International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page: www.iscientific.org/Journal.html

Clinical profile of pediatric urolithiasis

Khaled A. Abdel Baseer[1], Neveen A Soliman[2], Mohamed A. Elmonem[3], Ebtesam A. Abdelbaset[1], Hala M. Sakhr[1]

[1]*Faculty of Medicine, South Valley University, Qena, Egypt*

[2]*Department of Pediatric Nephrology & Transplantation, Kasr Al Ainy Medical School, Cairo University, Cairo, Egypt*

[3]*Faculty of Medicine, Cairo University, Cairo, Egypt*

Abstract

The terms "urolithiasis," "kidney stones," and "renal calculi" are synonymous with denoting the accumulation of solid, hard, nonmetallic minerals within the urinary tract. Urolithiasis in childhood has been increasingly diagnosed in the past three decades in several countries around the world. To highlight the urolithiasis epidemiologic pattern and provide a management plan (diagnostic and therapeutic) for cases of pediatric urolithiasis. The unique clinical features of pediatric urolithiasis call for a customized approach to diagnosis and treatment. Positive results depend on both tailored treatment plans and an early and accurate diagnosis. More studies are required to investigate the long-term effects of the illness on children and preventative strategies.

Keywords: Pediatric Urolithiasis, Kidney Stones, Epidemiology, Diagnosis, Treatment.

Full length article **Corresponding Author*, e-mail: ebtesamahmed1989@gmail.com

1. Introduction

Urolithiasis is characterized by the presence of calculi in both the lower and upper urinary tracts. It has been a companion to mankind for millennia. The existence of urolithiasis in Ancient Egypt has been established through the examination of mummy remains and papyri dating back to 1500 BC. In India, invasive therapies have been recognized since the sixth century BC. Frequent occurrences of severe complications prompted an attempt at conservative treatment with botanicals possessing diuretic and decontaminating properties. Affected were various age categories, primarily adults. Treatment for urolithiasis evolved over the centuries; prophylaxis became more important, and thus the investigation into the disease's causes commenced. The increased morbidity of urolithiasis in recent years has resulted in a renewed interest in the disease. These days, children and newborns are also impacted, which was previously thought to be psychotic [1]. Many authors propose that urolithiasis should be viewed more as a sign than a disease, particularly in the pediatric population. Consequently, long-term specialized care and a comprehensive investigation of the potential causes must come after the diagnosis [2].

1.1 Epidemiology

Although urolithiasis is more commonly seen in adults, it is increasingly occurring at an alarming rate in children. This is related to how society has evolved, how people eat and live, and maybe even how accessible ultrasonography has become. People between the ages of 20 & 60 are often the ones diagnosed with the condition. Urolithiasis incidence rates in the literature vary greatly from one study to the next [3]. It is estimated that 4% of women & 5.5% of men in Germany suffer from urolithiasis. Some estimates put the number of afflicted Europeans at 6–7% of women and 11–15% of men. Urolithiasis affects approximately ten percent of the population's youth [4]. Roughly two percent of the general population has urolithiasis in children. The disease's incidence in youngsters has increased fivefold in the past decade, which deserves attention [5]. Urolithiasis was previously thought to affect more boys than girls in pediatric practice, but now researchers in the United States have found no gender difference and an uptick in cases among female adolescents. The "obesity epidemic" is mentioned as a potential connection. Diabetes mellitus and hypertension are further symptoms of the condition [1]. There are notable geographical variations. In the Western Hemisphere,

particularly in the USA, urolithiasis is more common. Those who live in developed nations and consume a lot of animal protein are especially impacted. As such, urolithiasis ought to be regarded as a disease of lifestyle. Saudi Arabia exhibits the highest intake of animal protein and the highest incidence of the disease in its geographical area, suggesting a close relationship between the two variables and diet. [6]. In Western industrialized nations, African Americans have the lowest risk of developing kidney stones, followed by Mexican Americans, with non-Hispanic Caucasians having the highest incidence. Comparable variations among ethnic groups have been documented in a number of recent pediatric investigations [7].

Individuals of Caucasian ancestry are more prone to developing deposits within the urinary tract. It is noteworthy that the African population exhibits a low prevalence of the disease, given the potential correlation between the disease and warmer climates [8]. A relatively recent trend has emerged where the majority of pediatric patients have a metabolic tendency to build deposits. British data reveal that the etiology of the disease has shifted in the past thirty years, shifting from viral origins to metabolic factors [9].

Evidence from industrialized nations shows that deposits almost seldom occur in the bladder and instead tend to form in the renal pelvis and ureter [1]. Recurrence rates of urolithiasis are rather significant, reaching as high as eighty percent, as reported in the literature. New deposits will occur in 35–50% of instances unless preventative therapy is done. When compared to adult populations, juvenile populations exhibit a substantially greater recurrence rate. The problem is that these entries are based on old data; new records should be created using up-to-date information [10]. Last but not least, urolithiasis is endemic in many developing nations, with stone compositions that differ significantly from those in the West. These countries include India, Pakistan, Southeast Asia, and the Middle East. The majority of endemic calculi, which are usually found in the bladder, are made of ammonium urate. This acid is excreted in large quantities due to a high acid load caused by an acidogenic diet consisting of rice or "single cereal" as well as diarrhea, as well as by a lack of phosphate in the diet as well as urine [11].

1.2 Clinical Presentation

Several variables, including gender, age, food intake, period, and geographic area, influence the clinical presentation and stone composition in pediatric patients with urolithiasis. Common first symptoms include soreness in the abdomen or flanks. One study from a North American tertiary care institution found that sixty-three percent of children with stones experienced flank pain, and eighty-two percent of those children had microscopic hematuria found during the examination. In addition to the listed symptoms, you may also have dysuria, gross hematuria, urgency, nausea, vomiting, and nausea. According to previous study, infants seldom experience the classic description of severe loin discomfort linked to stone passage, which is more common in adults. If a baby is experiencing belly pain, it might be due to stones, colic, or another gastrointestinal issue. While ureteral stones are more common in older children and are associated with higher rates of spontaneous stone passing, younger children often arrive with a heavier stone burden and mostly renal stones. Among 102 children with a very low birth weight, six percent had renal calcification found by chance [12]. The formation of urinary tract stones is a complicated process depending on the interplay between multiple factors [13].

1.2.1 Elements That Affect Stone Formation

- Urine pH
- Urine concentration of stone-forming metabolites
- Urine volume
- Balance between crystallization-promoting and crystallization-inhibiting factors
- Anatomic abnormalities causing urinary stasis
- presence of foreign bodies [13].

Calcium oxalate is the prevailing form of stone observed in minors, comprising approximately 45 to 65 percent of all stones. Struvite or magnesium ammonium phosphate stones comprise three percent to thirty percent of pediatric stones, with a higher prevalence observed in developing nations and Europe compared to North America. If these stones originate in the renal calyx, they may exhibit a staghorn morphology. People who have urinary tract infections caused by urease-splitting organisms, like Proteus, which make ammonium and bicarbonate, often have struvite stones. Additionally, an elevated urine pH may be a contributing factor to the formation of struvite stones. Most structuralvite stones are found in kids who have problems with their urogenital tract that make them more likely to get urinary tract infections. For example, kids with neurogenic bladder or horseshoe kidney need to have catheterization every so often. Cystine and uric acid stones, among others, comprise only five percent to ten percent of the total stones observed in minors.

1.2.2 Pediatric constitution of stones

- Calcium-based stones are the most prevalent variety among adolescents.
- Struvite stones are more prevalent in developing nations, whereas they are frequently associated with underlying genitourinary abnormalities in the US.
- URIC acid & cysteine stones are rare and are associated with metabolic stone-forming disorders that lie beneath the surface [13].

1.3 Investigation

1.3.1 Imaging studies

When it comes to diagnosing kidney stone disease, ultrasonography is both the most essential and easiest imaging technique. The test produces extremely accurate results when carried out by an experienced ultrasonographer. It is very difficult, if not impossible, to see deposits in the ureter, particularly in its central region. On color Doppler US, a normal stone appears as a hyperechogenic object with a twinkle artifact and a posterior acoustic shadow. The US can detect stones with a diameter of up to 2–3 mm [2]. It is recommended to do non-contrast spiral computed tomography if diagnostic issues are observed. High levels of sensitivity and specificity were seen in the study, and the approach is becoming more widely available. Radiation concerns, however, mean it shouldn't be your go-to approach. In low-dose procedures, the radiation dose ranges from 0.5 to 0.7 mSv, whereas in normal treatment it is around 3.7 mSv [1]. Abdominal X-

rays are now a diagnostic instrument that is seldom employed due to advancements in imaging technology. Before extracorporeal shock wave lithotripsy (ESWL), it is possible to achieve precise visualization of the deposit's location. Moreover, an abdominal X-ray can provide an initial evaluation of the composition of kidney stones. Ultracapacitate stones are completely radiolucent, whereas calcium phosphate and calcium oxalate stones exhibit radiopaque characteristics. Strucvite and cystine calculi display a faint radiopaque effect. Traditional X-ray examinations emit between 0.5 and 0.9 mSv of radiation [2].

1.3.2 Metabolic evaluation of urolithiasis

There are numerous diagnostic algorithms described in the literature. However, every author agrees that metabolic evaluation is essential in every case of urolithiasis among pediatric patients. Metabolic disorders are prevalent among this age group in the preponderance of cases [14]. It is important to carefully review the patient's medical history, paying close attention to any instances of immobilization or prior bone fractures, before beginning the assessment. Things to keep an eye out for include a history of urolithiasis in the family, bouts of hematuria, stomach discomfort, sterile pyuria, urinary tract infections, and other disorders. Patients' dietary habits, hydration consumption, and prescription usage should also be carefully monitored. Metabolic testing should be done many times throughout the time following stone displacement. The evaluation process involves blood tests, urine samples taken twice in the morning, and a 24-hour urine collection. After ruling out a UTI, adhering to a regular eating & exercise routine should allow for accurate analysis [9]. Preliminary and complete evaluations are the two typical steps in a laboratory setting. Accurate preparation for the following exams is made possible by preliminary tests. It is also guaranteed that future research will provide interpretable findings via these tests. Patients with chronic renal illness are one group that may not always provide interpretable data. Particular attention should be paid to specific gravity, pH, leukocyte esterase, the presence of white and RBCS, and electrolytes during the preliminary urinalysis portion. In conjunction with the interpretation of leukocyturia, a urine culture must be performed to rule out an infection of the urinary tract. An analysis should be conducted on the concentrations of blood gases, creatinine, sodium, potassium, chlorine, calcium, phosphorus, and uric acid [4]. During a comprehensive assessment, it is important to analyze the levels of creatinine, calcium, uric acid, sodium, phosphorus, and magnesium in the urine. If there are clinical or laboratory symptoms, it is necessary to evaluate the urine excretion of oxalate, citrate, and cystine. These substances are examined in both the 24-hour urine analysis and the second-morning urine sample. The elimination of these ions in the second-morning sample should be correlated with the elimination of creatinine. It is necessary to replicate the tests in order to obtain precise test outcomes. Patients are advised to adhere to their regular dietary regimen [9].

The blood composition ought to encompass the following elements: uric acid, creatinine, sodium, potassium, calcium, phosphorus, magnesium, metabolites of vitamin D (25OHD), & uric acid. TSH as well as parathyroid hormone concentrations should be evaluated in the presence of additional clinical &/or laboratory indications [15]. Daily pH monitoring is an invaluable diagnostic tool [4]. Compositional knowledge of the expulsed stone is required. Nonetheless, the analysis is occasionally deceptive and cannot replace a comprehensive patient evaluation. There are presently only three approaches utilized for the assessment of stone composition: Polarization microscopy, X-ray diffraction, as well as infrared spectroscopy [15]. By establishing prophylactic treatment for all cases of urolithiasis, metabolic evaluation enables the implementation of appropriate conservative treatment. The essential information pertaining to the excretion of substances in urine that are crucial for the diagnosis of urolithiasis in pediatric patients is enumerated in Table 1.

2. Management

2.1 Conservative treatment of urolithiasis

Preventative measures and medication tailored to the patient's particular kidney stone type should be an integral part of their long-term medical treatment. Avoid consuming rhubarb, sorrel, spinach, chocolate, tea, or cola-type beverages if you are being treated for calcium oxalate urolithiasis with high oxalate secretion. To decrease gastrointestinal oxalate absorption, one should adhere to a normocalcemic diet. If hypocitraturia is present, it is recommended to take potassium citrate or magnesium citrate supplements with vitamin B6. The recommendation to provide hydrochlorothiazide in order to decrease calcium excretion is made in cases where significant clinical symptoms such as hematuria, stomach discomfort, or a high rate of stone formation are present, or when lower bone mineral density is also evident. Recent changes have been made to the daily supplementation guidelines for vitamin D. Research has demonstrated that even moderately high concentrations of vitamin D do not induce or worsen hypercalciuria. Conversely, sufficient consumption of vitamin D inhibits calcium oxalate crystallization in the urinary tract (Gambaro et al., 2016). However, these results do not apply to children with hypersensitivity to vitamin D or overdose, particularly infants. Typically, these individuals exhibit symptoms including hypercalciuria, hypercalcemia, and an elevated level of 25OHD3. Individually determined quantities of vitamin D supplementation should be advised for the remaining patients. Calcium excretion in the urine must be monitored every three months. Acidic urine and hyperuricosuria facilitate the formation of uric acid stones. Alkalization of urine induces deposit dissolution, which generally renders conservative treatment the preferred approach. An increased fluid intake and urine pH within the range of 7.0–7.2 should accompany the treatment of uric acid stones. A pH range of 6.5-6.8 is suggested for the prevention of uric acid stone formation.

It is advised to consume an abundance of fruits and vegetables (primarily citrus). Potassium citrate should be administered on occasion. A purine-rich diet (organ meats, bouillon, legume seeds) and a reduction in the consumption of animal protein are both desirable. Precautions should be taken with the saline supply. The administration of pH-acidifying substances (cranberry, vitamin C) is contraindicated. Administration of allopurinol is recommended in the presence of hyperuricemia. Urease-positive bacteria that infect the urinary tract are what cause the formation of struvite (magnesium ammonium

phosphate) stones. It is critical to eliminate all deposits, as even minute residual fragments increase the risk of recurrent urinary tract infections and the formation of new stones. Treatment with antibacterial agents is advised. Additional effective strategies encompass urine acidification, restricting consumption of foods high in phosphate, and supplementing with magnesium. Cystine kidney stones are a result of cystinuria, a genetically influenced tubulopathy. A treatment that requires increased fluid intake (greater than 1.5 l/m2 in infants) is critical. Additionally, saline and methionine consumption should be restricted, particularly in the evening (meat products, eggs). The solubility of kidney stones is enhanced through the process of alkalizing urine to a pH greater than 7 using potassium citrate. Pharmacologic intervention should be implemented if this treatment approach is deemed inadequate. The kidneys have no trouble excreting the soluble compounds formed by D-penicillamine and tiopronin with cystine. Several negative effects are unfortunately associated with this medication. Additionally, captopril is prescribed to those who are experiencing hypertension or post-inflammatory nephropathy. Nonetheless, this treatment's efficacy is still up for debate [16]. All deposits should be expelled, save for those that require long-term preventive therapy. Patients suffering from renal colic should pay special attention to this. Kidney stones cause pain because they clog the urine canal and create pressure in the renal pelvis. Urinary tract constriction, dilated renal arteries, increased urine output, and nerve fiber irritation are all symptoms of this disorder, which in turn drives prostaglandin synthesis. Treatment known as medical expulsion therapy (MET) involves the administration of pain relievers and medications that aid in the ejection of the stones [17].

Most frequently, nonsteroidal anti-inflammatory drugs (NSAIDs) are employed for analgesic purposes. When persistent, intolerable pain is present, opioids are administered; they may be combined with NSAIDs. As an additional benefit to nonsteroidal anti-inflammatory drugs (NSAIDs), desmopressin inhibits renal pelvic contractions and has an antidiuretic effect, according to some authors. Preventing overhydration necessitates vigilant monitoring of fluid balance. The recommendation for desmopressin, nevertheless, is a subject of controversy. The mechanism by which NSAIDs facilitate stone expulsion is by decreasing inflammation-induced edema. Nevertheless, these factors have no impact on the velocity at which stones are expelled. Additional frequently prescribed medications include α-blockers (doxazosin, alfuzosin, and tamsulosin), which aid in the elimination of ureteral deposits; tamsulosin is the most efficacious among these. Literature contains descriptions of nifedipine use (calcium channel blockers) [18]. Tamsulosin is more effective than nifedipine in blocking the urethra and calyces' spontaneous activity. The literature contains recommendations for the use of corticosteroids in expulsion therapy, as their anti-inflammatory properties may help with deposit expulsion. Although it appears advantageous to use them in conjunction with nifedipine or a-blockers, corticosteroids shouldn't be used as a stand-alone treatment [19]. Extreme hydration is contraindicated due to its potential to worsen pain and result in urinary tract obstruction caused by the buildup of deposits [2].

2.2 Invasive treatment of urolithiasis

Urinary deposits can spontaneously expel up to 80% of them. The remaining kidney stones should be removed using the least invasive procedures possible. RIRS, PCNL, lithotripsy during ureteroscopy (URSL), and ESWL are some of these techniques. Only a small number of carefully chosen cases require traditional surgical care. One of the indications for open surgery is the malformations of the urinary tract that accompany urolithiasis. This type of treatment allows the anatomical abnormalities to be corrected simultaneously.

2.3 Differential Diagnoses

Pediatric urolithiasis, a condition characterized by the formation of stones in the urinary system of children, can be confused with several other medical conditions due to overlapping symptoms. These differential diagnoses include hematuria, where blood is present in the urine, and hemolytic-uremic syndrome, a condition involving the destruction of blood cells leading to kidney failure. Hemorrhagic Fever with Renal Failure Syndrome is another serious condition characterized by high fever and renal failure. Munchausen Syndrome by Proxy, a psychiatric disorder where a caregiver causes or fabricates symptoms in a child, could also mimic some urolithiasis symptoms. Pediatric IgA Nephropathy, an immune-mediated condition affecting the kidneys, and Pediatric Medullary Sponge Kidney, a congenital disorder causing cystic dilatation within the kidneys, are also potential differential diagnoses [20]. Pediatric nephritis, an inflammation of the kidneys; pediatric pyelonephritis, a type of kidney infection; and pediatric urinary tract infection, commonly presenting with pain and discomfort, could also present similarly. Polycystic Kidney Disease, a genetic disorder leading to numerous cysts in the kidneys; Renal Cortical Necrosis, a severe form of acute kidney injury; Uric Acid Stones, a type of kidney stone; and Xanthinuria, a rare metabolic disorder, complete the spectrum of conditions that might be considered in the differential diagnosis of pediatric urolithiasis. Each of these conditions requires careful evaluation to distinguish it from urolithiasis, as their treatments vary significantly [21].

Observation of the subsequent algorithm may prove beneficial in establishing a definitive diagnosis subsequent to the initial diagnosis established through the analysis of spot urine samples and other pertinent clinical data (Figure 1) [22].

3. Prognosis

Because urolithiasis can happen again and again, prevention, long-term treatment, metabolic control tests, and permanent changes to the way you eat are all necessary. As there is currently no established, dependable indicator to forecast the likelihood of new stone formation, it is impossible to evaluate the disease's progression. However, observational studies suggest that eighty percent of patients relapse if untreated (with the percentage ranging from fifty percent to one hundred percent, contingent upon the form of deposit). 10–15 percent is the recurrence rate among treated patients.

Table 1: Normal values for 24-hour urine & 2nd fasting morning urine sample.

	24 hour urine	2nd morning urine sample mg/mmol of creatinine		
Calcium	<4 mg (0.1 mmol)/kg	<1 year 1-3 year 3-5 year 5-7 year >7 year	mg/mg <0.81 <0.53 <0.39 <0.28 <0.21	mol/mol <2 <1.5 <1.1 <0.8 <0.6
Oxalate	<45 mg (0.5 mmol)/1.73 m^2	<6 months 7-24 months 2-5 year 5-14 year >16 year	mg/g <188-260 <110-139 <80 <60-65 <32	mmol/mol <325-360 <132-174 <100 <70-82 < 40
Citrate	>365 mg (1.9 mmol)/1.73m^2 >310 mg (1.6 mmol) /1.73m^2	<5 year >5 year	g/g >0.42 >0.25	mol/mol >0.25 >0.15
uric acid	<0.56 mg/dl (33 µmol/l)/GFR			
magnesium	>0.8 mg (0.04 mmol)/kg		mg/mg >0.13	mol/mol >0.63
Cystine	<10y <13 mg (55µmol)/1.73m^2 >10 year <48 mg (200 µmol) Adults <60 mg (250 µmol)			
phosphate	TRP 85-95%			

TRP − tubular phosphate reabsorption ratio.

Table 2: An overview of the conservative and invasive treatment for pediatric urolithiasis [23].

Treatment Option	Description	Typical Indications
Conservative Management	Involves hydration, dietary modifications, and pain management.	Small stones that are likely to pass spontaneously.
Medical Therapy	Utilizes medications to help dissolve the stones or facilitate their passage.	Stones are formed due to specific metabolic conditions.
ESWL	By applying shock waves, the stones are fragmented into more manageable fragments, facilitating their passage.	Stones less than 2 cm in size, in the kidney or ureter.
Ureteroscopy	A small scope is used to visualize and remove stones or break them up with a laser.	Stones in the ureter, especially the lower ureter.
PCNL	A minor incision is made in the back in order to extract the kidney stone immediately.	Large stones or stones that cannot be treated with SWL.
Open Surgery	Traditional surgery to remove kidney stones rarely used due to its more invasive nature.	Particularly large or intricate stones, or in situations where alternative techniques prove ineffective.

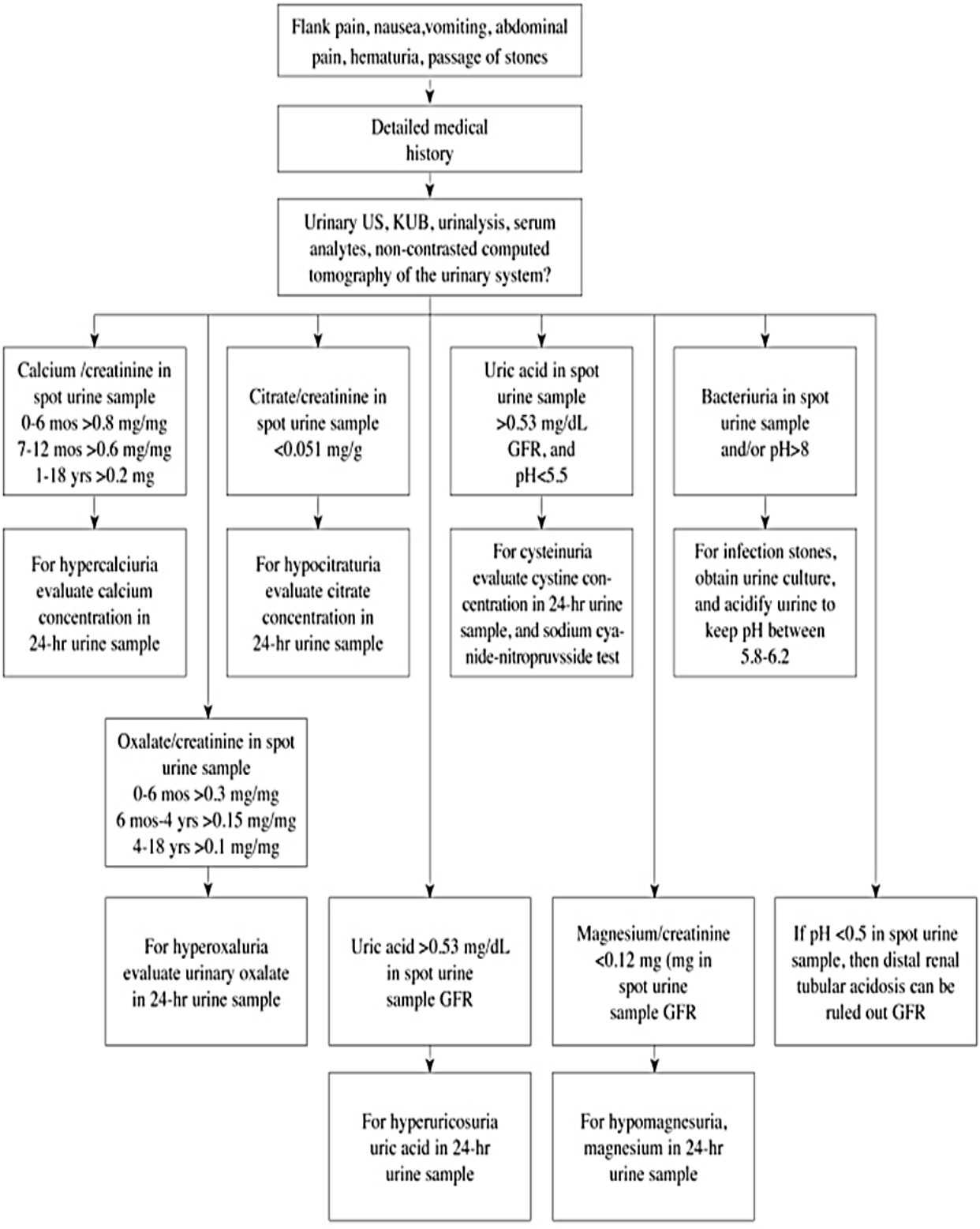

Fig 1: An algorithm that facilitates the differential diagnosis and practical assessment of pediatric urolithiasis [24].

Additionally, familial urolithiasis is observed in around forty percent of the reported cases [15]. Also influencing the prognosis is the specific variety of urolithiasis. It is imperative to emphasize that idiopathic hypercalciuria does not constitute the progression to chronic kidney disease. Individuals who experience urinary tract obstruction and recurrent urinary tract infections have an unfavorable prognosis. Consequently, the prognosis is significantly impacted by the provision of appropriate treatment [25].

4. **Conclusions**

Historically, delayed etiological diagnosis has resulted from the perception that pediatric urolithiasis is uncommon. It is imperative that all infants and children with stones undergo a comprehensive metabolic investigation. General metaphylaxis for all types of stones consists of modifications to the diet and sufficient fluid consumption. Cystinăuria and other stone-forming diseases continue to present a formidable treatment challenge due to the paucity of novel therapeutic approaches. Furthermore, routine examinations by pediatric nephrologists and pediatric urologists are required for these patients.

5**. List of abbreviation**

25OHD	Vitamin D
ESWL	Extracorporeal Shock Wave Lithotripsy
MET	Medical Expulsion Therapy
NSAIDs	Non-steroidal Anti-Inflammatory Drugs
PCNL	Percutaneous Nephrolithotripsy
RIRS	Retrograde Intrarenal Surgery
TRP	Tubular Phosphate Reabsorption Ratio
TSH	Thyroid-Stimulating Hormone
URSL	Lithotripsy During Ureteroscopy

References

[1] M.G.M.G. Penido, M.J.W.j.o.n. de Sousa Tavares. (2015). Pediatric primary urolithiasis: Symptoms, medical management and prevention strategies. 4(4): 444.

[2] P.J.P.p.D. Sikora. (2016). Kasza A. Kamica układu moczowego u dzieci: postępowanie diagnostyczno-terapeutyczne. 2.

[3] K. Stamatelou, D.S. Goldfarb In *Epidemiology of kidney stones*, Healthcare, 2023; MDPI: 2023; p 424.

[4] K.J.K.u.m.u.d.S.M. Gadomska-Prokop. (2015). Jobs K. 5: 714-723.

[5] E. Młynarska, J. Krzemińska, M. Wronka, B. Franczyk, J.J.I.J.o.M.S. Rysz. (2022). Rhabdomyolysis-induced AKI (RIAKI) including the role of COVID-19. 23(15): 8215.

[6] H.A. García-Perdomo, P.B. Solarte, P.P.J.U.C. España. (2016). Pathophysiology associated with forming urinary stones. 25(2): 118-125.

[7] V. Edvardsson, Urolithiasis in Children. In *Pediatric Nephrology*, Avner, E. D.,Harmon, W. E.,Niaudet, P.,Yoshikawa, N.,Emma, F.,Goldstein, S., Eds. Springer Berlin Heidelberg: Berlin, Heidelberg, 2014; pp 1-52.

[8] C.A. Torres-Vitolas, N. Dhanani, F.M.J.P.n.t.d. Fleming. (2021). Factors affecting the uptake of preventive chemotherapy treatment for schistosomiasis in Sub-Saharan Africa: A systematic review. 15(1): e0009017.

[9] A. Skolarikos, M. Straub, T. Knoll, K. Sarica, C. Seitz, A. Petřík, C.J.E.u. Türk. (2015). Metabolic evaluation and recurrence prevention for urinary stone patients: EAU guidelines. 67(4): 750-763.

[10] M. Kościelska, M.J.W.L. Mieczkowski. (2016). Metaphylaxis of urolithiasis-a neglected field in medicine? 69(5): 736-741.

[11] Y. Liu, Y. Chen, B. Liao, D. Luo, K. Wang, H. Li, G. Zeng. (2018). Epidemiology of urolithiasis in Asia. Asian J Urol. 5(4): 205-214.

[12] M. Rakowska, K. Królikowska, K. Jobs, M. Placzyńska, B.J.J.o.M. Kalicki, Child. (2018). Pathophysiology and symptoms of renal colic in children–A case report. 22(3): 265-269.

[13] V.J.A.i.P. Panzarino. (2020). Urolithiasis in children. 67: 105-112.

[14] G. Marra, F. Taroni, A. Berrettini, E. Montanari, G. Manzoni, G.J.J.o.n. Montini. (2019). Pediatric nephrolithiasis: a systematic approach from diagnosis to treatment. 32: 199-210.

[15] G. Gambaro, E. Croppi, F. Coe, J. Lingeman, O. Moe, E. Worcester, N. Buchholz, D. Bushinsky, G.C. Curhan, P.M.J.J.o.n. Ferraro. (2016). Metabolic diagnosis and medical prevention of calcium nephrolithiasis and its systemic manifestations: a consensus statement. 29: 715-734.

[16] M. Ordon, S. Andonian, B. Blew, T. Schuler, B. Chew, K.T.J.C.U.A.J. Pace. (2015). CUA Guideline: Management of ureteral calculi. 9(11-12): E837.

[17] I. Thia, M.J.A.J.o.G.P. Saluja. (2021). An update on management of renal colic. 50(7): 445-449.

[18] T. Campschroer, X. Zhu, R.W. Vernooij, M.T.J.C.D.o.S.R. Lock. (2018). Alpha-blockers as medical expulsive therapy for ureteral stones. (4).

[19] H. Wang, L.B. Man, G.L. Huang, G.Z. Li, J.W.J.D.d. Wang, development, therapy. (2016). Comparative efficacy of tamsulosin versus nifedipine for distal ureteral calculi: a meta-analysis. 1257-1265.

[20] A. Sehgal, S. Mehta, K. Sahay, E. Martynova, A. Rizvanov, M. Baranwal, S. Chandy, S. Khaiboullina, E. Kabwe, Y.J.V. Davidyuk. (2023). Hemorrhagic Fever with Renal Syndrome in Asia: History, Pathogenesis, Diagnosis, Treatment, and Prevention. 15(2): 561.

[21] B. Önal, E.A. Kırlı. (2021). Pediatric stone disease: Current management and future concepts. Turk Arch Pediatr. 56(2): 99-107.

[22] Y. Kumar, A. Koul, R. Singla, M.F.J.J.o.a.i. Ijaz, h. computing. (2022). Artificial intelligence in disease diagnosis: a systematic literature review, synthesizing framework and future research agenda. 1-28.

[23] R. Chimenz, L. Cannavò, V. Viola, V. Di Benedetto, M. Scuderi, L. Pensabene, V. Salvo, G.

D'Angelo, G. Stroscio, D.J.J.o.B.R. Impollonia, H. Agents. (2019). Pediatric urolithiasis. 33(5 Suppl. 1): 39-44. Special Issue: Focus on Pediatric Nephrolog.

[24] Y. Akın, M. Uçar, S. Yücel. (2013). Current medical treatment in pediatric urolithiasis. Turk J Urol. 39(4): 253-63.

[25] M. Montatore, G. Muscatella, L. Eusebi, F. Masino, R. Gifuni, W. Giannubilo, G. Sortino, G.J.C.R.R. Guglielmi. (2023). Current Status on New Technique and Protocol in Urinary Stone Disease. 1-16.