Chronic Kidney Disease Helper

I. Introduction

Chronic Kidney Disease (CKD), a condition characterized by a gradual loss of kidney function over time, is one of the silent killers of this century, next to cancer. According to 2019 annual report by USRDS [13], "the prevalence of recognized CKD has steadily risen each year, accompanied by a comparable increase in the percentage of patients with a stage-specific CKD diagnosis code." In particular, the proportion of Medicare patients in the United States with CKD has risen from 13.8% in 2016 to 14.5% in 2017. On December 31, 2017, there were 746,557 prevalent cases of *End Stage Renal Disease* (ESRD) in the United States; this represents an increase of 2.6% since 2016, and of 91.1% since 2000 [13]. In its latest news on March 04, 2020 [9], the National Kidney Foundation in the United States mentioned that one in three Americans (or 33%) are at risk of developing life-threatening kidney disease. More than 10% of world population is impacted by CKD; for example, CKD prevalence in Saudi Arabia and Belgium is estimated to be 24%; in UK and Singapore, it is estimated to be 16% [1].

Life expectancy of CKD and ESRD patients is short; for example, those aged between 70 to 75 years have a life expectancy of around four years [7]. Nephrologists around the world are keenly interested in finding ways to improve life span of CKD and ESRD patients. The research on finding survival factors for CKD patients started as early as 1992 [3]; yet, there are not adequate solutions found. Very recently, Robinson and others [11] analyzed the impact of ESRD worldwide and tried to identify the differences in treatments such as renal replacement therapy, modality and hemodialysis.

II. The approach

Since the number of factors affecting CKD and ESRD are too many, and the data collected through kidney centers is voluminous, it is not easy for medical practitioners to analyze these data manually and find ways to improve life expectancy of CKD and ESRD patients. Recently, with the advancements in artificial intelligence and machine learning, some researchers are attempting to use computerized solutions to analyze past data of patients and to find patterns or evidences for root causes of CKD and ESRD. As an example, Basar and Akan [2] described a data analytic solution to predict whether a patient has CKD, while Saha and others used machine learning techniques for the same problem [12]. A lot of work has been done in predicting mortality of CKD patients who undergo hemodialysis (an external process by which waste, salt and extra water are removed from the body, thus supplementing the regular function of a kidney) [4]–[6], [10]. These researchers believe that prediction of mortality is an important first step in finding solutions to improve the life expectancy of hemodialysis patients. However, the findings are too far from actual solutions mainly because of the number of factors contributing to life expectancy of these patients.

Kidney centers around the world, including the National Kidney Foundation (NKF) in the United States, are supporting research on identifying, diagnosing, and treating CKD and ESRD patients. In addition, they also would like to make potential patients aware of kidney problems through a number of channels such as posting news and blogs on their websites, supporting annual meetings and workshops for the researchers, and publishing their findings through conferences and journals.

Our current research work focuses on developing an online guidance tool called *CKD Helper* that can be used by healthcare practitioners. Though kidney diseases are generally treated by nephrologists, earlier diagnosis and preliminary treatment by other healthcare practitioners can prevent serious consequences at later stages and also can prolong life expectancy of CKD patients. In addition, the use of this tool can also reduce healthcare costs which is a significant expense for many people, especially for elderly and CKD patients. Our approach is to identify the various risk factors that influence CKD such as anemia, mineral bone disease, nutrition, renal replacement therapy option, AV access, proteinuria and acidosis, and provide guidelines for identification, diagnosis and preliminary treatment in each category. We would like to implement the guidelines for these from the publications of National Kidney Foundation [8]. The online tool will be very handy to use compared to the paper copies and other references. Currently, the shortage of nephrologists in the United States and poor access time to medical facilities lead to delayed treatment of many CKD patients. CKD helper is intended to help primary care providers to manage CKD based on national guidelines until these patients are seen by a nephrologist. Our aim is to build the tool with user-friendly interface so that it will serve several groups of healthcare practitioners such as physicians, physician assistants and registered nurses. Moreover, selection of categories and flow of information would be made easier for each group to find the relevant information quickly and easily. In addition, we would also like to provide an interface mechanism through which the tool can be linked to an existing medical database and thus can also be used as a monitoring tool for patients who need to be continually monitored through several months or years. We understand that when we link to any medical database, it involves a lot of work on ensuring security and privacy of healthcare information and we also need to implement HIPAA standards, at least for the work in the United States.

To this date, we just developed a small prototype that

implemented some of the guidelines for diagnosis of anemia and mineral bone disease. The feedback we received from a group of nephrologists motivated us to continue working on this tool implementing more features. Because of the number of categories and subcategories in the guidelines, and the number of healthcare factors (clinical parameters, comorbidities, survey analysis and so on) involved in this application, we would like to make use of data analytic techniques in building our tool. Moreover, as the research in kidney diseases advances, we would be obligated to incorporate more features into our tool from time to time. So, we are also planning to include machine learning techniques in our implementation.

We claim that CKD helper will not only provide guidelines for healthcare practitioners, but it can also be used as an awareness tool because early identification of symptoms and diagnosis of kidney diseases can also prevent a patient having CKD at a later time. In addition, we also claim that this work involve interdisciplinary collaborations between computer scientists and medical practitioners.

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