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CONFERENCE ABSTRACT

A Bottom-up Simulation Method to Quantitatively Predict Integrated Care System Performance

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Introduction: The demographic development resulting shows that the population distribution has already changed considerably and will further change over the next decades. That is, the number of older people with chronic conditions will increase intensively. This expected increase of older people in society poses an immense challenge to the public health care system. The integrated care could be a promising concept in redesigning care to tackle this. However, changing from conventional public healthcare policy to integrated care requires a lot of feasibility studies, and major health policy changes often has wide-ranging impacts on our community, the evidence of process redesign interventions regarding their ability to improve quality of care must be interpretable for populations. Furthermore, integrated care systems are made up of an interconnected set of relationships between individuals, organizations and groups, all of which have unique aims, motivations, beliefs and cultures. Given this complexity, it is very difficult to evaluate the impact of a major policy change through unilateral research, modelling or consultation processes, and efficient management of integrated care system also becomes a big challenge. Simulation can be used for dynamic as opposed to static analysis of integrated care system. Our research started from simulating Emergency Departments (EDs) in public healthcare system. Our ultimate aim is to model the entire integrated care pathway, from management of health in the home to acute care and provision of specialist services.

Methods: Integrated care system is a large, dynamic, complex environment. In this circumstance, not only accuracy in prediction, interpretability is also extremely important to have transparency in predictive modeling. Domain experts as well as civilian populations do not tend to prefer "black box" predictive models. They would like to understand how predictions are made, and possibly, prefer models that emulate the way a human expert might make a decision with a few important variables, and a clear convincing reason to make a particular prediction.

An agent-based model (ABM) (also called individual-based models) is a class of computational models for simulating the actions and interactions of entities (individual or collective entities such as organizations, departments) with a view to assessing their effects systematically as a whole. Therefore, we used ABM technique to simulate the complex integrated system from bottom up, that is, simulate the behavior of care staff and patient, and interactions among

them. The system performance as a whole will emerge from these interactions. Our AMB for simulating EDs was carried out by analyzing historical data (to determine the nature of distributions and transition probabilities), and conducting interviews with experienced healthcare staff (to establish comprehensive understanding).

Results: The developed simulation model has been calibrated and validated using actual data from Hospital de Sabadell. This model provides a flexible platform for studying ED operations as it predicts the system-level behavior from micro-level interaction. In this mode, the effect of policies on parameters such as waiting times and throughput could be quantified before actual implementing.

Discussion: The integrated care system comprises of many stakeholders and the underlying processes involve a lot of interaction among patients and service providers. To some extend, any one of the entities in the system is significant, has big influence on overall system performance. The proposed method has two potential usages in integrated care: (1) before implementing, the simulator (built according to proposals) can work as a virtual prototype to verify policies, (2) in the management of integrated care system, the simulator (polished according to actual system) can be used to predict system performance under unexperienced scenarios (like flu pandemia), so as to avoid overcrowding, and evaluate proposed changes before implementing. Of course simulations can never be a perfect model for reality, and it is important to understand their limitations, but they can provide substantially more information than theoretical research.

Conclusion: Start from simulating the emergency departments, our efforts proved the feasibility and ideality of using agent-based model & simulation techniques to study healthcare system. The framework developed in our work is a step towards building a full model of integrated care system. The final model will be able to represent a comprehensive tool to quantitatively evaluate prospective planned changes to the integrated care system for decision making, and open a wide field of possible simulation scenarios for a better understanding of the integrated care complex system. In conclusion, bottom-up simulations can help understand how the different elements of integrated care system work together under different conditions. It is a crucial pre-requisite for improving the coordination and integration of care, and increasing the efficiency of resource allocation.

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Keywords: decision-analytic model; agent-basemodeling and simulation; decision support system; emergency department; integrated care