Chapter 20
A Mobile Assistant to Aid Early Detection of Chronic Kidney Disease

Álvaro Alvares de Carvalho César Sobrinho
Federal University of Alagoas, Brazil

Leandro Dias da Silva
Federal University of Alagoas, Brazil

Leonardo Melo de Medeiros
Federal Institute of Alagoas, Brazil & Federal University of Campina Grande, Brazil

Maria Eliete Pinheiro
Federal University of Alagoas, Brazil

ABSTRACT

Early diagnosis and slowing the progression of chronic diseases are very important factors for improving the quality of life of people with this type of problem. Chronic Kidney Disease (CKD) is one of these diseases; however, with aggravating factors it can be the consequence of other chronic diseases of high incidence, such as Diabetes Mellitus (DM) and Hypertension. The use of Information and Communication Technologies may be a way to help the doctor provides a diagnosis in less advanced stages of CKD. In this context, a mobile assistant to aid the early diagnosis of CKD through a wireless communication and Coloured Petri Nets (CPNs) models is proposed.

INTRODUCTION

The use of technologies to health care has been much researched in the last years. These technologies include several types of devices embedded in the environment, or personal devices such as cell phones, tablets and Personal Digital Assistant (PDA), used by health professionals or patients to provide mobile health care.

Health care applications can be used by health professionals to assist the monitoring of patients in the hospital, in the constant checking and analysis...
of vital signs in order to avoid a risk situation. On the other hand, patients can benefit from the personal management of a disease, improving the understanding of their clinical condition, and in the prevention of health complications. Other possibilities are the remote monitoring of people who have mobility problems; social inclusion of elderly or patients with chronic diseases (e.g. Chronic Kidney Disease [CKD]); and to enable the realization of daily activities, providing better quality of life.

CKD is defined as permanent kidney damage, and it is a world health problem with a high incidence (Sarafidis, Li, Chen, Collins, Brown, Klag & Bakris, 2008; Batista, Pinheiro, Fuchs, Oliveira, Belchior, Galil & Andrade, 2005). The CKD results in reduced kidney function and the decline of the Glomerular Filtration Rate (GFR) (Conditions, 2008). It is associated with Diabetes Mellitus (DM) and Hypertension, which are risk factors for the development and progression of the CKD (Association, 2012; NIHCE, 2011).

Despite the high incidence of CKD, most people begin their treatment in the advanced stages, where it is necessary to perform dialysis and kidney transplantation, which increases the rates of mortality and morbidity1. Furthermore, it may also increase public health costs. The diagnosis of CKD in less advanced stages enables the reduction of these problems, and consequently improves the quality of life of patients. The use of a software system to monitor some specific patient’s biomarkers may be an approach to assist and facilitate the diagnosis of CKD.

Many recent studies have demonstrated the potential of using technologies to aid the health care. In (Pang & Chen, 2009) a solution for non-compliance in taking medications is proposed. In (Kulkarni & Ozturk, 2011) a software system for monitoring patients via wireless sensors and health alerts is presented. And the work (Nardini, Omicini, Viroli & Schumacher, 2011) proposes a middleware for coordinating services and security with runtime adaptation and its application in health care by the coordination of Electronic Health Record (EHR).

These and other related efforts to aid the health care have demonstrated the need for constant monitoring and management of clinical information. The realization of a monitoring provides a better understanding of the patients about their health status and fast access to the care.

In this context, an application with the focus on the patient could be used to monitor the risk factors to CKD development, and also to record the results of some specific patients’ biomarkers for early detection of CKD. Using this information, the application would be able to analyze a possible abnormality. This approach may accelerate and simplify the medical diagnosis.

The National Kidney Foundation (NKF) published in 2002 the important and widely accepted guideline Kidney Disease Outcome Quality Initiative (KDOQI) that presented the classification, evaluation and stratification of CKD (Foundation, 2002). Based on KDOQI and other recent medical publications, for example the National Institute for Health and Clinical Excellence (NICE) clinical guideline 73 (Conditions, 2008), the modeling and development of a mobile application to aid the early diagnosis of CKD is proposed in this work.

A formal language with a graphical representation is used to model the mobile application. The Coloured Petri Nets (CPNs) formalism and the CPN/Tools (Jensen, Kristensen, Michael & Lisa, 2007; Jorgensen, Lassen & van der Aalst, 2007) are used to edit graphical models, to simulate its behavior, and to develop an unambiguous documentation. The use of a formal and executable model is important to validate the application, as it is a critical one, and can also be used as a training tool for health professionals. The application, named MultCare, exchange information with CPNs thought a wireless communication using a socket implementation.

In the Section 2, the background is presented for the main theories about CKD, Hypertension, DM, the patient-centered application, and the
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