POLITECNICO DI TORINO
Repository ISTITUZIONALE

Agent-Based Modeling and Simulation of Care Delivery for Patients with Thrombotic and Bleeding Disorders

(Article begins on next page)

18 September 2024

Agent-Based Modeling and Simulation of Care Delivery for Patients with Thrombotic and Bleeding Disorders

Noemi GIORDANO[a], Samanta ROSATI [a], Federica VALERI [b], Alessandra
BORCHIELLINI [b] and Gabriella BALESTRA[a,1]

[a] *Department of Electronics and Telecommunications, Politecnico di Torino, Italy*
[b] *Oncologic Department, Città della Salute e della Scienza di Torino, Torino, Italy*

Abstract. The quality of patients care delivery is thought to be strongly affected by the physicians' workload. In this study we present an Agent-Based model of the processes during a typical working day. We simulated the current scenario and a possible scenario concerning the introduction of a second ambulatory as a potential improvement in the center organization. Our results validated the reliability of the model and showed that the introduction of a second ambulatory averagely reduces the daily physician' workload.

Keywords. ABM, simulation, process modelling, clinical process, NetLogo.

1. Introduction

It is nowadays well known that the delivery of high-quality healthcare services to patients and the resulting clinical outcomes are dependent on the workload of the clinical staff. Physician's workload higher than normal and consequent stress were proven to negatively impact on clinical outcome and on the quality of care [1]. Computational modelling and simulation is a unique tool to get a deeper insight in complex systems' behavior and to predict the effect of changes [2]. The diffusion of Agent-Based Modelling (ABM) strongly increased across the latest decades to face the growing complexity of the world [2]. The aim of this work is to present an ABM of the care processes for patients with thrombotic and bleeding disorders with different scenarios and their effects on the physician workload. The study was conducted at the "Malattie Trombotiche ed Emorragiche" center of a Turin hospital.

2. Materials and methods

In a previous work [3], we described the process involved and performed data collection. Two Process Modelling tools, namely Synopsis diagrams and Swim lane activity diagrams, were used to analyze all clinical processes carried out by the two

---

[1] Corresponding Author: Gabriella Balestra, E-mail: gabriella.balestra@polito.it.

physicians of the center during a typical working day. The results were used to perform the ABM modeling and simulation. Among available ABM software and tools, we chose NetLogo 6.1.0 platform[1] for its simplicity in use, high scalability and high computational modelling strength.

In our model, we defined three types of agents: 1) "**Physician**": specialists of the center; 2) "**Ambulatory patient**": patients with scheduled ambulatory visit; 3) "**Internal advice patient**": patients needing internal advice. Agents correspond to the actors previously identified as involved in clinical processes [3]. All agents moved and performed the activities in the simulation environment that was defined accordingly to the scaled map of real hospital. The model rules were defined by implementing the processes as previously modelled [3]. The simulation was based on several parameters statistically defined based on the collected data [3]. First, a simulation of an average typical day in the present situation was carried out to validate the reliability of the model. Then, since the ambulatory care absorbed the highest percentage of the workload, a new scenario was simulated to evaluate the effect of the availability of a second ambulatory room. Two different situations were modelled: (a) the second room was used only when ambulatory visits were performed both in the morning and in the afternoon; (b) the additional ambulatory was used in parallel with the first one.

3. Results and Conclusions

The results of the simulations are compared with the collected data. The overall physicians' workload (expressed in minutes) was 557 ± 74 for the current scenario, 561 ± 76 for the new scenario (a), and 555 ± 58 for the new scenario (b). Comparing the collected data (566 ± 135 minutes) with those obtained from the simulation of current scenario it can be noticed that the results are consistent demonstrating the accuracy reliability of the developed model. Moreover, it can be observed that the introduction of a second ambulatory room reduces the physician workload. Process modeling and ABM proved to be suitable tools to simulate clinical processes and to provide insight on possible organizational changes.

References

[1]   P. van den Hombergh, et al., High workload and job stress are associated with lower practice performance in general practice: an observational study in 239 general practices in the Netherlands, *BMC Health Serv. Res.* **9** (2009) 118.
[2]   D. Fone, et al., Systematic review of the use and value of computer simulation modelling in population health and health care delivery, *J. Public Health (Bangkok).* **25** (2003) 325–335.
[3]   S. Rosati, et al., Characterization of Physicians Workload in a Reference Center for the Treatment of Thrombotic and Bleeding Disorders *, in: Proc. 2019 40th Annu. Int. Conf. IEEE Eng. Med. Biol. Soc. (EMBC)40th Annu. Int. Conf. IEEE Eng. Med. Biol. Soc., IEEE, 2019: pp. 1359–1362.

---

[1] U. Wilensky, NetLogo, Cent. Connect. Learn. Comput. Model. Northwest. Univ. Evanst. (1999)