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## ORIGINAL ARTICLE

## CKD-EPI versus Cockcroft-Gault formula for predicting contrast-induced nephropathy following percutaneous coronary intervention in patients without significant renal impairment<sup>☆</sup>

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### KEYWORDS

Percutaneous coronary intervention;  
 Glomerular filtration rate;  
 Contrast media

### Abstract

**Introduction:** Individuals with glomerular filtration rate (GFR)  $\geq 60$  ml/min/1.73 m<sup>2</sup> estimated by the Cockcroft-Gault formula (CG) who undergo percutaneous coronary intervention (PCI) frequently develop contrast-induced nephropathy (CIN). This study aimed to assess whether individuals with significant renal impairment assessed by the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) formula, but not by CG, more often develop CIN following PCI than those without renal impairment by either formula.

**Methods:** In this cross-sectional study analyzing patients with baseline CG GFR  $\geq 60$  ml/min/1.73 m<sup>2</sup> before PCI, subjects were divided into two groups according to CIN occurrence. Baseline CKD-EPI GFR was calculated for all patients.

**Results:** We analyzed 140 patients. Baseline GFR was  $87.5 \pm 21.3$  and  $77.1 \pm 15.0$  ml/min/1.73 m<sup>2</sup> for CG and CKD-EPI, respectively. CIN occurred in 84.6% of individuals with baseline CKD-EPI GFR  $< 60$  ml/min/1.73 m<sup>2</sup> vs. 51.1% of those without. Males and those with higher body mass index were more likely to present baseline CKD-EPI GFR  $< 60$  ml/min/1.73 m<sup>2</sup> ( $p=0.021$ ). Non-ionic contrast agent use and baseline CKD-EPI GFR  $\geq 60$  ml/min/1.73 m<sup>2</sup> were protective factors against CIN. Greater amounts of contrast agent and acute coronary syndrome were associated with higher CIN risk. In subjects with serum creatinine  $< 1.0$  mg/dl, GFR was more likely to be overestimated by CG, but not by CKD-EPI (sensitivity 100.0%; specificity 52.0%).

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**PALAVRAS-CHAVE**

Intervenção coronária percutânea;  
Taxa de filtração glomerular;  
Meios de contraste

**Conclusion:** In patients undergoing PCI without renal dysfunction by CG, a finding of CKD-EPI GFR  $<60$  mL/min/1.73 m<sup>2</sup> was associated with a higher probability of CIN, especially among men and those with higher body mass index.

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### Fórmula de CKD-EPI versus Cockcroft-Gault na predição de nefropatia induzida por contraste após intervenção coronária percutânea, em pacientes sem disfunção renal significativa

**Resumo**

**Introdução:** Nefropatia induzida por contraste (NIC) após intervenção coronária percutânea (ICP) em pacientes com taxa de filtração glomerular (TFG)  $\geq 60$  mL/min, estimada pela equação de Cockcroft-Gault (c-G), não é infrequente. O objetivo desse estudo foi avaliar a capacidade da equação CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) em prever NIC em indivíduos sem disfunção renal significativa basal pela fórmula C-G.

**Métodos:** Incluídos pacientes submetidos a ICP entre 2008-2013, com TFG basal  $\geq 60$  mL/min pela equação de C-G. Estes indivíduos foram divididos em dois grupos, conforme ocorrência ou não de NIC. Para todos os casos, foi calculada a TFG basal conforme a equação do CKD-EPI.

**Resultados:** A amostra consistiu de 140 pacientes. A TFG C-G basal foi de  $87,5 \pm 21,3$  mL/min e de  $77,1 \pm 15,0$  mL/min/1,73 m<sup>2</sup> para CKD-EPI. NIC ocorreu em 84,6% dos pacientes com TFG CKD-EPI basal  $<60$  mL/min/1,73 m<sup>2</sup>, contra 51,1% daqueles com TFG CKD-EPI basal  $\geq 60$  mL/min/1,73 m<sup>2</sup> ( $p=0,021$ ). Indivíduos masculinos ou com peso corporal elevado apresentaram mais frequentemente TFG CKD-EPI basal  $<60$  mL/min/1,73 m<sup>2</sup>. Contraste não-iônico e TFG CKD-EPI basal  $\geq 60$  mL/min/1,73 m<sup>2</sup> foram fatores protetores à ocorrência de NIC. Em indivíduos com creatinina  $<1,0$  mg/dL, o achado de TFG superestimada por C-G, mas não pelo CKD-EPI, foi mais frequente (sensibilidade de 100,0%; especificidade de 52,0%).

**Conclusões:** Em pacientes sem disfunção renal por C-G, submetidos a ICP, o achado de TFG CKD-EPI  $<60$  mL/min/1,73 m<sup>2</sup> implicou em maior chance de NIC, principalmente entre indivíduos do sexo masculino e de maior massa corpórea.

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**Introduction**

Contrast-induced nephropathy (CIN) is a form of acute kidney injury that occurs within a few days of exposure to iodinated contrast media, which is often used in diagnostic and therapeutic medical procedures. In the last decade, CIN has been identified as the third most common cause of renal failure acquired in the hospital environment, with important short- and long-term prognostic implications.<sup>1-5</sup>

Various factors have been identified as predictors of CIN. Individuals with pre-existing renal dysfunction are the subgroup at greatest risk for its development.<sup>6-10</sup> Identification of such patients is thus of fundamental importance for the implementation of strategies to prevent the occurrence of CIN.<sup>2,3,10-12</sup>

A direct relationship between serum creatinine (sCr) levels and risk of developing CIN has been demonstrated, i.e. the higher the baseline sCr, the greater the likelihood of developing CIN.<sup>10</sup> However, sCr is an imperfect marker for measuring renal function, especially because of its low sensitivity for monitoring changes in renal function, since

reductions of more than 50% in glomerular filtration rate (GFR) may occur before any increase in sCr is observed. There is therefore a need for reliable methods for estimating GFR, in order to identify patients at higher risk for developing CIN.

Because of its practicality and ease of use, calculation of creatinine clearance (CrCl) is one of the most widely used methods for estimating GFR in clinical practice, most often by the Cockcroft-Gault (CG) formula, which has satisfactory reproducibility and accuracy.<sup>13,14</sup> The variables it takes into account are weight, gender, age and sCr. However, though easy to remember and apply, the CG formula is less accurate when used in certain clinical contexts or specific populations, especially the obese and the elderly.<sup>15-20</sup>

An alternative formula for estimating GFR proposed by the Modification of Diet in Renal Disease (MDRD) Study Group considers six variables: sCr, age, ethnicity, gender, and levels of blood urea nitrogen and serum albumin. However, this tool has been validated only for patients with chronic kidney disease, and is not applicable in the context of acute kidney injury. The MDRD formula often underesti-

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