Medical Cost Optimization using Interactive Knowledge-Graph for Clinical Decision Systems

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Abstract

Clinical decision support systems aim to improve access to relevant and practical clinical data to assist medical practitioners in diagnosis and treatment. However, the usefulness of such systems is limited due to the lack of effective user interactions and proper cost management for treatments. We propose solutions to the above issues through allowing interactive navigation of a knowledge graph of medical conditions and symptoms and novel cost management decision support. With a growing number of medical costs now available to the public due to a new U.S. law, we propose utilizing newly available cost data to allow medical practitioners to be aware of and consider these costs when they are making decisions about a patient's care. To this end, we propose an easily navigable graph where each node presents the likelihood of a patient having certain medical conditions as each new symptom is learned. Once new information about the patient is exhausted, we propose finding the order to test that patient's possible conditions that minimizes the overall expected cost. This full process is presented in a proof of concept application. In particular, the developed prototype is effective for uncommon medical conditions.

Keywords: CDSS; Clinical data; Knowledge graph; Medical costs; Optimization; Monte Carlo search tree;

1. Introduction

Price transparency is an increasingly important aspect of modern health care that is at times overlooked. In many cases, patients are stuck with unexpected bills as high as $250,000 for procedures and tests that were not covered by their health insurance [24]. Approaches to resolve this have been proposed such as clearly informing the patient and getting written consent, requiring health insurance providers to settle surprise emergency balances with the clinic, legally limiting what providers can charge in emergencies, and many others [10]. However, the most significant step forward has come from the Health Care PRICE Transparency Act. All hospitals must release the costs for procedures, tests, medications, and information about different insurance plan coverage.

A clinical decision support system (CDSS) is a computer system that helps a medical practitioner make decisions about an individual's health condition, usually in real-time. A CDSS can focus on helping with drug interactions and uses, as well as providing information about procedures, however they rarely notify if something is not covered by a patient's health insurance [13], [4]. This is due to the fact that many policies for coverage depend on specific known conditions about the patient, past procedures, and reasoning why the patient needs this exact procedure. Interest in clinical decision support systems increased upon learning that clinical decision support systems reduce the overall cost for a medical practice and lead to fewer errors [5]. Elaborate systems are being used in medical offices that handle billing, orders, medication tracking, patient history, lab results, and more. Most of these systems have some aspects of clinical decision support systems, even if they are limited when considering the modern definition of such systems.

In some cases, these systems may attempt to help with the diagnostic aspect using information extracted from past patient data [22]. Especially with uncommon or oddly presenting diseases, even specialized medical practitioners may not immediately know what is happening without seeking knowledge about similar cases. Most of these systems advise on things that are commonly overlooked. However, diagnostic decision support systems do exist where they attempt to guide the medical practitioner towards an exact diagnosis using prior knowledge and entered information [2]. Most systems, such as symptoms checkers, are designed for patients and are disliked by medical practitioners for caus-