Creatinine and Renal Function in Children

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Abstrak

Pada umumnya laju sintesis kreatinin tetap dan kadar kreatinin plasma (P_{kr}) mencerminkan laju eliminasinya melalui ginjal. Tiap anak sakit ginjal perlu diukur faal ginjalnya untuk mengetahui berapa jauh penyakit itu telah merusak jaringannya. Tujuan penelitian ini ialah mengukur P_{kr} dan faal ginjal atau laju filtrasi glomerulus (LFG) yang dinyatakan oleh kliren inulin (K_{in}) dan kliren kreatinin (K_{kr}) pada anak sakit ginjal, dan mengetahui bagaimana hubungan antara keduanya. Pada studi belah- lintang ini besar sampel dihitung dengan Sampel Tunggal untuk Estimasi Proporsi Suatu Populasi, dan analisis data dilakukan dengan Korelasi Produk Momen Pearson. Telah dilakukan pengukuran simultan K_{in} dan K_{kr} 112 anak dari bulan Maret 1991 sampai dengan Juli 1993. Hasil studi ini menunjukkan bahwa antara Pkr dengan LFG yang dinyatakan oleh K_{in} dan K_{kr} terdapat korelasi negatif hiperbolik pada semua anak dengan faal ginjal campuran (normal dan terganggu) : $P_{kr} = 4,34 - 0,03\ K_{in}$ ($r = -0,58$; $p < 0,001$; $N = 112$) dan $P_{kr} = 4,72 - 0,03\ K_{kr}$ ($r = -0,60$; $p < 0,001$; $N = 112$).

Abstract

In most clinical conditions, the rate of creatinine synthesis remains constant and its plasma concentration reflects the rate of renal elimination. To know how far the kidneys have been damaged the renal function in children suffering from renal diseases must be measured. The aim of this study was to measure plasma creatinine concentrations (P_{cr}) and renal function or glomerular filtration rates (GFR) expressed by inulin clearance (C_{in}) and cleatinine clearance (C_{cr}) in children suffering from renal diseases, and to know how would be the correlation between them. In this cross-sectional study sample size was estimated by the one-sample for estimating the population proportion, and data analyzing was done by the Pearson Product Moment Correlation. Simultaneous measurements of C_{in} and C_{cr} levels in 112 children were done over the period from March 1991 to July 1993. Result of this study showed there was a hyperbolic negative correlation between P_{cr} and GFR in all children with mixed (normal and decreased) renal functions : $P_{cr} = 4.34 - 0,03\ C_{in}$ ($r = -0.58$; $p < 0.001$; $N = 112$) and $P_{cr} = 4.72 - 0.03\ C_{cr}$ ($r = -0.60$; $p < 0.001$; $N = 112$)

Keywords: *Plasma creatinine, Inulin and creatinine clearances, Children*

INTRODUCTION

Creatinine, a product of creatine and phosphocreatine metabolism, is synthesized predominantly in the skeletal muscles. Creatinine is exclusively excreted through the kidneys, predominantly by the process of glomerular filtration and to a lesser extent by tubular secretion. In most clinical conditions, the rate of creatinine synthesis remains constant and its plasma concentration reflects the rate of renal elimination.[1]

The importance of measuring of renal function or GFR in children suffering from renal diseases is to know how far the kidneys have been damaged,[2] as GFR is the aspect of renal function that correlated closely with ability of the kidneys to maintain the composition of the body fluids within the ranges compatible with life.[3] Three methods to measure GFR are inulin clearance (C_{in}) (gold standard), radioisotopic clearance (C_{ra}) (accurate) and C_{cr} (sufficiently accurate).[4,5] There are limitations for the utility of these clearance methods. C_{in} takes a long time to perform, the procedure is difficult, very expensive, and it is not practical to use it routinely in the clinic. C_{ra} is available only in a well equipped and expensive health centre. In clinical practice GFR is measured by endogenous C_{cr}.[5]

The aim of this study was to measure the levels of plasma creatinine concentration (P_{cr}) dan GFR, expressed by C_{in} and C_{cr} in children suffering from renal diseases, and to know how would be the correlation between them.

This study needed to be investigated because the pediatric renal disease in our country comprised about

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2,3% of the hospitalized children, of which the frequency of renal failure was about 25%.[6] And every child in the community could suffer from renal disease irrespective of the socioeconomical class, education, in urban or rural area, and others.

MATERIALS AND METHODS

The procedures of this study were in accord with the *"Pedoman Etik Penelitian Kedokteran Indonesia".*[7] This cross-sectional study was performed in children suffering from renal diseases, admitted in the hospitals in Semarang, boys and girls, aged 2-14 years. During the first two years of life, GFG continues to increase and, based on boy surface area, reaches adult levels between one to two years of age.[8] Despite the increase in P_{er} GFR corrected for body surface area remains nearly constant and does not differ significantly between male and female subjects.[9] The sample size was estimated by the one-sample for estimating the population proportion.[10]

Measurements of the standard C_{in}[11] and the conventional endogenous C_{cr}[5] were undertaken simultaneously. A solution of 10% inulin as reagent was made by the method of CAS 9005-80-5.[12] Inulin concentration in plasma (P_{in}) (mg%) and in urine (U_{in}) (mg%) were assayed by UV-method for D-fructose.[13] P_{cr} (mg%) and creatinine concentration in urine (U_{cr}) (mg%) were assayed by Abbott Spectrum Autoanalyzer. Urine flow was V ml per minute. Renal clearance formula of standar C_{in} is $[(U_{in} \times V) : P_{in}]$ ml/min/1.73 m^2 and that of conventional endogenous C_{cr} is $[(U_{cr} \times V) : P_{cr}]$ ml/min/1.73 m^2.[5] Data analysis was done by the Pearson Product Moment Correlation.[14]

This study was got its Ethical Clearance approved by the Research Team of Medical Faculty of Diponegoro University / Dr Kariadi General Hospital in Semarang. Written informed consent have been obtained from all the pediatric patients' parents.

RESULTS

Simultaneous measurements of standard C_{in} and conventional endogenous C_{cr} were performed in 112 children suffering from renal diseases, admitted in the Children Wards of Dr Kariadi General Hospital, Telogorejo Hospital and St. Elisabeth Hospital in Semarang, age 2-14 years, consisted of 68 (60.7%) boys and 44 (39.3%), over the period from March 1991 to July 1993 (29 months). Range of the standard C_{in} was from 3 to 177 ml/min/1.73 m^2 and of the conventional endogenous C_{cr} was from 4 to 196 ml/min/1.73 m^2. Range of P_{cr} was from 0.23 to 15.83 mg%.

There was a hyperbolic negative correlation between P_{cr} and GFR expressed by C_{in} and C_{cr} in children with mixed renal functions (normal and decreased) showed by the regression equations : $P_{cr} = 4.34 - 0.03\ C_{in}$ ($r = -0.58$; p 0.001; $N = 112$) (Figure 1) and $P_{cr} = 4.72 - 0.03\ C_{cr}$ ($r = -0.60$; $p < 0.001$; $N = 112$) (Figure 2).

DISCUSSION

Hyperbola in Figure 1 showed the correlation between P_{cr} and C_{in} was in accord with that reported by Guignard et al[15] and that in Figure 2 showed the correlation between P_{cr} and C_{cr}, was in accord with that reported by Shemesh et al.[16] Elevated P_{cr} denotes diminished renal clearance and a decline in GFR. As it apparent from Figure 1-2 the relationship between P_{cr} and GFR were not linear.[1] These hyperbole curves were caused by the different GFR decrements to attain a new P_{cr} steady states between acute renal failure and acute on chronic renal failure. To detect 1 mg% rise in P_{cr} the former required at least 50% but the later required just 15% decrement from the initial GFR.[17,18] During steady state, it can be seen that only GFR less than 50% of normal would be diagnosed as abnormal using P_{cr} alone. Due to the relatively large range of normal values, the predictive value of individual P_{cr} is limited. Serial measurements of P_{cr} improve its usefulness.[1,4,15]

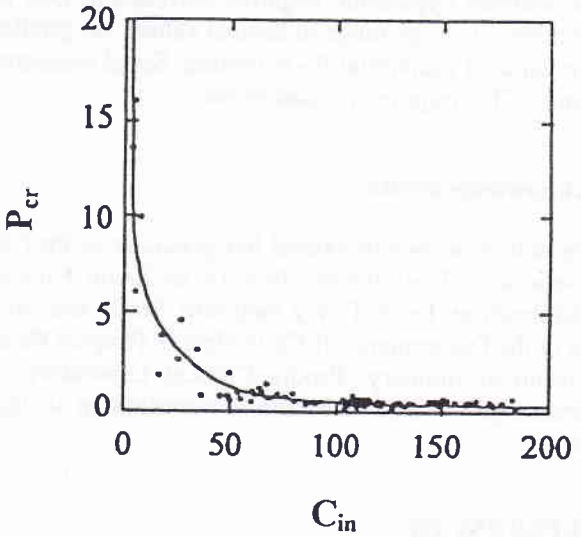

Figure 1. Hyperbolic negative correlation between plasma creatinine concentration (P_{cr}) and renal function (Normal and Abnormal) expressed by inulin clearance (C_{in}) in 112 children aged 2-14 years :

$P_{cr} = 4.34 - 0.03\ C_{in}$ ($r = -0.58$; $p < 0.001$; $N = 112$)

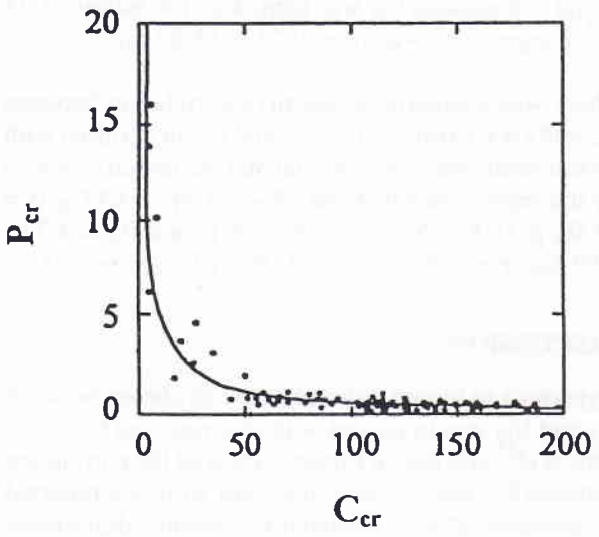

Figure 2. Hyperbolic negative correlation between plasma creatinine concentration (P_{cr}) and renal function (normal and abnormal) expressed by creatinine clearance (C_{cr}) in 112 children aged 2-14 years :

$P_{cr} = 4.72 - 0.03\ C_{cr}\ (r = -0.60;\ p < 0.001;\ N = 112)$

CONCLUSIONS

In children with normal and decreased renal functions, plasma creatinine concentrations and glomerular filtration rates, expressed by inulin and creatinine clearances, showed hyperbolic negative correlation. Due to the relatively large range of normal values, the predictive value of individual P_{cr} is limited. Serial measurements of P_{cr} improve its usefulness.

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