

CHRONIC KIDNEY FAILURE DATA MANAGEMENT SYSTEM WITH  
AUTOMATIC CLASSIFICATION

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requirement for the award of degree of  
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Lovingly dedicated to  
my parents, Murugiah Raman and Magespary Allimuthoo  
and to my sibings and friends.

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## ABSTRACT

Chronic kidney failure (CKF) is an irreversible loss of renal function for at least three months. The number of population with CKF and end-stage renal disease (ESRD) is increasing worldwide, places an enormous human, economic and social burden on the healthcare system. Targeted screening and early intervention are necessary to reduce the burden of the disease. Currently, most of the government hospitals and clinics are still using paper based record for CKF stage classification data management. This current system may cause severe problems such as difficulties to understand handwriting (laboratory test), longer data transfer time from laboratory to clinician office and paper based estimate Glomerular Filtration Rate (eGFR) calculation to determine CKF stage which may lead to many medical error or misdiagnosis. This project develops a user friendly electronic data management system which can store electronic health record and able to perform automatic eGFR value calculation based on Modification Diet of Renal Disease (MDRD) equation which authorized by MoH Malaysia for CKF stage classification. This system will assists health professional to store patient's information such as personal details, physical appearance, medical history, laboratory test results efficiently and assist clinician to classify the stage of CKF of patient by automatic calculation of eGFR value. This system is developed using MySQL and Microsoft Visual Studio C#. Based on comparison with other related system, this proposed system offer better features in term of data management and data storage of patient details, laboratory test results and clinician decision details electronically. At the same time, it can compute semi-automated classification of CKF stage 1,2,3,4 and 5 with the help of clinician.

## ABSTRAK

Kegagalan buah pinggang kronik adalah kegagalan buah pinggang berfungsi dengan baik dan ia tidak boleh dipulihkan. Bilangan penduduk dengan kegagalan buah pinggang kronik dan penyakit buah pinggang peringkat akhir semakin meningkat di seluruh dunia dan menyebabkan besar beban ekonomi dan sosial ke atas institusi kesihatan. Pemeriksaan dan intervensi awal perlu dibuat untuk mengurangkan beban penyakit itu. Pada masa sekarang, kebanyakan hospital dan klinik kerajaan masih menggunakan sistem rekod berasaskan kertas untuk pengurusan klasifikasi peringkat CKF. Sistem semasa boleh menyebabkan beberapa masalah seperti kesukaran untuk memahami tulisan (keputusan ujian makmal), masa yang lebih lama diperlukan untuk memindahkan suatu data dari makmal ke pejabat doktor dan pengiraan anggaran kadar penapisan glomerular (eGFR) untuk menentukan peringkat CKF yang berasaskan kertas boleh menyebabkan banyak kesilapan perubatan atau misdiagnosis. Projek ini telah membangunkan sistem pengurusan data elektronik mesra pengguna yang boleh menyimpan rekod kesihatan dalam bentuk elektronik dan melaksanakan pengiraan automatik nilai eGFR berasaskan persamaan MRDR yang diistiharkan oleh Kementerian Kesihatan Malaysia untuk mengklasifikasi peringkat CKF. Sistem ini dapat membantu profesional kesihatan untuk menyimpan maklumat pesakit seperti butiran peribadi, ciri fizikal, sejarah perubatan pesakit, keputusan ujian makmal dengan cekap dan membantu pegawai perubatan untuk mengklasifikasikan peringkat CKF pesakit dengan pengiraan secara automatik nilai eGFR. Sistem ini dibangunkan dengan menggunakan MySQL dan Microsoft Visual Studio C#. Sistem ini dapat mengurus rekod secara elektronik dan dapat melakukan pengiraan semi-automatik nilai eGFR.

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**LIST OF ABBREVIATION**

CKF	-	Chronic Kidney Failure
CKD	-	Chronic Kidney Disease
GFR	-	Glomerular Filtration Rate
eGFR	-	estimated Glomerular Filtration Rate
MoH	-	Ministry of Health
MDRD	-	Modification Diet of Renal Disease
GUI	-	Graphical User Interface
CKD-EPI	-	Chronic Kidney Disease Epidemiology Collaboration
EHR	-	Electronic Health Record
UACR	-	Urine Albumin Creatinine Ratio
UPCR	-	Urine Protein Creatinine Ratio
24- Hr	-	24 Hours
BMI	-	Body Mass Index
IC	-	Identification Card
Add	-	Address
MySQL	-	Microsoft Structured Query Language

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## **CHAPTER 1**

### **INTRODUCTION**

This chapter discuss project background, problem statement, objectives, scope of project and significance of this project.

#### **1.1 Project Background**

Chronic kidney failure (CKF) is an irreversible loss of renal function for at least three months and cause a major public health problem. The number of population with CKF and end-stage renal disease (ESRD) is increasing worldwide. Based on estimation, Asia has prevalence ranged from 12.1% to 17.5% which show an increase of 5.4% [1,2] from 2001 to 2009. In Malaysia, prevalence of patients with ESRD on dialysis treatment had increased from 88 325 per million population (pmp) in 2001 to 170 762 pmp in 2009 [1,2]. The increase in ESRD and CKF was largely driven by the increasing incidence of diabetic kidney disease (DKD) accounting for 58% of new patients receiving dialysis treatment.

The growing number of ESRD and CKF places an enormous human, economic and social burden on the healthcare system. Based on economic evaluation among Ministry of Health (MoH) dialysis centers in Malaysia, the cost of dialysis and erythropoietin was RM2,500 per month per person. In the United State of America, the cost of medical care was 1.7 times higher in patients with Chronic Kidney Disease (CKD) stage 3 and 2.6 times higher in those with stage 4 CKD compared with controls. Early kidney disease is asymptomatic disease [1,2]. This cause patients often present late with complications of CKD. Targeted screening and early intervention are necessary to reduce the burden of the disease.

In the current Clinical Practice Guideline [1] by MoH Malaysia, laboratory tests for detection and staging of CKD include estimated Glomerular Filtration Rate (eGFR) value based on the Modification Diet of Renal Disease (MDRD) equation. Serum creatinine laboratory test result should be used in combination with eGFR value in the assessment of renal function. Previously, serum creatinine value has been used in clinical practice to estimate renal functionality stage. However, it is affected by many other variables such as age, gender, ethnicity, muscle mass and protein meal hence should not be used as an independent marker of kidney function. Furthermore, serum creatinine is not a sensitive marker of early CKD as it will rise only after a reduction of renal function by at least 50%. Due to this limitation, MDRD equation was develop to estimate renal function [1,2].

MoH Malaysia and National Pathology Service implemented the standardized eGFR request form based on clinician request as attached in Appendix A [1,2]. This form require the information of Patient details, serum creatinine ( $\mu\text{mol/L}$ ), Urine Albumin (mg/L), Urine Creatinine (mmol/L), Urine Protein (mg/L) and Urine Volume (L/24 Hr), eGFR value and table of CKF stage classification based on eGFR value. Due to current implementation is paper-based health record, it may cause several severe problems such as difficulties to understand hospital personal handwriting, longer data transfer time among inter department, and the patient records are hard to store and sort out.



Due to today's advancement of technology, works should be done in more effective and efficient way with the help of technology. This paper based system should convert to electronic health record system [3]. With assistance of electronic health record will help to facilitate the patient clinical information retrieval and processing from different department and personal more effectively and efficiently. Automatic patient information transfer between different departments could also be speed up and reduce duplicate testing [4].

## **1.2 Problem Statement**

Currently, most of the government hospitals and clinics in Malaysia are still using paper based record for CKF stage classification data management. As laboratory test play important role in detection of chronic kidney failure, hence clinician's decision mostly depends on patient's laboratory test results. In current system, laboratory medical assistant will carry out laboratory test on patient, then key in all the laboratory results in a paper form. This paper form will then be handover to clinician to make decision.

The current implementation suffer from many weakness. For example, patient's laboratory test result require longer time to transfer from laboratory to clinician desk. In general, the laboratory officers will only deliver patient's laboratory test result if a certain number of patient is achieved at a time instead of deliver each patient's laboratory test result one by one to reduce travelling time. Besides that, difficulties to understand hospital personal handwriting also emerge as the main problem of existing paper-based system. In paper-based system, handwriting play an important role on delivering correct information. Poor handwriting by hospital personal can lead to wrong information delivery and medical error. For example, if clinician could not understand laboratory medical assistant's

poor handwriting on laboratory test results, the clinician will encounter problems to classify the CKF stage of the patient accurately.

Furthermore, patient health records are difficult to store, retrieve and manage. With paper-based system, larger physical space is required to store patient health records.

### **1.3 Objective**

Based on the problem statement, this project derives two objective as stated below:

- 1) To develop an electronic health care system for structured CKF data management, based on MoH standard form with user friendly graphical user interface (GUI).
- 2) To integrate a semi-automatic eGFR value calculation into the proposed electronic health care system for CKF stage classification.

### **1.4 Scope of Project**

The targeted users of this system are clinician, laboratory medical assistant and administrative staff. The semi-automatic eGFR value calculation that integrated with the proposed electronic health care system of CKF stage classification, based on Modification Diet of Renal Disease (MDRD) equation which authorized by MoH

Malaysia [1,2]. Since MDRD equation will be used to classify the CKF stage, the age of targeted patient is fall within the range of 18 to 70, non-dialysis patients, non-pregnant mothers, patients without skeletal muscle disorders and non-vegetarians.

MySQL and Microsoft Visual Studio C# was used to develop this system. All the data will be stored in the database and MySQL is used to manage the data in database.

### **1.5 Project Significance**

The developed system will assists clinician, laboratory medical assistant and administrative staff to store patient's information such as personal details, physical appearance, medical history, laboratory test results efficiently and assist clinician to classify the stage of CKF of patient by semi-automatic calculation of eGFR value with a user friendly GUI. Problems such as time constraint, difficulties to understand hospital personal handwriting and difficulty to store and retrieve patient details can be overcome by using this proposed system.

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