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Towards a simulation-based framework for decision support in healthcare quality assessment

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Abstract

This article describes a simulation framework for healthcare quality assessment from the perspective of management and corresponding decision-makers. The proposed framework will allow simulating “what-if” scenarios and getting alternative outcomes in case of decision support systems. In our research, we are dealing with heterogeneous data sources, which combine within data-flow processes. The data flow of the presented framework conceptually combines several modeling methods: discrete-event simulation, agent-based modeling and also includes data analysis. The experiments were executed based on data from the Almazov National Medical Research Centre hospital information and access control systems.

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1. Introduction

Nowadays, healthcare is experiencing a paradigm shift. There is a transition from the volume-based to value-based approach, from maximum assistance to all patients to individual service and care quality improvement along

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with efficient usage of resources. All healthcare processes become even more complex and consequently generate even more unstructured data. It makes management decisions more complicated. Existing HIS do not always allow proper decision-making support for medical professionals [1]. Therefore, in conjunction with extending of practical application and integration of HIS, it is important to develop new methods and technologies to support decision-makers within the paradigm of personalized medicine. The implementation of high-quality and well-timed decision-making support is only possible when using results of analysis of already existing data, and obtaining new knowledge based on the performed analysis.

At the same time, it's really necessary to improve the healthcare quality through, for example, an evaluation of patients' satisfaction. But in some cases, this type of evaluation is unavailable due to lack of feedbacks. That's why decision-makers can use some techniques from staff scheduling. These techniques allow optimizing workload but can't give any prediction in case of emergency or some unusual situations. For that reason, simulation and modeling had widespread application in healthcare.

2. Related works

Mankind experiences the growth of the life's length as well as the common population growth and it is the reason for pride. Meanwhile, the same achievements require strengthening of the economy, particularly, in the field of healthcare. There should be significant expenditures also because the world population is rapidly aging [2] and necessary technologies should be developed and deployed. Solutions of the costs' containment task vary in different countries. Nevertheless, the most useful were patient-oriented measures, e.g. more active treatment for people with multiple comorbidities and, in general, the increase in patient throughput in hospitals [3]. Also, staffing policies in healthcare are shown as ineffective since they consider volumes instead of the quality of care [4]. This marks the transition from volume-based to value-based approach and means the need to optimize the whole process of patient treatment depending on personal characteristics. In fact, the same idea has been voiced in the call of WHO to balance economy of means and quality improvement and appreciate patients' expectations [5].

One of the most important findings was that the nature of care and a warm attitude (primarily from nurses) determine the perception of the patient, not the technical side of care, as was previously thought [6]. This is also evidenced by patient-reported outcomes [7]. Reporting through surveys and questionnaires is the most widely used approach in assessing the quality of care [3,8–11]. It represents a fair feedback and allows giving an idea of overall healthcare statement at the hospital level. The nurse work environment is strongly associated with patient satisfaction [9] and it means the environment building is the mandatory step on the way to the main goal. Inattention to this leads to the burnout of nurses [3,8,11]. Even some studies state that nurse work overload has no effect on patient outcomes [8,10] it increases the number of errors of nurses the degrades the patient safety [12–14].

It should be noted that the perception of the quality of care for the hospital staff and the patient should be similar in order to avoid the loss of compliance [15] and managers should take this into account in corporate decision-making. Performance appraisals are required for effective management activities, i.e., promotions, training, coaching, etc. [16], which in turn leads to positive organizational and patient outcomes [10,11], including even patient mortality [17]. However, nurses are disappointed in the performance appraisals. There are identified subjectivity and lack of communication between managers and nurses as major points that must be eliminated in the performance appraisal system [18,19]. The system can be improved with the participation of all parties and improving the work environment while taking into account results of the assessment of the quality of care [11,20].

A fundamentally different approach to solving the problem of the quality assessment is the creation of data-driven models. Such models allow considering the interests of all parties objectively: to assess work environment from the staff point of view and the effectiveness of work from the management point. The key to objectivity is work with data from hospital information system (HIS) and electronic health records (EHR). Unfortunately, in most cases, the data does not conform to standardized terminology and has unusable (because of inaccuracy) timestamps [21]. A promising application of models is possible when assessing the workload of nurses. Stored data of admissions and discharges of patients allows obtaining accurate assessments [22]. The detection of overloads can have a positive effect on the quality of care as it was said earlier. To build a comprehensive assessment, it is necessary to consider nurse interventions based on HIS data, influence of doctors and managers.

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