

# Health Outcomes Analysis for the Patient in Hospital Context

Filipa Gramacho<sup>1,2(✉)</sup> and Gabriel Pestana<sup>3</sup>

<sup>1</sup> Universidade Europeia, Laureate International Universities, Lisbon, Portugal

<sup>2</sup> Centro Hospitalar Lisboa Norte, Lisbon, Portugal  
filipa.gramacho@chln.min-saude.pt

<sup>3</sup> Universidade Europeia, Laureate International Universities, Quinta do Bom Nome,  
1500-210 Lisbon, Portugal

gabriel.pestana@universidadeeuropeia.pt

**Abstract.** In the health sector it is perceived a knowledge gap concerning to the study of health outcomes for the patient. In this scope, paper provides an overview regarding the study of health outcomes from a patient-centric perspective. Based on data derived from the patient health profile and existing clinical records the proposed model will enable Hospitals to be aware about how well it is performing in relation to patient's health outcomes. The research follows the framework defined by the Design Science Research methodology and by incorporating Gamification's techniques it also contributes with an original approach within the hospital context. With the inclusion of the physical, mental and social health perspectives, the proposed model will contribute to improve the study of health outcomes increasing simultaneously the knowledge to the management in public health, providing data to a possible finance model of pay for performance.

**Keywords:** Design science research · Gamification · Health perspectives · Health outcomes · Patient health profile

## 1 Introduction

In the health sector it is perceived a knowledge gap concerning to the study of health outcomes for patients when they interact with the public health system. Existing studies are mostly focused on analysing the impact of healthcare services from the perspective of the healthcare process efficiency, they do not consider a patient-centric approach to analyse the impact of those healthcare services to the patient health. The main concern of existing approaches is to analyse if healthcare services are performed accordingly to existing standards and good practices or if the prescribed was adequate to the clinical diagnostic.

Data related to the patient clinical status are collected on a daily basis, however despite of such a huge amount of data, there is still a lack of knowledge concerning to the study of the impact of healthcare services to the patient and how they contribute to improve the patient healthcare outcomes [1]. The literature also indicates that most of existing studies [2, 3] analyse health outcomes from the clinical process point-of-view,

which does not reflect the quality of care, failing to present results in health outcomes to patient.

According to recent studies [4], what is missing is an approach to analyse existing data from a patient-centric perspective. Indeed, to better understand the benefits of health outcomes, the data need to be analysed from that perspective, meaning that a model is required to help healthcare professionals in perceiving how healthcare services may contribute to keep patients healthier or at least to understand how healthcare services impact positively or negatively in patient health status [4]. Since it is not possible to manage what it is not measured [5], the research presented in this paper address this gap in knowledge – study health outcomes from a patient-centric perspective, an approach identified by many [2, 6] as a research challenges.

To accomplish such research goal, health outcomes will be analysed according to three perspectives: physical, mental and social health, addressing aspects such as (i) How to measure health outcomes for the patient taking into consideration the physical, mental and social dimension; (ii) What kind of info-structure is required to classify existing data and help monitoring progresses related to health outcomes; (iii) How to analyse the impact of social aspects in the characterization of the health outcomes for the patient.

Due to complexity and to the broad scope of the healthcare sector, the paper addresses the study of the health outcomes for the patient in the hospital context and within this environment only healthcare services from the Emergency and Inpatient are considered. The emergency service usually is the gateway to the health system and the inpatient service is where patients spend more time associated with the complexity of care provided, thus in both situations the risk for hospital-acquired infection increases.

The research challenges will be analysed following the Design Science Research (DSR) methodology. The goal is to develop a model to be applied to electronic clinical data within the hospital context. In this phase the main goal is to verify what is achievable to measure using existing data, to know how much it is possible to outline about the health outcomes to the patient. The analysis of such results will require an info-structure of metadata in order to classify and explore patterns derived from relationships between variables. When translated into information, these patterns might generate valuable knowledge about the outcomes in health.

This paper is structured as follows: Sect. 2 summarizes the state of the art in health outcomes measuring; Sect. 3 provides a short overview to the DSR methodology; Sect. 4 provides an introduction to the approach to build a theoretical thinking on how to approach health outcomes from a patient-centric perspective, finally in Sect. 5 a summary and future work of the current research is presented.

## 2 State of the Art

In the literature, “health outcomes” is defined as a result of health care [4]. The results are understood as changes in the patient health status which is defined based on three fundamental perspectives: physical health (refers to the physiological and physical status of the body, including basic physical components such as if a person can wear or walk

without assistance), mental health (refers to the state of mind, including basic intellectual functions such as memory and feelings) and social health (refers to the ability to develop social interactions, such as relationships) [7].

Although physical health, mental health and social health are distinct concepts, they are also substantially interrelated. They can be analysed individually, but such approach is insufficient to describe the individual health status, since their interaction has a major role in the final outcomes [7]. In this research the extent of social health analysis represents a further challenge to the specification of a model capable to characterize health outcomes to the patient. Such assumption derives from very low expressiveness of social data in current clinical records.

According to the literature one of the difficulties in analysing the impact of care on the patient, is the ability to analyse the quality of the services provided to the patient [2–4]. The data collected by current healthcare systems are strongly focused in reporting what has been done to the patient (Structural components), for instance, characteristics of the settings in which care occurs with statistic data related to number of beds, number of healthcare professional, number of patient treated. Process components such as activities of the health service, is also very common namely with numbers related to surgeries performed and average time in attending each patient. In this domain, Porter [3] advocates the need to change the focus and start collecting the data to address measuring the quality of health care by Result component instead of focusing exclusively on Structural and Process components.

As outlined in Table 1, the approach is to start measuring the impact of care on the patient (e.g.: autonomy capacity after hospitalization episode) taking into consideration the study of health outcomes from the identified three perspectives using the International Classification of Functioning, Disability and Health (ICF) [8]. This classification allows organizing information on functioning and disability, conceptualizing a person’s level of functioning as a dynamic interaction between health conditions, environmental factors, and personal factors, aggregated into components, which are then divided in domains and sub-domains.

**Table 1.** Integrating health perspectives with ICF [8]

Perspectives	ICF components	ICF domains	ICF sub-domains
Physical health	Body functions	8	115
	Body structures	8	56
Mental health	Activity & Participation	9	118
Social health	Environmental factors	5	74

Regarding to result component, the literature also analyses health outcomes in a segmented way. Normally in a clinical perspective based, such approach means that only a specific part or organ of the patient (e.g.: specific medications to the area of Neurology) is considered. The patient is never visualised or considered as a whole system as the classification of functionality (ICF) does [8]. The challenge resides in finding a way to monitor health outcomes to timely provide the result about the hospital

performance, information that will be essential for the hospital differentiation. The analysis of health outcomes from the identified three perspectives besides contributing to increase the quality of the healthcare system [9] also represents a pragmatic response for the sustainability of the National Health System.

The construction of the model is based on applying the methodology defined by DSR, complemented with Gamification techniques to assure engagement and awareness of all intervenient actors [10]. The integration of gamification techniques contribute to the construction of structures that involve, drive and guide users (in this case, health professionals) in order to achieve their goal, encouraging the behavioural changes and creating instruments to promote organizational awareness in relation to the benefits in considering health outcomes from a patient–centric perspective. The theory is that gamification techniques will not only motivate but contribute to keep health professionals more committed in improving the results of health outcomes.

In the literature [2–4, 10] the adoption of gamification techniques in the health sector is mostly focused on patient healthcare education, especially on quality of life and well-being. Its use to keep health professionals aware of some misbehaviour risks or deviations from target goals is less frequent. That is what this research aims to contribute. The importance of the proposal is reflected in the production of scientific knowledge grounded in DSR and contributing to improving the performance of organizations with increased competitive advantage. This improvement will result in the increase of quality of service.

### 3 Design Science Research Methodology

The research work will be anchored in the DSR methodological approach, including the construction of artefacts, and their assessment, in order to meet the challenges listed in Sect. 1. Two main steps compose the DSR: construction and assessment. In the construction step we intended to generate a “Model”. The assessment in this research will be performed by validating the Model performance against a set of expected thresholds [11]. Figure 1 outlines how the knowledge acquired from the DSR methodology impacts the research, with each activity of the DSR providing a contribution in each stage of the research. The state of the art let us know that it is not done the monitoring of the health outcomes with the focus on the patient, and DSR will contribute to the construction of the Model.

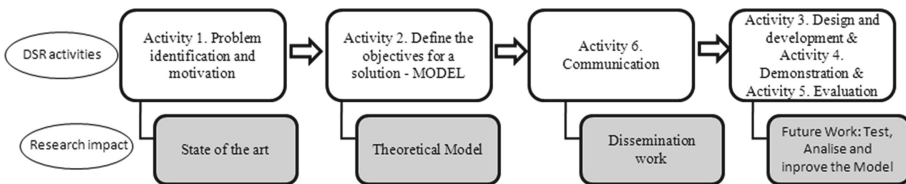


Fig. 1. Contribution of DSR to create the Model that is being research

The research artefacts will be validated using the DSR iterative cycle, which considers an active participation of key-users in the construction of the model. In a first iteration the model will be tested using a subset of clinical data extracted from anonymized patient electronic health records. The preliminary results will be validated with provided inputs from the healthcare professionals. These inputs will be used to change the informational artefact to improve the Model, which will then be tested and validated by experts in a hospital context, and then apply in real data in hospital context, and again be subjected to the scrutiny of the end-user.

The DSR methodology provides an iterative cycle, with errors, arrangements and adjustments throughout the process in which knowledge is used to create the artefact, and this is assessed to build knowledge. It is understood, therefore, that the construction of knowledge occurs together with the development, from the analysis of existing knowledge for creating the artefact to the application in specific context or situation, producing a new knowledge [12].

### 4 Theoretical Model

A list of characterizing parameters is being compiled and correlated with data typically found in a patient clinical record so that the proposed model may provide an info-structure of metadata to analyse existing data and help in establishing correlations and in identifying which values best characterize the patient health outcome. As presented in Fig. 2, by incorporating different perspectives (e.g.: physical, mental and social health) when analysing the data it is expected to provide an accurate result for health professionals performance and hospital performance, regarding the study of the clinical services which contribute to positively impact the patient health status. This information can be used in the improvement of management in health, for example, given data for the finance model of pay for performance (P4P).

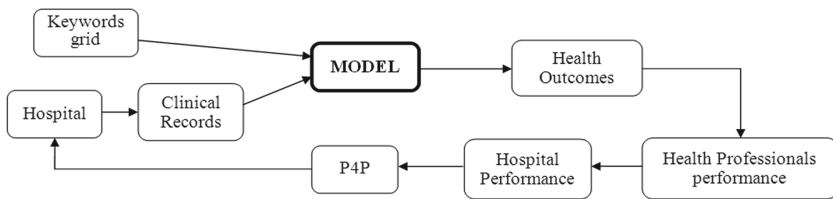


Fig. 2. Model inputs and outputs

It were identified as the most suitable the evaluation methods and experimental testing methods that allow to study the Model in a controlled environment to check his quality, as well as perform interfaces in order to identify possible failures and defects in an interactive process with successive Model improvements [11]. This includes critical analysis and incorporation of results from preliminary tests, literature knowledge, and information gathered from experts and from expertise literature, which correspond a greater maturity and robustness of the Model.

The use of gamification techniques in building the Model, lead the user to achieve specific objectives and results, contributing to the connection between users, as well as to healthy competition, which will generate internal motivation among health professionals. Thus, it becomes so important to attract health professionals to the project and to ensure its engagement with it, through gamification techniques such as feedback, constant challenges, recognition and self-awareness. Contributing to this objective, another strategy that wanted to join on building the Model, will be the inclusion of alarms algorithms that allow recall indications of guidelines and good practice guidance, and provide reminders to outliers based on defined criteria.

It is intended therefore that the Model have engagement mechanisms, encouraging proactive behaviours so that health professionals become inside actors of the project, bringing new ideas and suggestions for improvement, as well as implementation strategies on the field. The possibility of monitoring the results by health professionals allows them to become able to track their performance, making it possible to monitor their own progress. More than reward, it is essential a system of recognition of commitment and performance of health professionals by peers, the Organization as well as the patients. The focus of gamification, thus, focuses on the motivation of professionals, stimulating innovation in the health market.

There is a consensus in the literature that the great challenge of the use of data is the issue of privacy. The solution to the problem is awareness of the importance of privacy and the development of security protocols, such as through the use of tools as encryption, anonymization/pseudonymization (i.e.: delete names of people or replaced them by pseudonyms in databases), among others [5]. For security reasons, the monitoring results of running the algorithms, although automatic, necessarily have to be supervised by health professionals. Thus, it is promoted greater transparency, better information and use of information resources for health issues.

## 5 Conclusion and Future Work

Health data sector is being analysed in a way not adjusted to study health outcomes for the patient. When analysing health outcomes from a patient-centric point of view, as a way to improve the quality of health service, it is possible to develop strategies to improve competitive advantages. The proposed model incorporates gamification techniques with a clear commitment to test and analyse clinical data in a hospital context. The main goal is to outline hidden information regarding the study of health outcomes from a patient-centric perspective. By integrating the health professional as the end-user in the development and implementation of the Model, it will contribute to their engagement, setting strength and solidity to the Model itself, with direct impact to the management of the organization.

As future work, we intend to bring Visual Analytics component to the Model, as facilitating the visualization of data through interactive visual interfaces [13]. The aim is to contribute to better understanding and judgment, achieving more effective results in terms of data analysis tasks and decision-making. The challenge is adopt a visualization paradigm capable to bring the end-user into the decision-making process and

engage the user to be proactive in adopting the recommendations provided by the diagnostic presented by the model. In this sense, the proposed info-structure of metadata will provide the semantic context awareness according to each user profile (e.g.: medical profile, nurse profile, social worker profile), in order to give specific information addressing the user role. In this regard, the focus is moved from a simple presentation of results to address user's concerns and information needs.

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