A health record integrated clinical decision support system to support prescriptions of pharmaceutical drugs in patients with reduced renal function: Design, development and proof of concept

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ARTICLE INFO

ABSTRACT

Objectives: To develop and verify proof of concept for a clinical decision support system (CDSS) to support prescriptions of pharmaceutical drugs in patients with reduced renal function, integrated in an electronic health record system (EHR) used in both hospitals and primary care.

Methods: A pilot study in one geriatric clinic, one internal medicine admission ward and two outpatient healthcare centers was evaluated with a questionnaire focusing on the usefulness of the CDSS. The usage of the system was followed in a log.

Results: The CDSS is considered to increase the attention on patients with impaired renal function, provides a better understanding of dosing and is time saving. The calculated glomerular filtration rate (eGFR) and the dosing recommendation classification were perceived useful while the recommendation texts and background had been used to a lesser extent.

Discussion: Few previous systems are used in primary care and cover this number of drugs. The global assessment of the CDSS scored high but some elements were used to a limited extent possibly due to accessibility or that texts were considered difficult to absorb. Choosing a formula for the calculation of eGFR in a CDSS may be problematic.

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Conclusions: A real-time CDSS to support kidney-related drug prescribing in both hospital and outpatient settings is valuable to the physicians. It has the potential to improve quality of drug prescribing by increasing the attention on patients with renal insufficiency and the knowledge of their drug dosing.

1. Introduction

Renal impairment is relatively common in the general population; between 3.2 and 5.6% has a moderate decrease in eGFR (<60 ml/min/1.73 m^2) [1]. In the elderly it is shown that up to 27% in subjects over 80 years may have an eGFR <60 ml/min/1.73 m^2 [2] and is associated with increase in morbidity and mortality [3].

The renal function has an important role in the elimination of many pharmaceutical drugs and according to Seyffart about 60% of all registered medicines is mainly excreted via the kidneys in varying degrees [4]. Inappropriate prescriptions of drugs to patients with renal impairment are problematic and may cause adverse events [5,6], lead to unnecessary hospital admissions, prolonged hospital stays, increased costs and even deaths [5–10]. The prevalence of inappropriate medication in elderly inpatients with renal impairment is high up to 13% [11]. The greater the proportion of excretion through the kidneys is and the lower the GFR are, the greater the risk is of adverse effects [7]. Treatment with nephrotoxic drugs may also increase the risk [6]. It is therefore important to assess the renal function during treatment with drugs with a limited therapeutic window and that are mainly excreted through the kidneys.

Merely measuring p-creatinine is not sufficient to assess the renal function [12]. An appropriate formula to estimate GFR (=eGFR) is necessary. The most commonly used formulas used for estimating GFR for adults using creatinine as a marker are the Cockcroft–Gault (CG) equation [13], the Modification of Diet in Renal Disease (MDRD) equation [14] and the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation [15]. Information on how to dose drugs based on the renal function may be found in the summaries of the product characteristics (SPC) from the pharmaceutical companies. The recommendations may be based on different methods to estimate the GFR. It is difficult to find recommendations on dosing of drugs for patients with renal failure in existing registers of medical products [16].

Websites and mobile applications with the possibility to calculate the eGFR by entering clinical data are available. But despite implementation of electronic prescribing and automated reporting of eGFR, patients with renal insufficiency may still be exposed to inappropriate drug use [17]. Often prescribing physicians do not consider the renal function of the patients, rely on their clinical experience, consult FASS (the Swedish Physicians' Desk Reference) or occasionally take advice from a consultant physician with specific knowledge in the field or from a clinical pharmacologist. Automated CDSS for kidney related drug prescribing has previously shown promise in reducing medication errors and improving the frequency of appropriate dosing in hospital care [18,19] and can reduce the occurrence of preventable adverse drug effects related to the renal function [20]. Successful CDSS frequently use automated data entry and real time feedback [21].

While most of the CDSS in the literature covers hospital care, the patient population vulnerable to adverse drug effects receives care in a combination of primary and secondary care settings with drug prescriptions occurring mainly in primary care in Sweden. Systematic reviews of CDSS for kidney-related drug prescribing show that there are few systems that can provide real time recommendations for drug dose according to the renal function at the time of drug order entry and used in outpatient settings [18]. The Stockholm County Council (SLL) in 2010 decided to offer prescribers a CDSS for dose recommendations of drugs in patients with renal impairment as a step to increase the quality of drug prescription. For this purpose, Renbase®, a comprehensive knowledgebase with evidence based dosing recommendations is fully integrated into an already existing CDSS (the Janus toolbar) [22,23]. The CDSS is integrated in six different EHR systems and is developed by the SLL and has been in use since 2001.

The aim of this project is to introduce a CDSS in the Janus toolbar with evidence based recommendations on drugs and renal function that would cover the majority of the substances used in drugs on the Swedish market. The system would thus be accessible in both hospitals and outpatient settings and give automated real-time feedback based on the prescribed drugs and a calculated eGFR right at the time of drug order entry.

2. Material and methods

2.1. Renbase® – a comprehensive knowledgebase on drugs and renal function

Renbase® (Medbase Ltd in Finland) contains, based on a systematic review, a brief summary of scientific publications related to the dosage of a particular drug at different degrees of renal failure. It contains not only the official pharmaceutical information from the manufacturers but also published clinical data. The recommendations are based on research reports published in the Medline database and in American, Australian and European summaries of product Characteristics. All texts are produced and approved by specialists in clinical pharmacology [24]. The information is available as a XML file which contains substance names with a substance id. For each substance there is a recommendation for each of four categories of renal function: mild (eGFR