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Modelling the spread of antimicrobial resistance in hospital

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Antibiotic resistance has become one of the major health issues in the world. It kills around 700,000 people each year worldwide, and will become even worse if no new antibiotics are developed (Nature, 2017). Therefore, serious efforts are required to prevent more severe conditions in the future. One important effort in this case is understanding the dynamics of the problem so that effective policies can be prepared. To understand the dynamics of the problem, we propose a mathematical model that describes the interaction between sensitive and resistant bacteria with human population. Here, we focus on the spread of antimicrobial resistance in the hospital environment. We assume that bacteria population can be grouped into two compartments; resistant and sensitive populations, whereas patients population can be distinguished as uncolonized patient, sensitive-colonized patient, or resistant-colonized patient. Thus, the model that we develop is a two-level population model. A sensitive bacterium can be resistant due to, e.g., interactions with resistant bacteria, gene mutation, etc. An uncolonized patient or sensitive-colonized patient can be contaminated by resistant bacteria when he/she gets contact with unsterilized medical equipment, contaminated environment, etc. We consider the cases when patients are treated and not treated with antibiotics. In the first case, even if we consider that all patients that are administered to the hospital are uncolonized, eventually all of them will become colonized by resistant bacteria from the environment after a certain time interval. Therefore, apart from applying different strategies on the use of antibiotic, hygiene of environment is also playing crucial role in controlling the spread of the resistance. We show this via stability of the disease-free and endemic equilibrium of the model. Some numerical simulations will also be presented.

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