

# CAN WE COUNTERACT BIOFILM GROWTH ON IMPLANTS BY LOCALLY DELIVERED ANTIBIOTICS?

Parna Mandal<sup>1,2</sup> (p.mandal.1@research.gla.ac.uk), Nigel Mottram<sup>1</sup>, Sean McGinty<sup>2</sup>

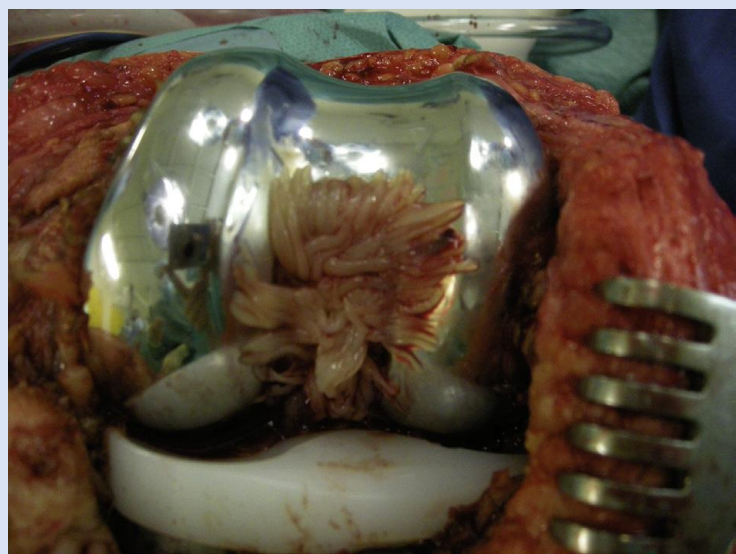
<sup>1</sup>School of Mathematics and Statistics, <sup>2</sup>Division of Biomedical Engineering, University of Glasgow



Implant infections account for **25.6%** of all health-care related infections [1].

**Aims:** To understand biofilm growth in the presence of antibiotic delivery, with a view to optimising antibiotic loading and release kinetics.

## Introduction



Following a few months, the patients had to undergo surgery due to implant infection on an orthopaedic and a hip implant, as seen in the following images [2, 3].

- Implant infection is a serious clinical problem which consists of bacterial colonies named as biofilm and treatment usually involves systemic delivery of antibiotics and sometimes surgery.

## Implant Infections?

## How does antibiotics work with the infection?

Due to the ability to survive antibiotic dosages that would ordinarily kill free-swimming proliferative bacteria, biofilm-based diseases are difficult to eradicate. This is called **antibiotic resilience**.

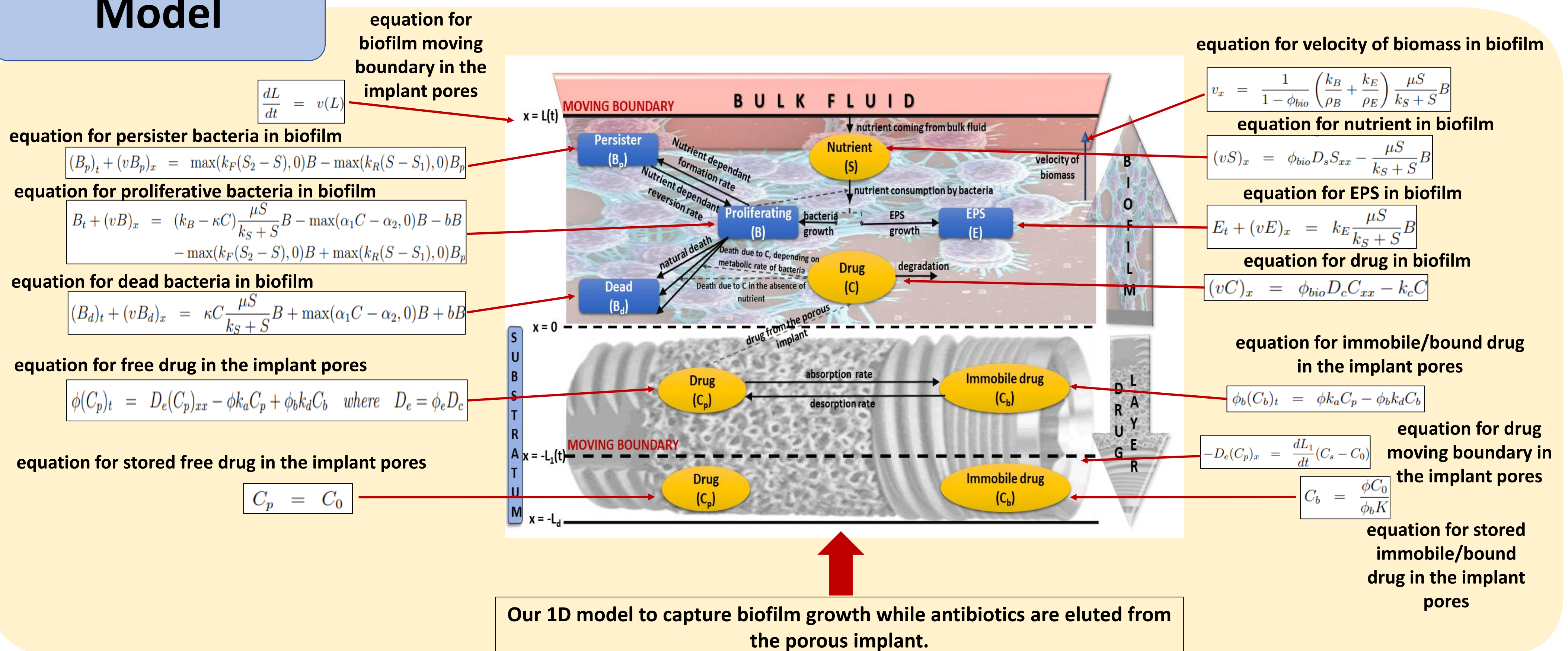
Reasons for resilience

- Nutrient insufficiency;
- State of hypoxia in lower levels of biofilm;
- Overdose or underdose of antibiotics.

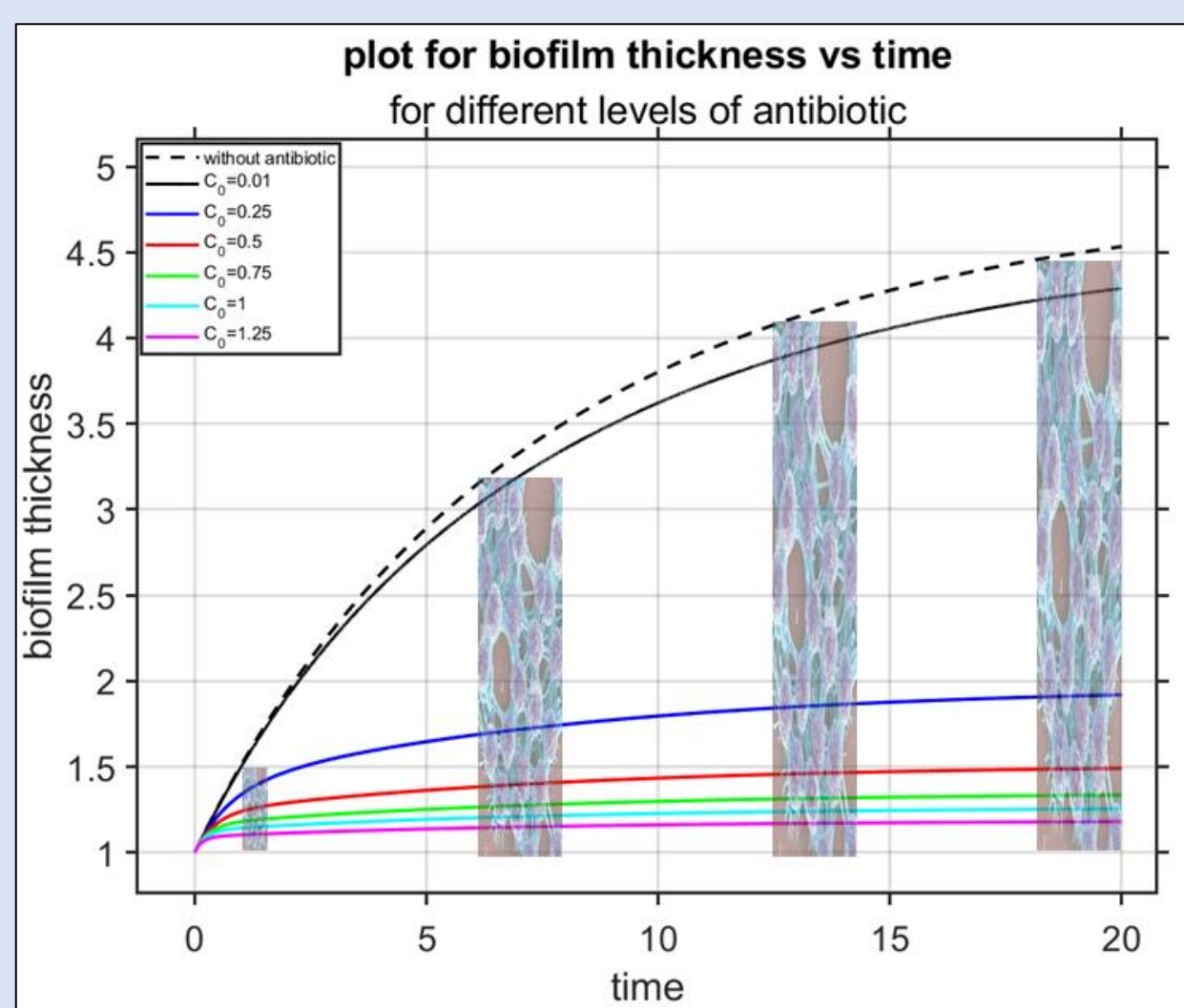
Preventive strategies

- Development of new drugs and administering them in correct concentration to disable the persister phenotype;
- Early-stage prevention by surface modifications of the implant and introducing biosurfactants to inhibit adhesion;
- Jamming communications through inhibition of quorum sensing.

## Model



## Results and Conclusion

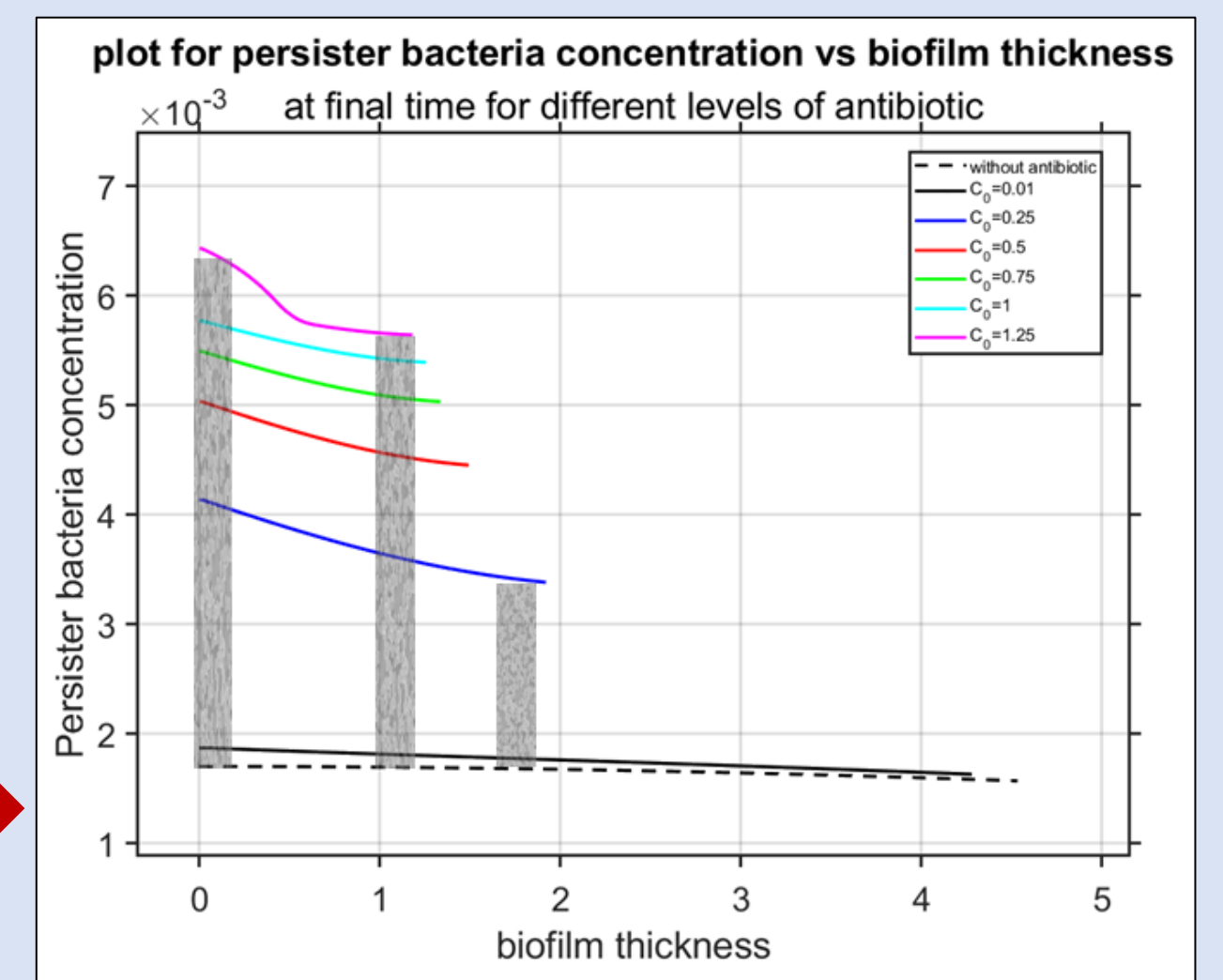


\* All variables in the plots are non-dimensionalised

Rate of growth of biofilm reduces with increasing antibiotic concentrations.

Does that mean the antibiotic is working?

Not really. Instead, the live bacteria is going through a phenotypic change for survival and as antibiotic concentration increases those persister bacteria increases demonstrating **resilience**.



**Next Step:** Identify the best antibiotic administration arrangement so that the infection and persister cells are eliminated, which will prevent any subsequent infections on the implant.

[1] Arciola, Carla Renata, et. al., Implant infections: adhesion, biofilm formation and immune evasion, *Nature reviews microbiology* 16, no. 7 (2018): 397-409.

[2] Malizos, K. N. et. al., Infection in total knee arthroplasty, *Management of Periprosthetic Joint Infections (PJIs)*, pp. 133-156. Woodhead Publishing, 2017.

[3] Drago, Lorenzo, ed. *A Modern Approach to Biofilm-related Orthopaedic Implant Infections*. Springer, 2017.