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ABMS SIMULATOR OF PROPAGATION OF NOSOCOMIAL INFECTION IN EMERGENCY DEPARTMENTS

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ABSTRACT

A nosocomial infection is caused by microorganisms acquired in healthcare environments and it causes serious health problems to patients. Controlling the propagation of this infection is a topic of great interest in the health field. Our work focuses on propagation of nosocomial infection in emergency departments from the point of view of the physical contact among the people involved in the care process, their characteristics and their behaviors.

1 INTRODUCTION

The propagation of nosocomial infections (NI) is a phenomenon widely studied in the medical field due to serious complications to the patients (Graves et al. 2007). In computational sciences some works have applied mathematics and statistical methods, as well as simulation to investigate it. Our work focused on a specific bacterium, the Methicillin-resistant Staphylococcus Aureus (MRSA), which is common in healthcare environments. We applied Agent Based Modeling and Simulation (ABMS) techniques to build a simulator of contact propagation of MRSA in Emergency Departments (ED). Our simulator is highly configurable and takes into account details such as the influence of objects and medical equipment in the transmission, as well as the quantity and quality of preventive policies that healthcare staff has applied. As initial parameters, some important variables are included in the model: the admission percentages of MRSA patients, the percentages of patients with predisposition that are admitted, and compliance level of healthcare staff with prevention policies. The simulator allows us to build virtual scenarios in order to understand the phenomenon of the propagation. Due to the ethical implications that supposed put patients in risk of infection in order to quantify the effectiveness of preventive actions, simulation is a good choice for this kind of studies.

2 CONCEPTUAL MODEL OF TRANSMISSION

The ABMS models allow us to represent a system as a collection of autonomous decision-making entities called agents. Agents are situated in an environment and they have capacity to interact with other agents. They make decisions based on a set of rules governing its behaviors (Macal and North 2005). With the aim of evaluate the possible impact of different behaviors of healthcare staff and the environment, among the percentages of propagation of MRSA in ED, we defined a model that work with two kind of agents, active and passive agents. The active agents are patients and healthcare staff. The passive agents are the medical objects and equipment used in the care process. It is worth noting that our work has been developed based

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on a previous ED simulator, that have been developed as part of previous works by our research group (Liu et al. 2014).

3 SIMULATION AND STUDY CASE

The principal way to MRSA transmission is the frequent interaction between patients and healthcare staff. But, in each interaction, it is reasonable to assume that the transmission may be more effective or less effective according to the state of the agent at risk of acquiring MRSA and compliance with the prevention policies. We show an experiment to analyse the impact of two prevention policies, hand wash and use of isolation material. The input values for this experiment are described in Table 1. We assumed a flow of 397 daily patients who arrive distributed by hourly, a healthcare staff of 25 members, 60 boxes available and a simulation time of 4320 hours (6 months). We carry out 2 executions, the first considering a hand wash probability of 50% (Execution A), and a second execution with a probability of 80%(Execution B). The effectiveness is between 50% and 100% in both cases. The Figure 1 shows the percentages of patients that acquired a NI during the care process. The results suggest that the percentage of patients who arrive as transmission vector has a significant influence on the percentage of patients who acquire a NI. Moreover, regardless of the likelihood of compliance with hand wash it is clear to see that the percentage of patients with NI decreased significantly when prevention policy was more effective.

Table 1: Initial values for simulation.

Description	Variable	Value
Percentage of Transmission Vectors that arrive	percen_TV	2% and 4%
Percentage of patients with predisposition	Percen_predis	5%
Hand wash probability	HW-Prob	50% and 80%
Hand wash effectiveness	HW-Effect	between 50% and 100%
Use isolation material	Iso-Prob	90%
Use isolation material effectiveness	Iso-Effect	90%

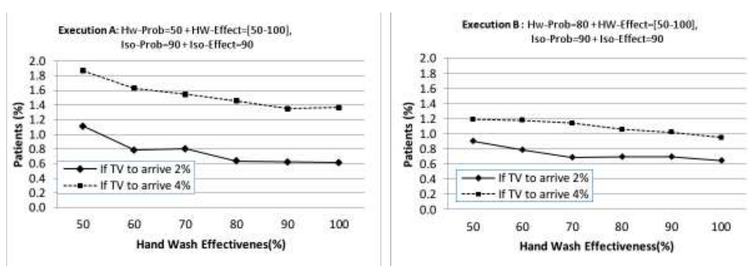

Figure 1: Percentage of patients who acquired NI.

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