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TABLE OF CONTENTS

AGRICULTURAL SCIENCES

BIOLOGICAL SCIENCES

MEDICAL SCIENCES

MODERN OPPORTUNITIES OF LABORATORY DIAGNOSTICS OF KIDNEY DAMAGE IN HYPERTENSION

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Intoductions. Renal damage is one of the most common and prognostically unfavorable complications of arterial hypertension (AH), leading to the development of chronic kidney disease (CKD) and significantly increasing the risk of cardiovascular events.

Timely and accurate laboratory diagnostics are crucial for the early detection of kidney damage, assessment of its degree, monitoring of progression, and adjustment of treatment in patients with AH (Golafshan F., 2024; Ameer O.Z., 2022).

Aim. The purpose of the work is to analyze scientific sources on the problem of diagnostics of renal damage among patients with arterial hypertension

Materials and methods. We analyzed the scientometric databases PubMed, Scopus, Web of Science and conducted a retrospective analysis of literature sources. The most relevant sources on this topic were selected for analysis.

Results and discussion. Modern laboratory capabilities have significantly expanded, supplementing traditional methods with new, more sensitive, and specific markers. The traditional and primary laboratory markers that remain key in the diagnosis of hypertensive nephropathy, despite the emergence of new methods, include (Yang X., 2021; Mizdrak M., 2022):

Serum creatinine and estimated glomerular filtration rate (eGFR):

Serum creatinine level is a standard method for assessing kidney function. Based on the level of creatinine, age, sex, and race, the eGFR is calculated using

specific formulas (e.g., CKD-EPI). A decrease in eGFR is an important criterion for diagnosing CKD and reflects a reduction in the kidneys' filtration capacity.

Proteinuria/Albuminuria:

The presence of protein (especially albumin) in the urine is a sensitive indicator of glomerular damage. Quantitative assessment of proteinuria (24-hour protein excretion) or the albumin-to-creatinine ratio in a spot urine sample are widely used for the detection and monitoring of renal damage in AH. Microalbuminuria (a small increase in albumin excretion) is often one of the first signs of hypertensive kidney damage.

New and promising biomarkers: recent studies have focused on the search for earlier and more specific markers of kidney damage that can detect injury even before a significant decrease in GFR or the appearance of pronounced proteinuria. Hypertension can lead to damage not only to the glomeruli but also to the renal tubules. (Raveendran J., 2025; Romejko K., 2023; Canki E., 2024; Younes-Ibrahim M. S., 2022; Odegbemi O. B., 2024):

Cystatin C: This protein is produced by all nucleated cells and is freely filtered by the glomeruli but not reabsorbed in the tubules. Its serum level is less dependent on muscle mass, age, and sex compared to creatinine, which makes it a potentially more accurate marker of GFR, especially in elderly individuals and those with significant variations in muscle mass.

Neutrophil gelatinase-associated lipocalin (NGAL): The level of NGAL increases in acute and chronic kidney injury, reflecting stress and damage to the tubular epithelium.

Kidney Injury Molecule-1 (KIM-1): This transmembrane protein is expressed on proximal tubular cells following their injury. Its elevation in urine serves as an indicator of tubular damage.

Liver fatty acid-binding protein (L-FABP): A protein expressed in the proximal tubules that is involved in fatty acid metabolism. Its elevation in urine may indicate ischemic or toxic tubular injury.

Uromodulin (Tamm–Horsfall protein): The most abundant protein in the urine

of healthy individuals, produced by the cells of the thick ascending limb of the loop of Henle. The serum level of uromodulin correlates with kidney function, and its decrease is associated with an increased risk of developing chronic kidney disease (CKD).

Other modern approaches**:**

"Omics" technologies: Proteomic and metabolomic analyses of urine and blood open new prospects for identifying panels of biomarkers that can more accurately reflect the pathogenic mechanisms of hypertensive nephropathy and predict its development and progression. Although these methods are still largely in the research stage, they hold significant potential for personalized diagnostics. (Govender, M. A., 2024).

Recent studies emphasize the importance of using both traditional and novel laboratory markers for the early and accurate diagnosis of hypertensive nephropathy. The implementation of new markers may improve the detection of the disease at its early stages and facilitate timely treatment. It is important to stress that laboratory diagnostics of kidney injury in hypertension should always be performed in conjunction with instrumental examination methods, including renal ultrasonography, Doppler imaging of the renal arteries, and, when indicated, computed tomography or magnetic resonance imaging. (Qin, Y., 2025).

Conclusions.

Thus, modern laboratory diagnostics of kidney injury in hypertension are based on the use of both established and novel biomarkers. Serum creatinine measurement with GFR calculation and the assessment of proteinuria/albuminuria remain the primary methods for screening and monitoring.

However, the inclusion of biomarkers such as cystatin C and markers of tubular injury enhances the sensitivity and specificity of diagnosis, particularly at early stages.

The further development of "omics" technologies promises the emergence of new, more advanced methods for evaluating kidney function in patients with hypertensive disease, contributing to improved prognosis and quality of life. Regular

screening and a comprehensive approach to examination are critically important for the timely detection and effective management of hypertensive nephropathy.

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