論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	A risk analysis framework for nosocomial influenza infection using agent-based simulation
著者(和文)	ゾンミングエン
Author(English)	Nguyen Dung Dung
出典(和文)	学位:博士(理学), 学位授与機関:東京工業大学, 報告番号:甲第9612号, 授与年月日:2014年9月25日, 学位の種別:課程博士, 審査員:出口　弘,新田　克己,寺野　隆雄,三宅　美博,小野　功
Citation(English)	Degree:Doctor (Science), Conferring organization: Tokyo Institute of Technology, Report number:甲第9612号, Conferred date:2014/9/25, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（論文博士）

論　文　要　旨（英文）　（800語程度）

報告番号	乙 第　　号	氏　名	Nguyen Dung Minh(グエン　ゾンミン)

The purpose of the research is to develop a framework to assess the risk of a highly contagious and mortal influenza-like illness infection to health care workers (HCW) in a hospital under different scenarios of infection control. The method is to build an agent- based model for simulating infection of the virus in the hospital and use an open-source software to visualize a risk graph of infection. The simulation results have shed more light on epidemiological belief of that direct patient care HCW have high risk of catching nosocomial influenza virus and that washing hand and wearing mask are effective to prevent an outbreak of the disease in the hospital. The methodologies of quantification and visualization the infection risk is a potential methodology for risk management in infection control of nosocomial infection.

A Nosocomial infection, also known as hospital-acquired infections (HAI) occurs worldwide and it represents a major source of morbidity and mortality for hospitalized patients. In recent years, with the worldwide spread of severe acute respiratory syndrome (SARS) and the 2009 influenza pandemic, research in infection prevention and control in hospitals become increasingly important. Computer simulation can be an experimental and educational tool for hospital administrators to test strategies for controlling nosocomial infections. The great advantage of simulation model is that they unable experiments which are impossible or undesirable.

Our simulation framework consists of an agent-based model for simulating nosocomial infection and a component of visualizing the contact network generated after the simulation. The advantage of agent-based model is that macro-level statistical experiment results can be achieved from micro-level evolution of agent interactions. On the other hand, network analysis can help to visualize and track micro-level contact between agents. Since most of pathogen transmissions in healthcare settings occur via close contact, either between healthcare workers (HCW) or between HCW and patients, to visualize and detect those contacts is one of the aims of the research.

The agent-based model is developed by an agent-based simulation language called SOARS (Spot Oriented Agent Role Simulator). An agent is autonomous individual which represents a patient or a visitor, a doctor, a nurse or a hospital staff. Agent

is goal-oriented and interacts with other agents in the environment that is called "spot". Virtual agent contamination level and spot contamination are calculated and they decide probability of infection. Infection protection measures taken by agent, such as wearing mask or washing hand are modeled. 4 scenarios of infection control are generated. Simulations are iterated for 30 times and in 30 days. Infection risk of doctors and nurses is observed from simulation results. The "risk graph" that is generated from simulation logs shows close and frequent contact between doctors, nurses and inpatients. Correlation between list of infected HCW and degree of the nodes in the risk graph has been confirmed. The visualization of risk graph can be a promising method to assess infection risk of HCW in the hospital model. We can highlight and track all contacts of agents in real time. Integration with human real time tracking systems can be potential for tracking and detecting contacts between health care workers or between health care workers and patients.

Although data and knowledge for the model have been constructed based on several field works onsite, due to the lack of statistics data and impossibility of taking those experiments in a hospital, empirical validation of the model could not be conducted. Although there was no observed data fitted the simulation results, outputs are qualitatively similar to observed phenomenon in the real world.

The future work is to integrate real data collecting by sensor to the simulation framework. We have developed and used wireless tracking system to track real-time movement of humans in a building. The real data of movement of patients and health care workers in a real hospital can be achieved using the system. Changing parameters of the disease transition module can be applied to study other infectious diseases. Infection control measures can be changed in many scenarios depending on infection control resources of the hospital. The core module inherits from the current module but can be rebuilt to fit the structure of a new hospital. Simulation output shows real-time graph of the number of hospitalization, infected patient and HCW. By visualizing contact network, close and frequent contact with high-risk patients can be tracked and monitored. Variation of virtual virus contamination level of places and agents can be monitored in real time. The simulation framework could be a potential decision-making support tool for hospital administrators to evaluate nosocomial infection control and it can also be used as an educational tool to study nosocomial infection.