PhD contract proposal / Proposition de contrat doctoral

Title: Modeling and Analysis of Antimicrobial Resistance (AMR) Transmissio Dynamics in Healthcare Networks

Titre : Modélisation et analyse des dynamiques de transmission des pathogènes résistant aux antibiotiques dans les réseaux d'institution de soin

Background and Objectives:

Antimicrobial resistance (AMR) is a significant global health concern, causing an estimated 700,000 deaths annually. The ARCANE project aims to investigate the transmission dynamics of AMR in healthcare networks. This PhD proposal focuses on the analysis of patients' movements in healthcare systems and building propagation models. The main objective of this research is to develop a comprehensive understanding of how AMR transmission dynamics are influenced by patient movements and interactions within healthcare networks. This knowledge will contribute to the design of effective control measures to prevent and mitigate AMR transmission.

Research Questions

1. How do patients' movements in healthcare systems affect the spread of AMR?
2. What are the key factors influencing the propagation of AMR within healthcare networks?
3. Can we develop predictive models for AMR transmission dynamics in healthcare networks?
4. What are the most effective control measures to prevent and mitigate AMR transmission within healthcare networks?

Methodology:

The research builds upon previous work performed by the group on healthcare networks [1–4]. The aim is to go on step further to account for the diversity of patient care pathways and plasticity of the network in time. The research will involve a combination of data analysis, mathematical modeling, and simulation studies. The first step will be to collect and analyze patient movement data from participating national and regional hospital discharge databases in France and Germany, respectively. This data will be used to develop a temporal network representation of the healthcare systems involved [5].

Next, the research will focus on building propagation models for AMR transmission dynamics within the healthcare networks. The models will incorporate factors such as patient movements, contact rates, and antimicrobial usage patterns. The models will then be validated using epidemiological data from hospital acquired infection surveillance systems.

The final step of the research will involve developing predictive models for AMR transmission dynamics in healthcare networks [6]. These models will be used to evaluate different control measures and identify the most effective ones for preventing and mitigating AMR transmission within healthcare networks.

Expected Outcomes

The proposed research aims to contribute to a better understanding of how patient movements and interactions influence AMR transmission dynamics within healthcare networks. The outcomes of this research will provide valuable insights into the design of effective control measures for AMR transmission in healthcare settings, ultimately contributing to improved patient safety and public health.

Supervision

The proposed PhD research will be supervised by Professor Pascal Crépey at EHESP School of Public Health, France. The student will work in close collaboration with other researchers involved in the ARCANE project, including those from Cnam (Laura Temime), IPLESP (Vittoria Colizza), University of Münster (André Karch), and University Hospital Freiburg (Tjibbe Donker) in Germany.

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Setting

The position will be set at *Ecole des Hautes Etudes en Santé Publique* (EHESP) in Rennes, France, with possibilities of short terms stays with other project partners. EHESP is a prestigious French graduate school of public health, recognized for its excellence in teaching and research in various fields of public health, including epidemiology, biostatistics, health policy, and environmental health. It offers a dynamic and stimulating academic environment that fosters interdisciplinary collaboration and innovation. EHESP has a strong research focus with several research units and centers dedicated to various aspects of public health. Doctoral students will have the opportunity to work alongside leading experts in their field, participate in cutting-edge research projects, and benefit from access to state-of-the-art facilities and resources. In addition, the school also offers a variety of training programs and workshops to help doctoral students develop their research skills, communication abilities, and career prospects.
Rennes is a vibrant and dynamic city located in the heart of Brittany, just 1h30 from Paris. Known for its rich cultural heritage, stunning natural beauty, and high quality of life, doctoral students will enjoy a safe and welcoming environment with easy access to affordable housing, excellent public transportation, and various recreational activities.
Overall, EHESP offers a unique opportunity for doctoral students to pursue their research interests in a world-class institution with strong support and resources, while also enjoying the benefits of living in a charming and lively city in France.

Candidate profile

This project offers a unique opportunity for students with a background in physics, applied mathematics, or computer science to apply their skills to a real-world problem with significant societal impact. Candidates with a public health, health economics, or medical background able to demonstrate advanced competencies in biostatistics and programming may also apply. The project's interdisciplinary nature, international collaboration, and cutting-edge research make it an exciting and rewarding experience for anyone interested in using mathematical modelling and computational simulations to improve public health.

Application and information

Interested candidates must submit before **June 1st, 2024**:

- CV (including names of two referees),
- cover letter,
- master's transcript
- master's internship report (if available)

Applications and request for additional information must be sent to:
Pascal Crépey, Professor EHESP,
pascal.crepey@ehesp.fr

Bibliography

[1] Donker T, Wallinga J, Grundmann H. Patient referral patterns and the spread of hospital-acquired infections through national health care networks. PLoS Computational Biology 2010;6. https://doi.org/10.1371/journal.pcbi.1000715.

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[3] Donker T, Smieszek T, Henderson KL, Walker TM, Hope R, Johnson AP, et al. Using hospital network-based surveillance for antimicrobial resistance as a more robust alternative to self-reporting. PloS One 2019;14:e0219994–e0219994. https://doi.org/10.1371/journal.pone.0219994.

[4] Nekkab N, Crépey P, Astagneau P, Opatowski L, Temime L. Assessing the role of inter-facility patient transfer in the spread of carbapenemase-producing Enterobacteriaceae: the case of France between 2012 and 2015. Sci Rep 2020;10:14910. https://doi.org/10.1038/s41598-020-71212-6.

[5] Holme P, Saramäki J. Temporal networks. Physics Reports 2012;519:97–125. https://doi.org/10.1016/j.physrep.2012.03.001.

[6] Valdano E. Computing the Epidemic Threshold on Temporal Networks 2018.