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Analyzing Hospital Readmissions Using Creatinine Results for Patients with Many Visits

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Abstract

Analyzing who is likely to be readmitted and understanding some key factors contributing to preventable readmissions in hospitals is being widely researched, but few studies have examined the role of clinical disease markers in predicting frequent readmissions related to disease progression. In this study, we explore 7-day readmission risk prediction using data on patients' creatinine levels, a key laboratory marker of serious illness, as a potential predictor of future readmission for patients with a large number of repeat hospital visits. Using Electronic Health Record data on 5,103 patients, we explore prediction of readmission using a multivariate logistic regression model. Preliminary results suggest three significant components impacting the readmission occurrence: age, gender and creatinine levels. Further research will incorporate other disease markers using data mining methods, combined with time-invariant and time-varying covariates, to identify more insightful set of longitudinal factors for readmission risk reduction.

Keywords: Hospital readmissions; Clinical disease markers; Creatinine levels

1. Introduction

The problem of hospital readmission, wherein some patients return shortly after they are discharged and are readmitted for the same or related condition, has become a challenge worldwide from both care quality and financial perspectives[1]. Predicting who is likely to be readmitted and understanding the factors contributing to preventable

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readmissions is a critical problem that is being widely investigated[2]. This study proposes an approach for assessing the potential factors leading to readmission instances. In particular, based on a clinical marker which is a routinely collected laboratory test result, we seek to understand how readmission risk may progress over many separate hospital admissions. These insights may help physicians and hospital management to develop early interventions to identify and treat patients at high risk of readmissions.

2. Background

In Israel, an advanced information technology enabled healthcare delivery system and universal coverage have led to readmission rates being relatively stable in the last decade[3]. In 2011, out of approximately 130,000 hospitalizations, about 19,000 patients (an estimated 14%) were readmitted within 7 days. Factors influencing readmission were identified as age, gender (men had 1.13 higher likelihood of readmission) and length of stay of 5 to 7 days during the initial admission (chances of readmission increased by 1.28)[3]. Israel's ministry of health has deployed an incentive program for health maintenance organizations (HMOs) implementing initiatives to reduce readmissions, including extensive use of health information technology. To facilitate readmission reduction, physicians send the patient's medical records through a Health Information Exchange (HIE) to the relevant clinicians in the community. Past findings have shown that electronic health record (EHR) use reduces readmissions after seven days[4,5]. Policy implications and concrete steps to prevent readmissions are also starting to emerge. However, despite these efforts, readmission rates remain unacceptably high[6].

Models of patient level factors such as medical comorbidities, basic demographic data, and clinical variables are much better able to predict mortality than readmission risk[7-9]. Broader social, environmental, and medical factors such as access to care, social support, substance abuse, and functional status contribute to readmission risk in some models, but the utility of such factors has not been widely studied[10]. A recent study has found that health IT usage, patient demographics, visit characteristics, payer type, and hospital characteristics, are all significantly associated with patient readmission risk in the context of Congestive Heart Failure (CHF)[2]. However, with healthcare organizations operating under constrained resources, there is increasing interest in identifying patients at the highest risk of costly complications and readmissions using routinely collected laboratory data[11,12]. In this study, we investigate the role of patients' creatinine level, routinely obtained via a blood test for most emergency and hospitalized patients, in tracking and identifying patients at high risk of readmission. In contrast to our prior work using longitudinal data[13], we apply logistic regression to predict readmission risk and elicit risk factors relevant for addressing this challenge.

The level of serum creatinine in the blood is a key indicator of kidney function, which is tested almost every time a patient has a hospital stay. Increased creatinine levels in the blood point to possible diseases or conditions that affect kidney function and frequently lead to hospitalizations. Multiple studies have shown that creatinine level is an important indicator for tracking readmission risk in patients with heart disease[14-16]. In this study, we use creatinine results (retrieved from the EHR) for each patient who had between seven and twelve hospitalizations during the study period of four years, which provided sufficient data from a sizeable population to extract preliminary insights.

3. Methods

This study is based on data from the largest HMO in the State of Israel, listed as one of the world's largest non-governmental HMOs. The data includes patients' demographics, medications, adverse reactions, sensitivities, lab and imaging results, past diagnoses, and healthcare procedures.

We extracted data from the EHR systems of several Emergency Departments (ED) across Israel. In this preliminary study, in order to test our hypothesis that laboratory results such as creatinine values can be useful in monitoring patients who are at higher risk of readmissions, we selected 5,103 patients who experienced hospital admissions for varied conditions and at least one readmission episode. We targeted creatinine levels from their laboratory results for analysis of potential progression in the severity of the patient's health condition over time and many visits that may indicate increased likelihood of readmission. We explore risk stratification and prediction using multivariate logistic regression modelling and analysis.