REVIEW OF LITERATURE
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For the creatinine clearance a lot of work has been done in different categories of patients. Creatinine excretion has a definite relation to a fat free mass (or lean body mass). The lean body mass is considered to be directly propotional to active tissue mass. It provides total body weight for expression of such factors as metabolism, nutritional requirements and drug doses\textsuperscript{24}.

The lean body mass (Kg) is equal to 20.97 + 0.5161 (urinary creatinine excretion mg/hour). Table for easy calculation of lean body mass (LBW) from height and weight is introduced by R. Hume (1966)\textsuperscript{30}.

The relation of creatinine clearance to muscle mass has been earlier studied and summarized in monographs by Hunter, Breard, and Brody\textsuperscript{12,2,3}.

Male have a higher creatinine concentration and a greater excretion than female with same creatinine clearance, 1.73 per square meter, is probably due to male's relatively larger muscular mass\textsuperscript{28}. Negative nitrogen and calcium balance result from immobalization alone\textsuperscript{7} and even greater changes follow skeltal\textsuperscript{11} and spinal cord trauma\textsuperscript{6}. Atrophy of musculature results in persistant changes\textsuperscript{31} in body composition.
Siersback - Nielsen and Co-workers (1971)\textsuperscript{32} purposed the equations and nomogram to predict creatinine clearance.

In 1976 Cockcroft and Gault\textsuperscript{5} suggested a formula to predict creatinine clearance from serum creatinine in male.

\[
\text{Creatinine Clearance} = \frac{(140 - \text{Age(years)} \times \text{weight(kg)})}{72 \times \text{Serum Cr. mg\%}}
\]

In female the creatinine clearance would be 15% less than male.

\textbf{Predicted & Measured creatinine clearance by Cockcroft and Gault}
They compared the predicted creatinine clearance from same equations & nomogram to their measured values. These equations are -

1. Creatinine Clearance = \( \frac{100 - 12 \text{ (ml/min/1.73 mt}^2)}{\text{Scr (mg%) (Jelliffe, 1971)}} \)

2. Creatinine clearance = \( \frac{98-16 \text{ (Age-20)}}{20 \text{ (ml/min/1.73 mt}^2)} \text{ (Scr (mg%) (Jelliffe, 1973)}} \)

3. Creatinine clearance = \( \frac{94.3 \text{ (Scr (mg%)} 1.8 \text{ (ml/min/1.73 mt}^2)}\text{ (Edward & Whyte, 1953)}} \)

The predicted creatinine clearance by equation no. 3 was measured was not presented by Cockcroft & Gault.

Hackler and Associates listed most common causes of decreased renal function in paraplegics as, pyelonephritis, renal amyloidosis, renal calculus disease, non obstructive hydronephrosis and vesicoureteral reflux. The comparative studies have been done in paraplegics with vesicoureteral reflux or without.

In 1979 Wheeler and Scheiner advised that urine method to assess creatinine clearance may actually be preferable to traditional method in the routine setting.

R.W. Jelliffe had shown that bedside estimation of creatinine clearance to calculate the drug doses, was necessary. The equation was compared with a computer programme for estimation of creatinine clearance.
This simple equation also agrees with nomogram
developed by Siersback - Nielsen and Collagues.

A computer assisted programme for Gentamicin &
Kannamycin therapies in normal and reduced renal function
has been given by Jelliffe R.W., Night R, Buell J, Kalaba
R, and Rockwell R17,20.

Biological half life of drug primarily excreted
by the kidney, is prolonged in patients with impaired renal
functions, in some instances alternate pathways of meta-
bolism become increasingly important. These informative
data are shown in tabular form by Bennett et al33.

The toxicity of digitalis in elderly is due to
decreased creatinine production will cause serum creatinine
in normal range despite of decreased glomerular filtration
rate (GFR)10.

In 1974 Kampmann Siersback-Nielsen, Kristensen &
Henson19 reported the variation in creatinine clearance
according to age, sex and weight and creatinine clearance
were evaluated in hospitalized 368 patients with normal
renal function and 106 with abnormal renal function. They
were able to generate a popular nomogram -
"Nomogram for rapid evaluation of endogenous Creatinine clearance"

With a ruler join weight to age, keep ruler at crossing point of line marked R. Then move the right hand side of the ruler to the appropriate serum creatinine value and read the patients clearance from the left side of the nomogram.
Body weight, urinary volume and creatinine excretion increase with age to a maximum level in both male and female. Urinary excretion gradually decreases with age in male (further) and significantly reduce from the maximum level by eight decade. A similar, less well defined pattern occur in female. The creatinine output significantly become higher in male than female.

Previous attempts to predict creatinine clearance in spinal cord injury patients have been reported.

In 1982 Sawyer & Hutchins examined 5 quadriplegics, 9 paraplegics, 2 stroke patients and 2 patients suffering from multiple Sclerosis. The predicted creatinine clearance levels exceeded the true creatinine clearance by 31 percent when actual body mass was used. If lean body mass was used, instead of actual body weight, predicted creatinine clearance exceeded measured levels by 19 percent.

In 1983 Mirhamadi & Associates examined the validity of the Cockcroft & Gault formula to predict creatinine clearance in 36 male quadriplegics and 22 male paraplegics. The predicted exceeded the measured creatinine clearance by 67% in quadriplegics and 26% in paraplegics. Therefore, they applied a correlation factor that would adjust the Cockcroft & Gault predicted creatinine clearance. If the patient was quadriplegic, the Cockcroft & Gault predicted creatinine clearance value was multiplied by 0.6 and if paraplegics, by 0.8.
In 1986 Mohler et al. studied 101 spinal cord injury patients (79 male; 22 female; 43 quadriplegic, 58 paraplegics) found that Kampmann and Associates nomogram was improper to spinal cord injury patients to predict creatinine clearance and they recorded a new equation and nomogram.

### Nomogram for evaluation of creatinine clearance in quadriplegics

With ruler, connect patient weight with interval of injury for appropriate sex. Note point of intersection on R line and keep ruler there (this is pivot point). Turn right end of ruler to appropriate serum creatinine (S.cr)value. Point where ruler intersects scale at left side will indicate clearance in ml. per minute.
Nomogram for evaluation of creatinine clearance in paraplegics. A, with ruler, connect interval of injury to patient age to determine creatinine production. B, once creatinine production is determined, connect creatinine production (CP) for appropriate sex to patient weight. Note point of intersection on R line and keep ruler there. Turn right end of ruler to appropriate serum creatinine (S.cr) value and left scale will indicate clearance in ml. per minute.
Mohler & Associates compared measured creatinine clearance vs predicted, to Cockcroft & Gault, Jelliffe & nomogram of Siersbaek & Nielsen.

Predicted versus measured creatinine clearance (C<sub>cr</sub>). Creatinine clearance predicted by 3 popular nomograms or equations is plotted as function of actual creatinine clearance as measured in 101 spinal cord injury pts. Open circles on white background indicate predicted creatinine clearance that exceeds measured clearance. Conversely, white circles on black background indicate predicted creatinine clearance that is less than measured clearance.
predicted versus measured creatinine clearance (Ccr). Creatinine clearance produced by equations is plotted as function of actual measured creatinine clearance in 38 spinal cord injury patients.

In 1988 Mohler, Ellison and Flangan\textsuperscript{27} have studied 6 predicted equation by various workers and reported that Sawyer & Hutchins equation is better than others.

In 1990 Kaji et al observed that in spinal cord injury patients, urinary creatinine production was decreased but they could not explain its relation with age, sex or body weight\textsuperscript{18}. 