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SIMULATION MODELLING FOR THE IMPLEMENTATION APPRAISAL OF CARDIOVASCULAR DEVICE IMPLANTS

Samuel Omoniyi
Navonil Mustafee
Andi Smart

The Centre for Simulation, Analytics and Modelling (CSAM)
University of Exeter
The Business School, Rennes Drive
Exeter, EX4 4ST, UK

ABSTRACT

Aging population and changes in lifestyles have increased incidents of cardiovascular diseases in the UK. Where drugs cannot provide effective treatments for these chronic diseases, Cardiovascular Implanted Electronic Devices (CIEDs) serve as alternative treatments for patients. But implant implementations have significant impact on patients and healthcare resources. Simulation modelling can support the clinical and healthcare operational management decisions connected to the implant processes. The appraisal of the operational requirements for implementing these implants would examine the impact of the intervention on hospital resources and the evaluation of their applicability during patient selection processes. An effective appraisal of implant implementation would ensure that stakeholders can make better decisions to enhance the effectiveness and efficiency in healthcare resource management. Hybrid of systems dynamics and agent-based modelling would be used to investigate many of the decision uncertainties arising from the complexity of a typical hospital system involved with this healthcare intervention.

1 INTRODUCTION

The implementation of Cardiovascular Implanted Electronic Devices (CIED) have specific intervention characteristics that are applicable to specific patients. The implant implementations have significant impact on the healthcare resources and patients' access to these resources. The appraisal of these implants, through simulation modelling, can reduce decision uncertainties and increase the diffusion (extent of use) of these devices within a specific healthcare delivery system.

The appraisal of cardiovascular device implants is a comprehensive evaluation of the operational requirements for implementing these implants to satisfy the effectiveness and efficiency objectives for the relevant level of healthcare delivery system. The implant implementation appraisal includes the evaluation of the impact of this intervention on hospital resources and the evaluation of their applicability during patient selection process. The overall purpose of the implementation appraisal is to identify key decision variables and policy objectives that would need to be managed in the decision-making processes.

2 OBJECTIVES

The purpose of this study is to support the operational decisions on the implant implementation outcomes, processes and capability for CIEDs. Specifically, the objectives include the following:

- To examine how simulation modelling, including hybrid simulation comprising of system dynamics (SD) and agent-based modelling (ABM), can be used to provide decisions support to

enhance the operational efficiency and effectiveness of cardiovascular device implants in terms of the impact on hospital resources and their sustainable replications for patients.

- To investigate existing knowledge gaps on the links between the clinical guidelines provided for implantable cardiovascular devices and the operational requirements for the actual implementation of the implants.

3 LITERATURE REVIEW

The uncertainties surrounding the implementation of CIED implants can be problematic to decision makers and could impact negatively on the clinical outcomes, the quality of life of patients and population health (Ivlev 2015). The healthcare decision-makers can be assisted by modelling key decision variables and objectives and use simulation to that help them make better decisions in ways that expected outcomes and preferences can be appropriately replicated (Durbach and Stewart 2012).

4 METHODOLOGY

The study combines systems thinking approach of SD with the phenomenon-based modelling approach of agent-based modelling ABM. The phenomenon in this case is the diffusion (extent of usage) of specific device implants within a hospital delivery system. System thinking techniques will be explored to demonstrate how the dynamics of the stock and flow variables relevant for implant implementation can be formulated and experimented within a computer program to support decisions on CIED implementation in hospitals.

The application of agent-based model can support the healthcare decisions through the structuring and experimentation with heterogenous agents in order to understand their interacting behaviours in a complex device implant delivery system. Hybrid modelling is chosen to reduce the limitations of the individual methods.

5 MODELLING PROCESS

The study will begin with conceptual modelling of the device implant ecosystem. For the ABM technique the conceptual modelling will explore all the types of agents within a hospital for device implants and their interacting behaviours in the context of CIED implants. The conceptual modelling for SD will use system thinking approach to identify the aggregate variables such as stocks and flows as well as their dynamics in the course of implant operations. The SD modelling process will also set the model boundaries for the purpose of isolating the exogenous variables from endogenous variables.

6 POTENTIAL AREAS OF CONTRIBUTION

The study will contribute to the understanding of how simulation modelling and hybrid simulation can be used to provide decisions support to enhance the operational efficiency and effectiveness of cardiovascular device implants in terms of the impact on hospital resources and their sustainable replications for patients. Further, it would contribute to filling the existing knowledge gaps concerning the essential links between the official clinical guidelines for implantable cardiovascular devices that are informed by health technology assessments on one hand and on the other hand, by the operational requirements for the actual implementation of the implants.

REFERENCES

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