Assessing post-contrast acute kidney injury in children with congenital heart disease undergoing cardiac catheterization using cystatin C based equation for estimated glomerular filtration rate

Anhesis

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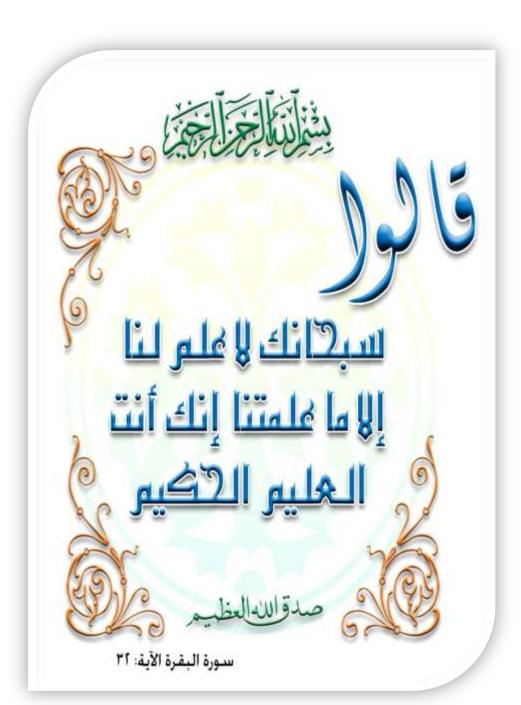
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List of Abbreviations

Abbr. Full-term

AARs : Acute adverse reactions

ACEI : Angiotensin converting enzyme inhibitor

AKI : Acute kidney injury

AKIN : Acute kidney injury network

AUC : Area under Curve BMI : Body mass index

BSA : Body surface area

CHD : Congenital heart disease

CI-AKI : Contrast-induced acute kidney injury

CIN : Contrast-induced nephropathy

CM : Contrast media

COA : Coarctation of aorta

CpA : Compound A

CT : Computerized tomography

Cys C : Cystatin C

eGFR : Estimated Glomerular filtration rateELISA : Enzyme-linked immunosorbent assay

GFR : Glomerular filtration rate

HOCM: High osmolar contrast media

ICM: Iodine Contrast Media

IGFBP7 : Insulin-like growth factor—binding protein 7

IL-18 : Interleukin-18

KDa : Kilo-Dalton

KDIGO: Kidney Disease: Improving Global Outcomes

KIM-1 : Kidney injury molecule 1

L-FABP: Liver-type fatty acid binding protein

LMWH : Low Molecular weight heparin

LOCM: Low osmolar contrast media

MACD: Maximum allowable contrast dose

MRI : Magnetic resonant imaging

NGAL : Neutrophil gelatinase-associated lipocalin

NSAID : Nonsteroidal anti-inflammatory drugs

PA : Pulmonary artery

PAS : Pulmonary artery stenosis

PC-AKI : Post-contrast acute kidney injury

PCI : Percutaneous coronary intervention

PDA : Patent Ductus Arteriosus

pRIFLE: Pediatric Risk, Injury, Failure, Loss, End-Stage

Kidney Disease

RBF : Renal blood flow

ROC : Receiver Operating Characteristic Curve

RV : Right ventricle

sCr : Serum creatinine

SD : Standard deviation

TFA : Tranfemoral approach

TIMP-2: Tissue inhibitor of metalloproteinase-2

TRA : Transradial approach

VSDs : Ventricular septal defects

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Introduction

The term Post-contrast acute kidney injury (PC-AKI) is used to describe a decrease in renal function that follows intravascular administration of contrast media. The decrease in renal function is usually mild, peaking at 2-3 days, and renal function usually returns to baseline values within 1-3 weeks. Like all forms of AKI, an episode of PC-AKI is a marker for increased short-and long-term morbidity and mortality and prolonged hospital stay (van der Molen et al., 2018).

Contrast media (CM) used in cardiac catheterization is low osmolar non-ionic contrast media (iohexol) has less effect on cardiac function and fewer side effects than conventional ionic contrast media, Contrast material dosing is based on a standardized dosing nomogram adjusted for patient weight (McDonald et al., 2018).

A new biomarker Cystatin C (CysC), a non-glycosylated low-molecular-weight (13 kDa) protein encoded by the CST3 gene, a protease inhibitor, that is synthesized and released into the blood at a relatively constant rate by all nucleated cells. It is freely filtered in normal circumstances by the glomeruli and completely reabsorbed in the proximal tubule. In the absence of tubular dysfunction, its serum levels reflect glomerular filtration, therefore it could be used as a convenient measure of glomerular filtration rate (Cecchi et al., 2017).

As blood levels of cystatin C are not significantly affected by age, sex, race, or muscle mass, it is a better predictor for glomerular function compared with serum creatinine (sCr) in patients with chronic kidney disease (Mostafa et al., 2016).

Cystatin C equation: (eGFR =70.69 x (CysC)^{-0.931}) for estimation of GFR may have advantages over serum Creatinine-based equations (**Schwartz et al., 2012**).

In children, the revised Schwartz formula to estimate GFR is recommended. eGFR (ml/min/1.73 m²) = $0.413 \times \text{height/sCr}$ (sCr in mg/dl, height in cm) (Schwartz et al., 2009)

Also one of the promising candidate biomarker for AKI is Neutrophil gelatinase-associated lipocalin (NGAL), a 25 kDa siderophore binding protein composed of 179 amino acids, a member of the lipocalin family, covalently attached to human neutrophil gelatinase, secreted by activated neutrophils. Lipocalins are proteins binding small lipophilic molecules and transporting them between the cells of the body. NGAL is involved in processes of cell-mediated immunity, bacteriostatic effects, cell proliferation, differentiation and apoptosis processes. It increases when there are conditions such as infection and malignancy (**Lichosik et al., 2015**).

In the kidney, NGAL is mainly expressed in the loop of Henle and distal convoluted tubules. It's filtered by the renal glomeruli and reversibly reabsorbed in the proximal convoluted tubules (Andreucci et al., 2016).