Computer-interpretable Guidelines driven Clinical Decision Support Systems: An Approach to the Treatment Personalisation Routes of Patients with Multi-Diseases

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Abstract

Clinical Decision Support Systems help the delivery of care by supplementing generic clinical guidelines with decision support. This is achieved by encompassing patient-specific recommendations that support the implementation of the computer-interpretable guidelines (CIGs). CIG implementation involves understanding the risks and outcomes of a treatment, which may show diversifications between patients with multiple diseases and those without. The objective of this study is to present a state-of-the-art approach for CIG-based treatment personalisation routes and stages for patients with multiple diseases.

Introduction

Treatment of several chronic diseases is a challenging task, due to their complex management involving continuous monitoring, evaluation and amendment of a care plan. This is exacerbated by multiple conditions, which can be at odds with each other in terms of medication compatibility between diagnostics, treatment plans and amount of available medical information. Since the population is aging, there is a vast number of people suffering from multimorbidities that can be defined as the co-existence of two or more chronic diseases in one individual [1]. In order to contribute to the well-being, quality of life and life-expectancy of a patient, recommendations should not cause any serious conflicts between medications of different diseases (i.e., drug-drug or drug-patient interactions), adverse effects on other diseases while treating the index disease (i.e. drug-disease interactions) or be inconsistent and/or unnecessary. To deal with these complex patients and their associate disease risks, treatment personalization is required.

Clinical Decision Support Systems (CDSSs) help to customize care plans for each patient. In the case of multimorbid and comorbid patients this requires conciliation of the activities recommended by various single-disease clinical practice guidelines (CPGs), which are mainly paper-based clinical protocols and provide evidence-based clinical recommendations to caregivers regarding diagnosis, therapy or treatment plans on treating a particular disease. CDSSs can also help to highlight and offer early warning to caregivers on potential issues that may not be seen in time, due to the complexities and the 'decentralised' approach of morbidities. CPGs have no adaptability to dynamic states in patient health conditions; particularly, in the presence of multi-morbidities this is an important issue, as CPGs are static and mostly designed for the treatment of a single

disease. Thus, they are not able to address the needs of patients with complex concurrent diseases[2] that can be linked with decreasing life expectancy, quality of life and increasing risk of adverse drug events.

CPGs can be formalised into a digital form, called computer-interpretable guidelines (CIGs), in order to increase their flexibility, minimise errors and generalise the use of guidelines across organisations. For instance; Arden Syntax[3], GLIF[4], and Asbru[5] are some of the well-known formalisations for representing CIGs. Studies have shown that the adoption of CIG-based CDSS can reduce clinical errors, improve the caregiver performance and patient outcomes, as well as reduce the inefficient patient attendances (returning patients) and hospital costs[6,7]. In this study, we summarise the state-of-the art of the literature and proposed a CIG-based framework on the treatment personalisation routes of patients with multiple diseases, under a clinical decision support context.

Methods

We systematically review the literature on activity based views of how CIGs are used in CDSSs to personalize treatments. We consider papers that have been published between 2000 and 2017 on scientific journals by querying Science Direct, Web of Science, and PubMed. The search terms covered “computer interpretable guidelines”, “clinical guidelines”, “computer-assisted decision making”, “clinical decision support systems”, “patient-centred care”, “care pathway” AND “computer based guidelines”, “workflow” AND “computerised guidelines”, and “guideline interactions”. In addition, we conduct a grey literature search. We then derive a systematic workflow on personalisation treatment routes for multi-morbid patients, through the use of CIGs.

Results

To demonstrate how treatments are customized (i.e. personalized care routes) using CDSS, and how CIGs are integrated into a care-flow, we introduce a short description of a patient treatment journey as follows: if patients would like to be treated by a caregiver, initially they should be registered to an integrated electronic healthcare record (EHR) system of one of the treating medical centres. Such system can record patients’ visits in terms of episodes of care, e.g. reason for encounter, lab tests, x-ray results, treatments. Integrated EHR systems can be connected with a CDSS. Hence, the caregiver can use the CDSS to get information about the patient, and make an initial assessment regarding the patients’ disease(s). Afterwards, the caregiver may provide her assessments to the system as an input, as well as including other clinical information via the graphical interface of the CDSS. This information is then linked with the CIGs. By this integration, disease can be detected and the treatment of a patient can be started, based on the solicited decision support output of the CDSS and the *patient-caregiver shared decision making* that caregiver establishes the treatment target, schedule and supplies information on patient preferences/requests, in return patient aims to obtain information on his disease and has a voice over the decision making. This paper has resulted in the identification of the typical use of CIGs in healthcare and presents a summary of the main stages (as patient-medical centre, CIG-CDSS and patient-caregiver encounters) that CIGs are (in) directly involved in, one would expect to find when using CDSS for morbidities.

Discussion

CDSSs support the implementation of CIGs targeting the improvement of healthcare actors' performances on clinical decision-making, quality of care and patient safety. The reviewed publications show that the key fields of work are still open for further investigation: CIG interactions and medical knowledge, merging and execution of co-existing CIGs for multi-disease treatments, guideline interaction analysis: new methods, techniques and algorithms etc., timing constraints, and patient empowerment in CDSSs.

Conclusion

This paper summarises the findings of an extensive review of the literature on the key components of CDSSs for the treatment of morbidities and also proposes a framework of integrating CIGs into the delivery of care. Care customisation has been widely investigated in the literature[8,9] with different perspectives, approaches and solution methods. As far as we are concerned, we are the first that consider the implementation steps of CIG-driven treatment personalisation pathways, including guideline, temporal factor, and patient-caregiver interactions. Our proposed framework can be useful for researchers and/or healthcare actors to understand how treatments of patients with multiple-diseases can be personalised. In addition, it provides an understanding of how clinical recommendation mechanisms work in practice, and how the adoption of CIG-based CDSS and patient-centred care can improve the caregiver performances, patient outcomes and healthcare processes.

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