Diagnosis The Chronic Kidney Disease Based on Serum Creatinine using The Software Tool "Kid -Care"

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ABSTRACT: Organ transplant has increased in the last few years, and preoperative evaluation is a key factor for a favorable outcome. The kidney is one of the organs that are currently most transplanted. So how to prevent the kidney from the kidney diseases is a major issue. The software tool KID-CARE is used to give the status of kidney.

KEYWORDS: Chronic kidney disease, Serum creatinine, Glomerular filtration rate, Alkaline picrate method, Cockcroft –gault formula, Schwartz formula, diets.

I. INTRODUCTION:

According to World Health Organization (WHO) Global Burden of Disease Project, disease of the kidney and urinary tract contribute to approximately 850,000 deaths every year of which Chronic Kidney Disease (CKD) is the 12th leading cause of death and 17th leading cause of disability in the world. The two different formulas used to calculate the glomerular filtration rate for male, female and also children. The Cockcroft- gault formula is used to calculate the GFR for only male and female and the Schwartz formula is used to calculate the GFR for children [1]

CHRONIC KIDNEY DISEASE:

Each kidney is made up of about one million tiny units called nephrons. The kidneys filter about 200 quarts of blood each day. They remove about two quarts of waste products and excess fluid in the form of urine. The urine flows through two tubes, called ureters, to the bladder and each kidney has the weight is 150 gram. Chronic kidney disease (CKD), also known as chronic renal disease, is a progressive loss in renal function over a period of months or years. Chronic kidney disease is diagnosed as a result of screening of people known to be at risk of kidney problems, such as those with high blood pressure or diabetes and those with a blood relative with CKD. Chronic kidney disease is identified by a blood test for creatinine. Higher levels of creatinine indicate a lower glomerular filtration rate and as a result a decreased capability of the kidneys to excrete waste products. To fully investigate the underlying cause of kidney damage, various forms of medical imaging, blood tests, and often renal biopsy (removing a small sample of kidney tissue) are employed to find out if a reversible cause for the kidney malfunction is present[2].

II. SERUM CREATININE TEST:

Serum is the fluid part of blood, without the clotting factors or blood cells. **Serum** is the undiluted, extracellular portion of blood after adequate coagulation is complete [3].

Creatinineis the metabolic waste product resulting from the breakdown of creatine. Creatineis a naturally occurring nitrogenous organic acid that helps to supply energy to musclecells. . About 2% of creatine is converted to creatinine each day. A creatinine level of greater than 1.2 for women and greater than 1.4 for men may be an early sign that the kidneys are not working properly. The level of creatinine in the blood rises, if kidney disease progresses[4]

The Creatinine test is basically done to determine whether the kidneys are working properly or not. Measuring serum creatinine is a simple test, and it is the most commonly used indicator of renal function. A better estimation of kidney function is given by calculating the estimated glomerular filtration rate (GFR). Blood creatinine levels may also be used alone to calculate the estimated GFR (GFR) [5]

Each day, 1-2% of muscle creatine is converted to creatinine. Men tend to have higher levels of creatinine than women because, in general, they have a greater mass of skeletal muscle. Increased dietary intake of creatine or eating a lot of protein (like meat) can increase daily creatinine excretion. A rise in blood creatinine level is observed only with marked damage to functioning nephrons. GFR can be accurately calculated using serum creatinine concentration [6]

III. GLOMERULAR FILTRATION RATE:

"Glomerulus" is the first part of the microscopic unit in the kidney that filters certain chemicals from the blood, such as urea, and passes them out in the urine. Each glomerulus is like a filter. The structure of the glomerulus allows waste products and some water and salt to pass from the blood into a tiny channel called a tubule [7].

Glomerular filtration rate (**GFR**) is the volume of fluid filtered from the renal (kidney) glomerular capillaries into the Bowman's capsule per unit time. Glomerular filtration rate (GFR) is equal to the Clearance Rate when any solute is freely filtered and is neither reabsorbed nor secreted by the kidneys. The rate therefore measured is the quantity of the substance in

the urine that originated from a calculable volume of blood. Glomerular filtration rate (GFR) is a test used to check how well the kidneys are working. Specifically, it estimates how much blood passes through the glomeruli each minute. Glomeruli are the tiny filters in the kidneys that filter waste from the blood.

Measuring GFR is widely accepted as the best overall index of kidney function. The most common method for assessing GFR in the past was performing a timed urine collection for evaluation of creatinine clearance. However, this test was inconvenient and frequently inaccurate as a result of improper collection and overestimation of GFR due to kidney tubular secretion of creatinine [8]

IV. STAGES IN CKD:

There are five stages of CKD based on GFR:

- Stage 1: GFR is 90 or higher. There may be slight kidney damage.
- Stage 2: GFR is 60-90. There is a mild decrease in kidney function.
- Stage 3: GFR is 30-60. There is a Moderate decrease in kidney function.
- Stage 4: GFR is 15-30. There is severe decrease in kidney function.
- Stage 5: GFR is l5 or less. This is considered kidney disease. Treatment is necessary to sustain life [9]

MATERIALS AND METHODS:

In this thesis, 10 male, female and child patient are included. The GFR is calculated based on serum creatinine. The serum creatinine is calculated from his/her blood using the alkaline picrate method.

V. SAMPLE DATA FOR FEMALE PATIENTS:

patient id	age	weight	serum creatinine
P001	41	55	0.6
P002	50	75	2.2
P003	24	45	1.9
P004	39	88	1.7
P005	56	79	1.8
P006	30	58	2.2
P007	19	40	0.8
P008	56	55	3.0
P009	28	70	2.2
P0010	46	78	0.9

MALE PATIENTS:

patient id	age	weight	serum creatinine
P0011	20	56	0.8
P0012	41	55	2.2
P0013	50	75	1.9
P0014	24	45	1.7
P0015	39	88	1.8
P0016	56	79	3.2
P0017	30	58	0.8
P0018	20	40	2
P0019	46	78	2.2
P0020	34	67	0.9

VI. CHILD PATIENTS:

patient id	Age	height (cm)	serum creatinine
P0021	12mth	22	0.4
P0022	2Years	33	0.5
P0023	5 Years	36	0.6
P0024	7 Years	52	0.8
P0025	4 Years	40	0.7
P0026	9 Years	52	0.5
P0027	11Years	53	0.9
P0028	15Years	70	0.10
P0029	13Years	65	0.4
P0030	10Years	47	0.5

VII. ALKALINE PICRATE METHOD:

The method is still in use 125 years following the discovery of the principle, which is a fact unparalleled in clinical chemistry. Despite the advent of the enzymatic creatinine analysis, the Jaffe method is still popular due to its simplicity and low cost.

PRINCIPLE:

Creatinine reacts with picric acid in alkaline medium forming a yellow orange color complex which is measured at 492nm.Picric acid in an alkaline medium reacts with creatinine to form an orange coloured complex with the alkaline picrate. Intensity of the colour formed during the fixed time is directly proportional to the amount of creatinine present in the sample.

Creatinine + Alkaline Picrate Orange Coloured Complex [10]

CALCULATIONS

$$\text{Creatinine in mg/dl} = \frac{\Delta AT}{\Delta AS} \times 2.0$$

AT =change in the absorbance of sample
AS =change in the absorbance of standard
Some years ago, and the laboratory technicians, use the manual calculation for serum creatinine calculation using the alkaline picrate method. But now a day the serum test tube placed in bio- chemistry analyzer, few seconds easily calculate the serum creatinine.

COCKCROFT-GAULT FORMULA:

To circumvent these limitations, several equations have been developed to estimate GFR from the serum creatinine concentration adjusted for age, sex, body weight and demographic factors .The equation proposed by Cockcroft and Gault in 1976 is widely used throughout the world .Adjustment for body surface area has been shown to improve the accuracy of the original Cockcroft-Gault equation [11]

Cockcroft–Gault formula

$$GFR = \frac{(140 - Age) \times Mass}{72 \times Serum\ creatinine}$$

(If patient is female multiply 0.85)
For patients who were underweight, Cockcroft-Gault had the greatest accuracy (80.0%). The use of formulas to estimate kidney function is implemented more frequently in clinical practice. The most frequently used formulas are the Cockcroft-Gault and the Cockcroft-Gault equation estimates clearance of creatinine

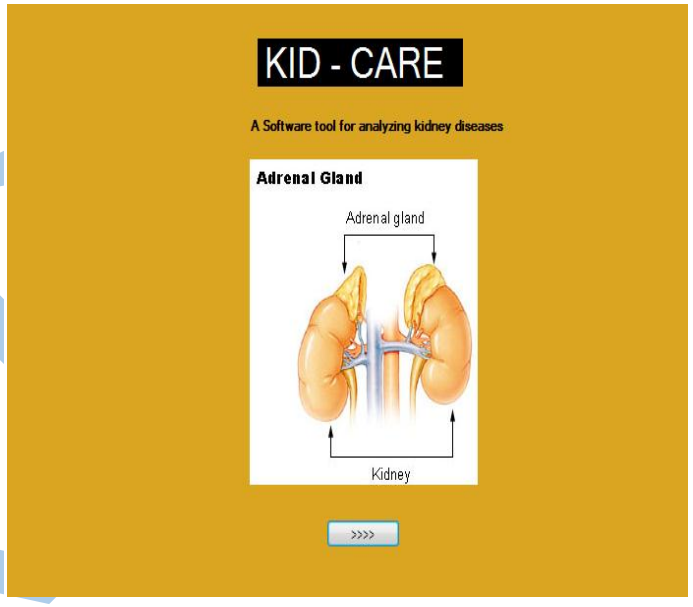
SCHWARTZ FORMULA:

The most commonly used equation for calculating GFR in children is the Schwartz equation (GFR-Schwartz), which is calculated from serum creatinine concentration, height, and an empirical constant, *k*, that adjusts for muscle mass and the creatinine measurement method. Estimate GFR in children independent of height. Because a height-independent GFR can be easily calculated by laboratory reporting software, use of these alternative equations may significantly improve pediatric care and facilitate screening for chronic kidney disease (CKD) in children[12]

$GFR(mL/min/1.73m^2)=k(Height)/Scr$
Scr= serum creatinine
k=constant
k=0.33 in preemie infants
k=0.45 in term infants to 1 year of age
k=0.55 in children to 13 years of age
k=0.70 in adolescent males (not females)because of the presumed increase in male muscle mass,the constant remains 0.55 for females
Height in cm
Serum creatinine in mg/dl

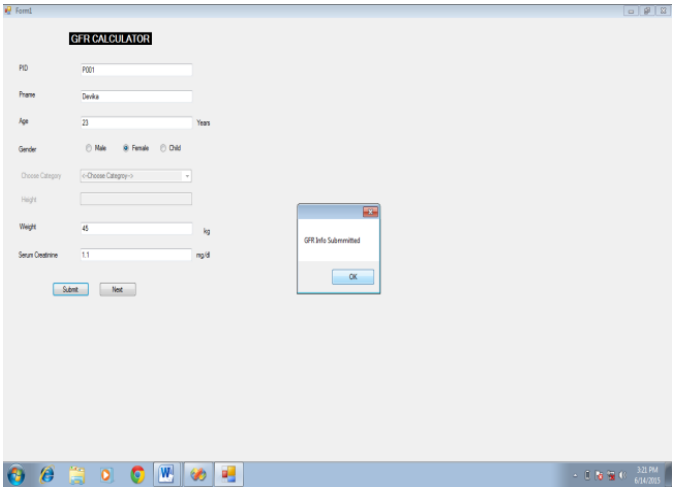
VIII. SOFTWARE TOOL:

The KID-CARE is our developed software tool used to calculate the glomerular filtration rate.The Cockcroft-gault formula used to calculate GFR for male and female.The Schwartz formula used to calculate GFR only for children.



This calculator easily calculates the GFR for which a person needs to know his/her serum creatinine range and also need to know the some inputs like age, weight, height. This calculator is made up of C#.net as front end and SQL server 2005 as backend. The user must have .net framework and SQL server on his /her system.

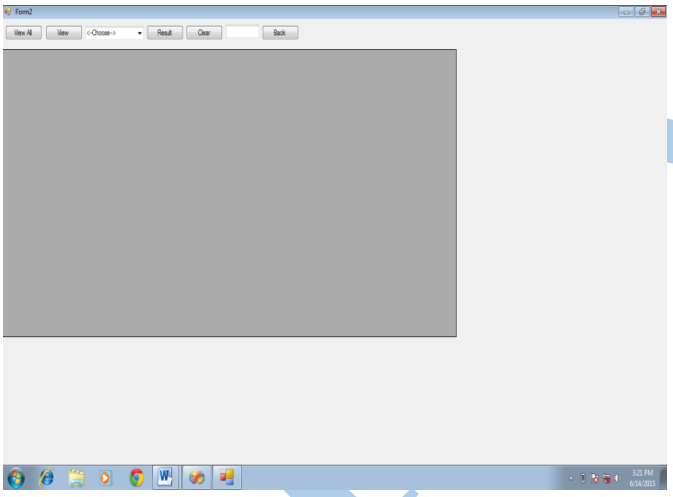
FIRST WINDOW:
This form is the registration form of the patient where the patient needs to enter the inputs for the fields: patient id, patient name, age, gender, weight, serum creatinine and height (applicable for children). These inputs are stored in the database. The height and birth type selection fields are hidden in this form, until the child option is chosen for the gender field.



SECOND WINDOW:

The second form contains various views of patient's details in grid view. The views are:

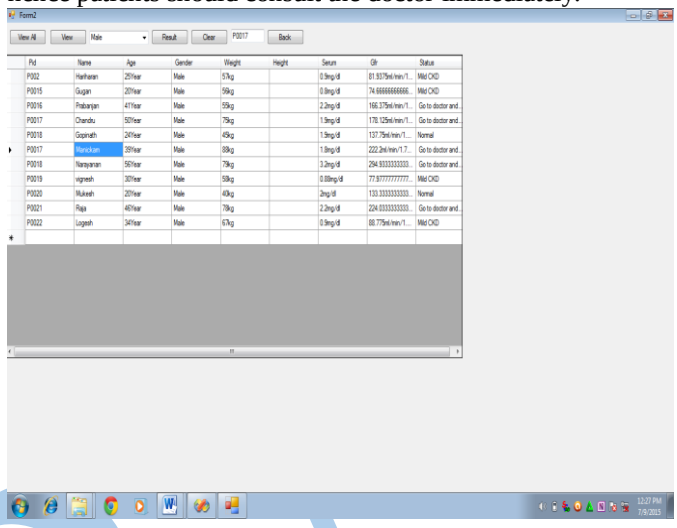
- View all -It will display the detail of all the patients in the database
- View results-It will display the patient's details based on the selection made for gender category.
- Remove Patient detail-The patient record will be deleted from the database



IX. RESULTS AND DISCUSSION:

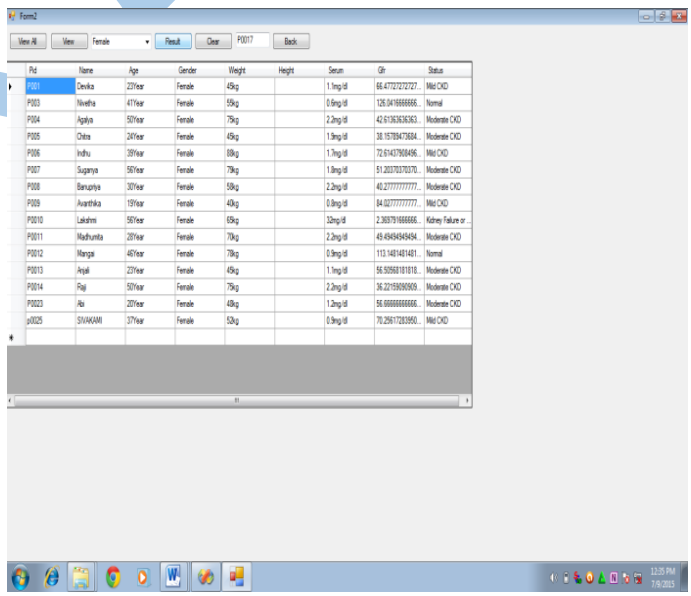
MALE PATIENTS OUTPUT:

The KID-CARE is very useful to calculate the Glomerular filtration rate easily for male, female and children. GFR is calculated for male and female using the Cockcroft- gault formula and for children it is calculated using the Schwartz formula.The database is loaded with 30 patient detail; 10 for each; male, female and children. Two male patients among the 10 have the normal status for kidney function that is GFR is between the range of 90 - 140. Four of them have mild CKD that is the GFR range is between 60 -90. The remaining four patients have the GFR greater than 140 which is severe and hence patients should consult the doctor immediately.



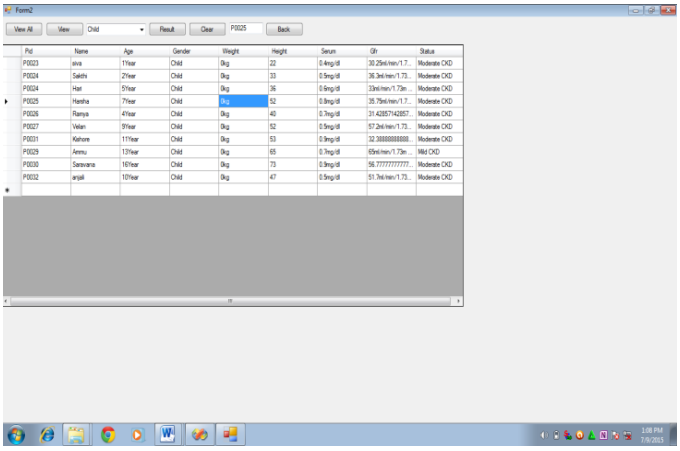
FEMALE PATIENTS OUTPUT:

The same process is followed for female category as well but the formula is slightly different from the formula used for male. The seven patients among the 10 have the moderate CKD that is GFR range is between 30 -60 and two patients have the mild CKD. One patient has severe kidney disease that is called end stage kidney disease. In this case, the GFR range is between 15 – 30.



CHILD PATIENTS OUTPUT:

The schwartz formula is used to calculate GFR for children. The children are also affectedby the kidney diseases these days.10 child patient detail is used for this thesis. More child patients has the moderate CKDthat is the GFR range between 30 -60 and one child patient have the mild CKD means GFR range is between 60-90.



X. CONCLUSION:

Oxidation is a normal process for energy production and many chemical reactions in the body, but excessive oxidation of fats and cholesterol creates molecules known as free radicals that can damage your proteins, cell membranes and genes. Heart disease, cancer, Alzheimer's disease, Parkinson's disease and other chronic and degenerative conditions have been linked to oxidative damage.

Many of the foods that protect against oxidation are included in the kidney diet and make excellent choices for dialysis patients or people with chronic kidney disease (CKD). Eating healthy foods, working with a renal dietitian and following a renal diet made up of kidney-friendly foods is important for people with kidney disease because they experience more inflammation and have a higher risk for cardiovascular disease. According to the International Diabetes Federation, about 285 million people around the world are living with diabetes and estimate that the number will rise to about 440 million people by the year 2030.Diabetes accounts for over 40 percent of the cases of kidney disease. So it's clear that one of the primary ways to prevent kidney disease is to prevent diabetes and also effective treatment can reduce the impact that the condition has on your kidneys. A healthy lifestyle, including physical activity and a heart-healthy diet, can help to normalize blood pressure and also slow kidney disease. Following are few examples of kidney friendly food:

- Red Bell pepper
- Cabbage
- Cauliflower
- Garlic
- Onions
- Apples
- Strawberries
- Cherries
- Fish
- Egg whites
- Olive oil
- Red grapes

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