et al. (2020) *Nat. Commun.* 11 (1), 4229.
6. Fernandez, M. O. et al. (2019) *J. R. Soc. Interface.* 16 (150), 20180779.