

A unified stochastic modelling framework for the spread of nosocomial infections

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Over the last years, a number of stochastic models have been proposed for analysing the spread of nosocomial infections in hospital settings. These models often account for a number of factors governing the spread dynamics: spontaneous patient colonization, patient-staff contamination/colonization, environmental contamination, patient cohorting, or health-care workers (HCWs) hand-washing compliance levels. For each model, tailor-designed methods are implemented in order to analyse the dynamics of the nosocomial outbreak, usually by means of studying quantities of interest such as the reproduction number of each agent in the hospital ward, which is usually computed by means of stochastic simulations or deterministic approximations. In this work, we propose a highly versatile stochastic modelling framework that can account for all these factors simultaneously, and analyse the reproduction number of each agent at the hospital ward during a nosocomial outbreak, in an exact and analytical way. By means of five representative case studies, we show how this unified modelling framework comprehends, as particular cases, many of the existing models in the literature. We implement various numerical studies via which we: i) highlight the importance of maintaining high hand-hygiene compliance levels by HCWs, ii) support infection control strategies including to improve environmental cleaning during an outbreak, and iii) show the potential of some HCWs to act as super-spreaders during nosocomial outbreaks.

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