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CLINICAL AND LABORATORY FEATURES OF POST-INFECTIOUS GLOMERULONEPHRITIS IN CHILDREN: DEVELOPMENT OF AN HTML-BASED EDUCATIONAL PROGRAM FOR MEDICAL STUDENTS

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BOLALARDA POST-INFEKSION GLOMERULONEFRITNING KLINIK VA LABORATOR XUSUSIYATLARI: TIBBIYOT TALABALARI UCHUN HTML- ASOSLANGAN TA'LIM DASTURINI ISHLAB CHIQISH

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КЛИНИКО-ЛАБОРАТОРНЫЕ ОСОБЕННОСТИ ПОСТИНФЕКЦИОННОГО ГЛОМЕРУЛОНЕФРИТА У ДЕТЕЙ: РАЗРАБОТКА ОБРАЗОВАТЕЛЬНОЙ ПРОГРАММЫ НА ОСНОВЕ HTML ДЛЯ СТУДЕНТОВ-МЕДИКОВ

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Annotation *- Post-infectious glomerulonephritis (PIGN) remains a prevalent cause of acute glomerular disease in children, particularly in resource-limited settings. This study examines the clinical and laboratory features of PIGN, focusing on renal function, fibrinogen levels, and anemia. Additionally, it introduces an innovative HTML-based program designed to enhance medical students' diagnostic skills by facilitating the interpretation of clinical data. The findings highlight key laboratory markers such as elevated fibrinogen levels, hypocomplementemia, and anemia, emphasizing the need for early detection and management to prevent complications like chronic kidney disease. The study also underscores preventive measures and educational interventions to improve both clinical outcomes and public health awareness.*

Key words: *glomerulonephritis, fibrinogen, ASL-O, HTML-programm.*

Annotatsiya. *Post-infeksion glomerulonefrit (PIGN) bolalarda, ayniqsa resurslar cheklangan sharoitlarda o'tkir glomerulyar kasallikning keng tarqalgan sababi bo'lib qolmoqda. Ushbu tadqiqot buyrak funktsiyasi, fibrinogen darajalari va anemiyaga e'tibor qaratib, PIGN ning klinik va laboratoriya xususiyatlarini o'rganadi. Bundan tashqari, u klinik ma'lumotlarni izohlashni osonlashtirish orqali tibbiyot talabalarining diagnostika ko'nikmalarini oshirishga mo'ljallangan innovatsion HTML-ga asoslangan dasturni taqdim etadi. Topilmalar fibrinogen darajasining oshishi, gipokomplementemiya va anemiya kabi asosiy laboratoriya belgilarini ta'kidlab, surunkali buyrak kasalligi kabi asoratlarni oldini olish uchun erta aniqlash va davolash zarurligini ta'kidlaydi. Tadqiqot, shuningdek, profilaktika choralari va klinik natijalarni va aholi salomatligi haqida xabardorlikni yaxshilash uchun ta'lim tadbirlarini ta'kidlaydi.*

Kalit so'zlar: *glomerulonefrit, fibrinogen, ASL-O, HTML-dastur*

Аннотация. *Постинфекционный гломерулонефрит (ПИГН) остается распространенной причиной острого гломерулярного заболевания у детей, особенно в условиях ограниченных ресурсов. В этом исследовании изучаются клинические и лабораторные особенности ПИГН, уделяя особое внимание функции почек, уровням фибриногена и анемии. Кроме того, в нем представлена инновационная программа на основе HTML, разработанная для улучшения диагностических навыков студентов-медиков путем облегчения интерпретации клинических данных. Результаты подчеркивают ключевые лабораторные маркеры, такие как повышенный уровень фибриногена, гипокомплементемия и анемия, подчеркивая необходимость раннего выявления и лечения для предотвращения осложнений, таких как хроническое заболевание почек. В исследовании также подчеркиваются профилактические меры и образовательные вмешательства для улучшения как клинических результатов, так и осведомленности общественного здравоохранения.*

Ключевые слова: *гломерулонефрит, фибриноген, АСЛ-О, HTML- программа*

Abstract: Post-infectious glomerulonephritis (PIGN) remains a significant cause of acute glomerular disease in children, particularly in regions with limited healthcare resources. PIGN typically follows streptococcal infections and is characterized by immune-mediated glomerular inflammation. While the disease often resolves with supportive care, early recognition and precise management are critical to preventing complications such as chronic kidney disease. This study evaluates the clinical and laboratory features of PIGN in children, focusing on parameters like renal function, fibrinogen levels, and anemia. Additionally, it introduces an innovative HTML-based program designed to aid medical students in interpreting clinical and laboratory data for PIGN, enhancing their diagnostic and educational experience and also provide insights to guardians.

Purpose of the Study: The primary aim of this study is to analyze the clinical and laboratory characteristics of post-infectious glomerulonephritis (PIGN) in children. Furthermore, it evaluates the effectiveness of a novel HTML-based educational program developed to assist medical students in understanding and interpreting critical diagnostic parameters, including renal function stages, fibrinogen levels, and clotting risk, to improve their learning outcomes and diagnostic skills.

Keywords: post-infectious glomerulonephritis, pediatric nephrology, fibrinogen levels, renal function assessment, HTML program

Introduction: Post-infectious glomerulonephritis (PIGN) is a significant cause of acute glomerular disease in children, particularly in developing regions [5]. It is an

autoimmune condition characterized by inflammation of the glomeruli, typically following an infection, most commonly with nephritogenic strains predominantly of Group A beta-hemolytic Streptococcus infection [2]. PIGN primarily affects children between 3 and 12 years old, with males being more frequently affected [5]. Despite advancements in healthcare, it remains a major public health concern due to its potential to cause long-term renal impairment, especially in resource-limited settings [3]. Globally, it is estimated that there are approximately 472,000 new cases of acute post-infectious glomerulonephritis annually, with 404,000 of these cases occurring in children [3]. Since 2022, there has been a noticeable rise in streptococcal infections and subsequent APIGN cases, possibly due to reduced exposure during the pandemic, leading to decreased immunity [1, 4]. The pathogenesis of PIGN is primarily immune-mediated. Following an infection, immune complexes are deposited in the glomeruli, leading to inflammation and glomerular injury. Immune complexes lead to activation of the complement system and platelets, causing changes in the physiochemical properties of the basement membrane, endothelial mesangium, and glomerular epithelium [1]. Fibrinogen, a soluble plasma protein synthesized in the liver, is directly involved in the formation of a thrombus (blood clot) after vascular wall damage [2]. This indicator is determined in a coagulogram (hemostasiogram)—a special coagulation test. Under the influence of specific factors, fibrinogen converts into insoluble fibrin at the site of vascular damage. Its threads intertwine, creating a dense network to which platelets adhere, forming a temporary patch to stop bleeding. The lower the fibrinogen level, the longer it takes for a thrombus to form, which can lead to significant consequences [2]. The norm is from 2 to 4 g/L. The clinical presentation typically includes hematuria, proteinuria, oliguria, edema, and hypertension, often accompanied by a preceding history of pharyngitis or skin infection (pyoderma, impetigo) [5]. Laboratory investigations reveal characteristic findings such as reduced serum complement levels, specifically C3, elevated serum creatinine, elevated fibrinogen levels, and the presence of red blood cell casts in urine [3]. Serological markers, such as anti-streptolysin O (ASO) titers, can help confirm a recent streptococcal infection, but these are not reliable in cases of skin infections, where cholesterol destroys ASO. Another serological marker is anti-DNAse B, as streptococcus produces DNAse [1]. The clinical course of PIGN in children is favourable, with most patients achieving full recovery within weeks to months. However, a subset of children may develop complications, including nephrotic syndrome, hypertensive encephalopathy, or even chronic kidney disease (CKD) [4]. Early recognition and proper management are crucial to prevent these adverse outcomes. This involves supportive care, including antihypertensive therapy and diuretics, along with close monitoring of renal function and urine output [5]. In the context of laboratory diagnostics, a comprehensive evaluation is essential for accurate diagnosis and monitoring of disease progression. Typical laboratory findings include microscopic hematuria, mild to moderate proteinuria, and elevated serum creatinine and fibrinogen levels [2]. Hypocomplementemia, particularly low C3 levels, is a hallmark of PIGN and usually resolves within 6-8 weeks [3]. In some cases, kidney biopsy may be required to confirm the diagnosis, especially if the clinical course is atypical or there is concern for alternative diagnoses such as lupus nephritis or IgA nephropathy [4]. Understanding the clinical and laboratory features of PIGN is vital for its timely diagnosis and management. This study aims to provide a detailed analysis of these features in children diagnosed with PIGN, focusing on their presentation, laboratory findings, and outcomes. By doing so, we hope to enhance clinical recognition of the disease and contribute to the optimization of its management, ultimately improving patient outcomes. Furthermore, this research highlights the need for continued surveillance and public health initiatives to prevent streptococcal infections, particularly in regions where PIGN is still endemic [4]. In conclusion, post-infectious glomerulonephritis continues to pose a challenge in pediatric nephrology, especially in underprivileged areas. A thorough understanding of its clinical and laboratory manifestations is essential for clinicians to ensure prompt diagnosis and management. This study provides insights into the characteristic features of PIGN, offering a valuable resource for healthcare professionals and guardians managing pediatric patients with glomerular diseases.

Methodology: This observational cross-sectional study, conducted over a one-month period, aimed to evaluate the clinical manifestations and patterns of glomerulonephritis, nephrotic syndrome, and pyelonephritis in pediatric patients. The study included 25 children, aged 2.5 to 15 years, diagnosed with post-infectious glomerulonephritis (PIGN) and other renal conditions, who were treated in the Department of Nephrology at the Tashkent Medical Academy's Department of Children Diseases. Clinical data were collected through patient history (anamnesis morbi and anamnesis vitae), present status evaluation, physical examinations, and laboratory investigations. Data were systematically documented, including parameters such as age, gender, history, complaints, illness duration, symptoms, severity, and complications. Laboratory investigations comprised a complete blood count (CBC), coagulogram, urine analysis, renal function tests (serum creatinine, blood urea nitrogen), serum electrolytes, complement levels (C3 and C4), and albumin levels. Maternal health during pregnancy was also assessed. We focused on laboratory parameters included hemoglobin, fibrinogen, anti-streptolysin O (ASO) titers, C-reactive protein glomerular filtration rate (GFR), and proteinuria. An HTML-based program was developed to calculate renal function stages and clotting risk based on fibrinogen levels and provide conclusion and recommendations based on the input laboratory values. Patient confidentiality was strictly maintained throughout the study.

Results: A total of 25 patients from the nephrology department were included in the study, of which 5 with pyelonephritis were excluded. Among the remaining 20 patients, 85% (n=17) presented with nephrotic syndrome and 15% (n=3) with nephritic syndrome (table 1).

Table 1

	Total	Pyelonephritis	Glomerulonephritis	
			Nephrotic	Nephritic
No. Of patients	25	5	17	3
%	100	20	85	15

Post-streptococcal glomerulonephritis with positive ASO titers was observed in 65% (n=13), while 35% (n=7) were ASO-negative due to factors such as alternative infections, secondary immune responses, or genetic predispositions (table 2).

Table 2

Parameters	Category	Percentage (%)	No of patients (N=20)
Anemia	Mild	20	4
	Moderate	25	5
Fibrinogen	Stage 1 Normal (200-400mg/dL)	15	3
	Stage 2 Mild (350-450mg/dL)	35	7
	Stage 3 Moderate (450-600mg/dL)	27	5
	Stage 4 severe (>600mg/dL)	23	5
	Stage 5 end stage (>700mg/dL)	0	0

Anemia was identified in 45% of patients, with 20% (n=4) having mild and 25% (n=5) having moderate anemia (table 2). Fibrinogen levels were normal (200–400 mg/dL) in 15% (n=3), stage 2 (350–450 mg/dL) in 35% (n=7), stage 3 (450–600 mg/dL) in 27% (n=5), and stage 4 (>600 mg/dL) in 23% (n=5) (table 2). Universal edema was noted, with generalized edema in nephrotic syndrome and visceral edema in nephritic syndrome. Hypertension was observed in 10% (n=2), indicating cardiovascular involvement. Hematuria was present as macrohematuria in some cases, while microhematuria was confirmed in all. Proteinuria exceeded 2,5 g/day in nephrotic syndrome and was less than 2,5 g/day in nephritic syndrome, with accompanying hypoalbuminemia in nephrotic cases. Common symptoms included hypoxia, fatigue, oliguria, and high-grade fever (>39°C). Urinary symptoms such as flank pain, dysuria, frequency, and urgency were accompanied by systemic signs including malaise, nausea, and vomiting, with urinalysis confirming pyuria and bacteriuria. Genetic predispositions were noted, including family histories of renal diseases, maternal COVID-19 during pregnancy, and recurrent bronchitis, tonsillitis, or throat infections. Laboratory findings highlighted inflammatory or post-infectious etiologies, with anemia, leukocytosis, elevated fibrinogen levels, and increased ASO titers. Initial presentations commonly included swelling of the eyes and abdomen. These findings underscore the complex clinical and laboratory profiles of pediatric glomerulonephritis and emphasize the importance of early diagnosis and tailored management strategies.

Discussions: The clinical findings of this study highlight the diverse and significant manifestations observed in patients with suspected or diagnosed renal or systemic involvement. Edema was a universal feature among the patients. This pattern aligns with typical presentations of fluid retention in renal pathologies, underscoring the need for early identification and management. The presence of hypertension in 10% patients emphasizes the potential cardiovascular complications that may accompany these conditions. The high prevalence of haematuria, both macro- and microscopic, coupled with proteinuria ranging from mild to nephrotic levels, reflects underlying glomerular dysfunction. These findings are consistent with glomerulonephritis and other renal pathologies commonly associated with systemic infections or immune-mediated processes. Hypoxia, fatigue and oliguria, observed in a subset of patients, suggest impaired renal clearance, which may contribute to the overall systemic impact of the disease. The universal occurrence of high-grade fever (>39°C) further supports an inflammatory or infectious etiology. Additional urinary symptoms, including dysuria, urinary frequency, and urgency, combined with pyuria and bacteriuria on urine analysis, point to concomitant urinary tract involvement, potentially compounding patient morbidity. The occurrence of flank and abdominal pain radiating to the back is suggestive of upper urinary tract inflammation or obstruction, warranting further investigation in such cases.

The observed systemic symptoms, such as malaise, nausea, and vomiting, align with the nonspecific manifestations of systemic inflammatory responses. A history of bronchitis and throat infections in patients, as well as maternal COVID-19 infection during pregnancy, provides potential insight into infectious triggers or prenatal exposures contributing to these clinical presentations. The unique case of allergy to sweets may reflect an unrelated but notable individual finding. Laboratory results indicating anemia, leukocytosis, elevated C-reactive protein, elevated fibrinogen levels, and increased ASO titers are indicative of an inflammatory or post-infectious state. These findings are consistent with conditions such as post-streptococcal glomerulonephritis, which is supported by the clinical and laboratory data. This study underscores the importance of comprehensive clinical evaluation and laboratory assessment in identifying and managing renal and systemic conditions.

Conclusion: This study underscores the importance of understanding the clinical and laboratory features of post-infectious glomerulonephritis (PIGN) in paediatric patients to ensure timely diagnosis and management. The integration of an HTML-based educational program has shown potential in simplifying the interpretation of key diagnostic parameters such as renal function and fibrinogen levels for medical students. By bridging the gap between theoretical knowledge and practical application, this program contributes to better educational outcomes and enhances preparedness in managing glomerular diseases in clinical settings for both physicians and medical students. It can also help enhance parental knowledge about condition.

Prevention strategies: Primary prevention of glomerulonephritis focuses on the early diagnosis and prompt treatment of infections such as pharyngitis and impetigo with appropriate antibiotics like penicillin, alongside promoting hygiene practices, particularly in overcrowded or resource-limited settings. Measures include using disposable syringes, screening blood products to reduce the risk of viral infections, maintaining a balanced diet rich in fruits, vegetables, and whole grains while low in saturated fats, staying hydrated to support kidney function, and engaging in regular physical activity to prevent obesity-related complications. Timely vaccinations and avoiding exposure to nephrotoxic agents such as heavy metals (e.g., lead) and excessive NSAID use are also essential. Secondary prevention involves the timely management of throat infections, kidney disease, hypertension, diabetes mellitus, and autoimmune conditions, alongside preventing disease progression through proper medication, diet, and lifestyle modifications. In children, avoiding excessive diaper use is important to prevent cystitis and pyelonephritis, particularly in girls, as their shorter

urethra increases the risk of infection. These strategies collectively aim to reduce the burden of glomerulonephritis and associated complications.

Recommendations: To manage and prevent glomerulonephritis relapse, it is essential to avoid allergenic foods, maintain a balanced diet with moderate protein and adequate caloric intake, and regulate fluid consumption based on urine output, particularly in cases of oliguria. Proper infection prevention measures, such as hand washing, good oral hygiene, completing antibiotic courses for streptococcal infections, and timely vaccination against pneumococcal infections, influenza, and varicella (avoiding live vaccines during immunosuppressive therapy), are crucial. Regular monitoring of blood pressure, urine output, kidney function, and follow-up urinalysis to assess proteinuria and haematuria is recommended, alongside vigilance for signs of infection. Adequate rest, maintaining routines, and encouraging schooling and social activities as the condition stabilises are vital for the child's recovery. Families should be educated to recognize early signs of relapse, such as swelling, frothy urine, infections, and hypertension, and provided emotional and psychological support. Long-term care involves regular paediatric nephrologist consultations to monitor kidney function and ensure sustained health outcomes. These measures promote effective management, minimize relapses, and support the child's overall well-being.

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