Implementation of a Prototype Glomerular Filtration Rate Application To Monitor Creatinine Kinetic Dynamics in Critically Ill Patients

Fatimah Dzaharudin
Faculty of Mechanical Engineering
Universiti Malaysia Pahang
Pekan, 26600
Email: fatimahd@ump.edu.my

Azrina Md Ralib
and Mohd Basri Mat Nor
Kulliyyah of Medicine
International Islamic University Malaysia
Telephone: (+609) 570 4000
Fax: (+609)-571 6770

Ummu Kulthum Jamaluddin
Faculty of Mechanical Engineering
Universiti Malaysia Pahang
Pekan, 26600
Email: ummu85@ump.edu.my

***Abstract*—It has always been desirable for clinicians to ascertain whether glomerular filtration rate has recovered or still depressed at the bedside as increase in serum creatinine often indicates acute kidney injury to a clinician. In recent years, several clinical studies have developed mathematical models to simulate the creatinine response to changes in glomerular filtration rate which includes the estimated glomerular filtration rate Chronic Kidney Disease Epidemiology Collaboration, the Chen-kinetic estimated GFR model and the modified Chen-Pianta-Endre-Pickering-Bukley-Pecke kinetic estimated GFR model. Another study also showed that the ratio of creatinine excretion rates to creatinine production rates may predict changes in plasma concentration. The aim of this study is to allow clinicians to gauge the performance of glomerular filtration rate estimation using the aforementioned equations and models to predict worsening of renal function, indicated by a low kinetic estimated glomerular filtration rate or creatinine production rates less than unity, or recovery of kidney function, indicated by high kinetic estimated glomerular filtration rate. In order to achieve this a mobile software is developed to aid data collection and calculation for the clinical study based on the aforementioned models. This paper summarises the implementation details of the native application development and presents the graphical user interface of the system in practice.**

I. Introduction

Glomerular filtration rate (GFR) estimation is important in assessing kidney function as it is an indication of either renal recovery or acute kidney injury (AKI) and often gauged by measuring the changes in serum creatinine [1], [2]. It has always been desirable for clinicians to ascertain whether GFR has recovered or still depressed at the bedside (i.e. at the time of measurement). However, in practice, GFR cannot be measured easily and instead estimated from equations using age, race, sex and serum creatinine [3].

Among the models that may estimate GFR are the GFR Chronic Kidney Disease Epidemiology Collaboration (eGFR CKD-EPI) [3]–[5] and the kinetic estimated GFR (keGFR) [2], [6]. The eGFR (CKD-EPI) has been widely used for estimating kidney function when the plasma creatinine is stable. However, studies have shown that when plasma creatinine changes rapidly, the eGFR model no longer provides a good estimation [2]. This is the condition in which the kinetic eGFR (keGFR) model supersedes the eGFR model whereby it enhances the fundamental clearance equation by allowing for the analysis of kidney function in acute settings.

Since estimation of GFR is important, it is no coincidence that there are several GFR mobile applications currently available; one GFR application on the iOS platform, by the name of eGFR Calculators by National Kidney Foundation and two on the android platform, by the name of eGFR Calculators and eGFR Calculator by National Kidney Foundation and Oguz Gelal. These mobile applications purely calculate the estimated GFR output and does not store any data. Hence, the user is neither able to retrieve previous calculations of estimated GFR values nor save patient readings necessary to obtain the eGFR output.

The application developed in this study enables storage of patient data such as patient information and consecutive creatinine readings which provides a systematic and accurate data collection method paramount for more accurate estimation of GFR from the models. This is an important step since the current system in Malaysian hospitals rely heavily on manual hard copy input of patient data [8]. The difficulty is compounded by the fact that the data set for the patient readings are large, complex and time dependent. Human error in transferring the data from the patient report as digital inputs to the equations may affect the accuracy of the model.

Furthermore, the application that has been developed here allows for storage of all the calculated eGFR values computed based on several eGFR equations. This allows for more efficient monitoring of GFR, enables comparison between different GFR models in the Malaysian cohort and leave open the possibility to develop a more accurate eGFR model more suitable for local patients. This is indeed important since eGFR models are developed based on patient data from the United States whereas studies have shown that ethnicity, diet and demographics to be factors affecting serum creatinine concentration [7].

In this application, three mathematical models aimed to