Biomonitoring of Cadmium

– Relationship between Cadmium in Kidney, Blood and Urine, Interpretation of Urinary Cadmium, and Implications for Study Design

Akademisk avhandling

som för avläggande av medicine doktorsexamen vid Sahlgrenska akademin, Göteborgs universitet, kommer att offentligen försvaras i sal Hamberger, Medicinaregatan 16, fredagen den 25 april 2014 kl. 9:00

av

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Avhandlingen baseras på följande arbeten:

I. Akerstrom M, Barregard L, Lundh T, Sallsten G. The relationship between cadmium in kidney and cadmium in urine and blood in an environmentally exposed population. *Toxicology and Applied Pharmacology. 2013 May 1;268(3):286-93*

II. Akerstrom M, Sallsten G, Lundh T, Barregard L. Associations between Urinary Excretion of Cadmium and Proteins in a Nonsmoking Population: Renal Toxicity or Normal Physiology? *Environmental Health Perspectives. 2013 Feb;121(2):187-91.*

III. Akerstrom M, Lundh T, Barregard L, Sallsten G. Effect of molybdenum oxide interference on urinary cadmium analyses. *International Archives of Occupational and Environmental Health. 2013 Jul;86(5):615-7*

IV. Akerstrom M, Barregard L, Lundh T, Sallsten G. Variability of urinary cadmium excretion in spot urine samples, first morning voids, and 24 h urine in a healthy non-smoking population: Implications for study design. *Journal of Exposure Science and Environmental Epidemiology. 2014 Mar;24(2):171-9*

UNIVERSITY OF GOTHENBURG

Göteborg 2014

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ABSTRACT

Cadmium is an environmental contaminant which accumulates in the kidney and can potentially affect human health at relatively low concentrations. Biomarkers such as cadmium in urine or blood are normally used to assess the body burden of cadmium.

We studied the relationship between cadmium in urine, blood, and kidney by using 109 healthy environmentally exposed kidney donors. The variability in urinary cadmium excretion, its interpretation, and effects on the study design were further examined using repeated urinary samples from 30 non-smoking healthy men and women.

The results showed a strong association between cadmium in urine and kidney (r_p=0.7), with an excretion corresponding to a biological half-time of about 30 years. A kidney cadmium of 25 µg/g corresponded to a urinary cadmium of 0.42 µg/g creatinine (i.e. a urine to kidney ratio of 1:60). Previous estimates of the urine to kidney cadmium ratio (1:20) may thus underestimate the kidney cadmium at low urinary cadmium excretion. On average, 70% of the urinary cadmium excretion could be explained by kidney cadmium. Urinary cadmium excretion was also affected by cadmium in blood and urinary albumin excretion.

There was a circadian rhythm in the urinary cadmium excretion over 24h, affecting both the interpretation of urinary cadmium measures and the appropriate study design.

There was an association between urinary cadmium and urinary proteins within individuals. Hence, when urinary cadmium is used as a biomarker for cadmium body burden, normal short-term variability in renal function may result in an overestimation of the nephrotoxicity of cadmium.

Keywords: Cadmium, urine, blood, kidney, biological half-time, variability, biomarkers, determinants, study design

ISBN: 978-91-628-8923-4 (tryckt)
ISBN: 978-91-628-8972-2 (e-pub)
http://hdl.handle.net/2077/34823