A model of Carbapenemase-Producing Enterobacteriaceae spreading in the French hospitals network

Jonathan Roux, Clément Massonnaud, Pascal Crépey

Univ Rennes, EHESP, REPERES – EA 7449, France

Context

Carbapenemase-Producing Enterobacteriaceae (CPE) are spreading at an alarming rate and threaten health systems and patient safety worldwide. In France, their transmission is driven by importation of international cases and inter-regional dissemination potentially due to patients' transfers between hospitals.

Objectives

Defining a mathematical model reproducing CPE transmission on the French network of hospitals.

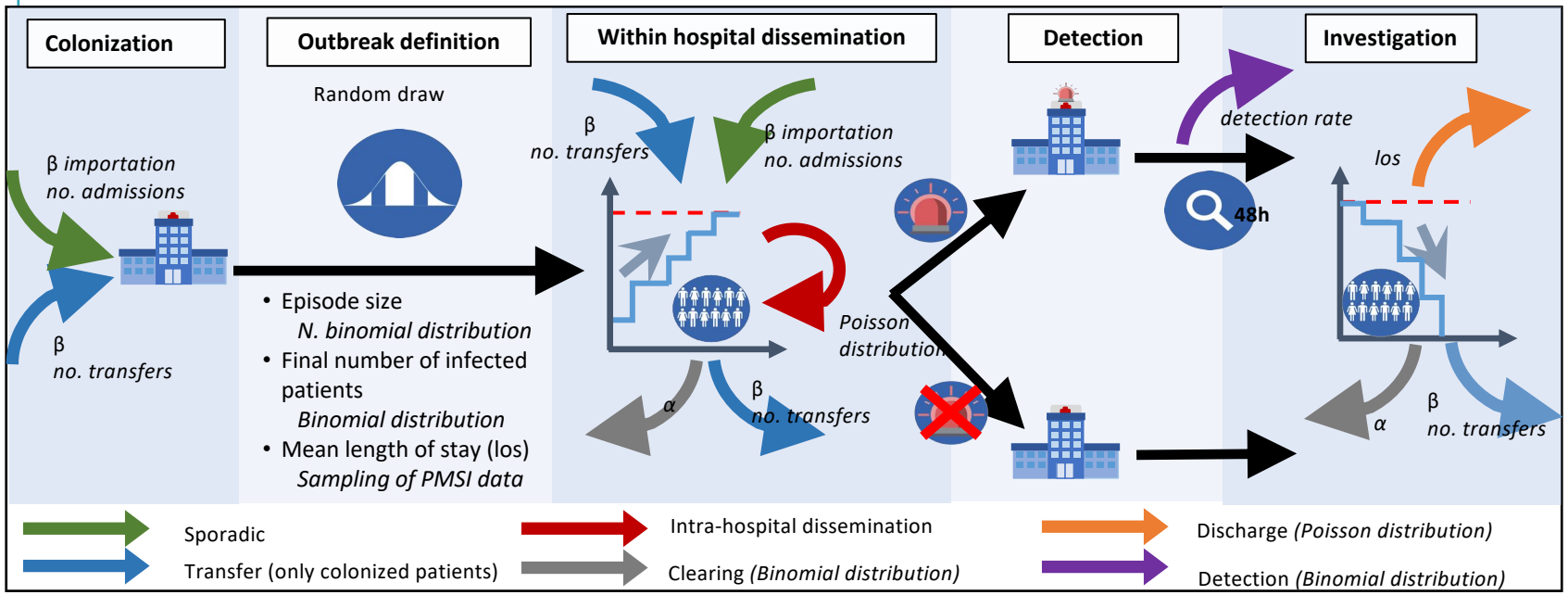
Methods

Hospital outbreak model

CPE spreading is modeled using a stochastic susceptible-colonized-infected (SCI) hospital-based model. It takes into account both CPE dissemination through patient transfers, and importations either from foreign countries or in-town transmission.

Transmission parameters (βs) are estimated on Santé Publique France data:

- Imported infected episodes
- Non-imported infected episodes
- Imported colonized-only episodes
- Non-imported colonized-only episodes



The patient transfer network was reconstructed using data from the French hospital discharge database (PMSI) over the years 2014-2017.

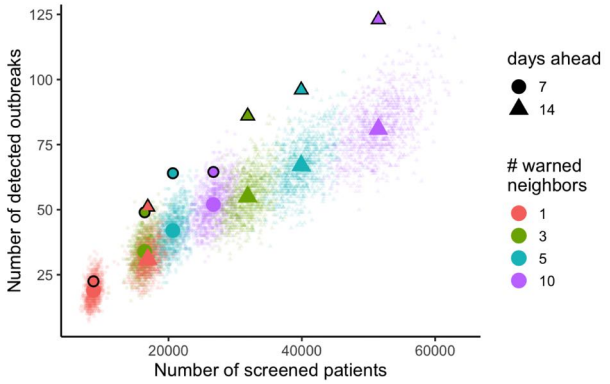
Epidemiological parameters were estimated from surveillance data of CPE episodes from August 2010 to November 2016 from the French national Healthcare-Associated Infections Early Warning and Response System.

Results

Our epidemiological model replicates the number of CPE hospital outbreaks occurring in France on a network of 2,426 hospitals. It allows to estimate the number of unobserved hospital colonizations and differentiate outbreaks due to foreign importation from those due to patient transfers.

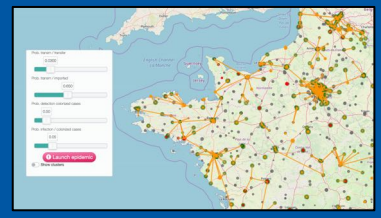
The model has been used to benchmark control strategies based on patient redirections, or targeted screening.

The plot beside show a « hospital neighbor warning » strategy: Once an outbreak is detected in a given hospital, its most connected neighbors (1-10) are warned so that they implement 1) Systematic screening of patients coming from the colonized hospital, 2) Screening of patients who have been transferred within the last week (or two weeks). Shapes with black outline show the average number of prevented outbreaks.



Conclusions

- This study is the first to simulate the spread of CPE hospital outbreaks in France using real-life patient transfers data.
- Our mathematical model may further help public health authorities in the definition and evaluation of new control strategies of CPE transmission based on patient flows between hospitals



An online visual interface has been developed whose access may be requested to the authors.
Contact: pascal.crepey@ehesp.fr

Or meet us at Maison FRANCE

Acknowledgements

This work was supported by the French national research agency (ANR), through the SPHINx project.
The authors would like to thank Mélanie Colomb-Cotinat and Anne Berger-Carbonne from Santé Publique France for data access.

EUPHA 2019 Marseille – November 2019