Astana Medical Journal
e2790-1203

https://doi.org/10.54500/2790-1203-2025-5-125-amj007

Modern Aspects of the Metaphylaxis Management for Recurrent Urolithiasis

Zhanat Tagayeva [1], Zhanat Nakipova [2], Saltanat Kyrkbayeva [3], Ainash Oshibayeva [4], Gulnaz Nuskabayeva [5], Kidirali Karimbayev [6]

[1] Doctoral student, International Kazakh-Turkish University named after Khoja Ahmed Yasawi, Turkestan, Kazakhstan

[2] Doctoral student, International Kazakh-Turkish University named after Khoja Ahmed Yasawi, Turkestan, Kazakhstan

[3] Head of the Center for Strategic Development, Rating, and Quality, International Kazakh-Turkish University named after Khoja Ahmed Yasawi, Turkestan, Kazakhstan

[4] Vice Rector for Science and Strategic Development, International Kazakh-Turkish University named after Khoja Ahmed Yasawi, Turkestan, Kazakhstan

[5] Associate professor, Dean of the Faculty of Medicine, International Kazakh-Turkish University named after Khoja Ahmed Yasawi, Turkestan, Kazakhstan

[6] Professor, Department of Surgical Diseases, International Kazakh-Turkish University named after Khoja Ahmed Yasawi, Turkestan, Kazakhstan

Received: 11.02.2025
Accepted: 21.06.2025
Published: 31.10.2025

*** Corresponding author:**
Zhanat Tagayeva,
E-mail: zhanet16-16@mail.ru

Citation: Astana Medical Journal, 2025, 125 (5), amj007.

Abstract

Urolithiasis, or kidney stone disease, is a common condition characterized by the formation of stones in the kidneys and urinary tract. The recurrence rate is about 50% within the first 5–10 years after the initial episode, making recurrence prevention a key medical goal. Metaphylaxis, a comprehensive approach to preventing stone recurrence, includes lifestyle modifications, dietary recommendations, pharmacotherapy, and regular patient monitoring. This approach allows consideration of individual metabolic, genetic, and environmental factors contributing to stone formation.

This review aims to summarize the literature on the primary methods used in the metaphylaxis of recurrent urolithiasis in adults.

A systematic review was conducted using databases such as PubMed, Embase, Cochrane Library, Web of Science, and Google Scholar. Studies published between 2010-2024 in English, Russian, and Kazakh were included. Clinical studies, RCTs, systematic reviews, and meta-analyses were selected. Citation tracking was also used to identify additional relevant sources.

The primary strategies for metaphylaxis in urolithiasis include increased fluid intake, dietary adjustments, and pharmacological treatment. Consuming at least 2.5 liters of water per day lowers the risk of stone formation. Pharmacotherapy with thiazides, citrates, and allopurinol has proven effective in reducing recurrence rates. Advanced technologies assist in patient monitoring and provide more precise treatment.

Metaphylaxis for urolithiasis represents a comprehensive approach based on lifestyle modifications, pharmacotherapy, and the use of new technologies. Personalized strategies have demonstrated effectiveness. Technological advancements promise further improvements in treatment outcomes and enhance patient adherence to preventive measures.

Key words: urolithiasis, kidney stones, recurrence, metaphylaxis, dietary therapy, pharmacotherapy, lifestyle changes.

1. Introduction

Urolithiasis, commonly referred to as kidney stones, affects approximately 10% of population globally and is associated with a high recurrence rate, with approximately 50% of patients experiencing stone formation again within 5-10 years of the initial episode [1,2]. Men are more likely to develop kidney stones; however, women often face more severe complications, such as a higher risk of chronic kidney disease (CKD) [2]. Recurrent urolithiasis presents not only a medical challenge but also a socioeconomic burden. Due to their acute presentation, kidney stones result in a significant number of emergency department visits and hospitalizations. Worldwide, the socioeconomic burden of recurrent urolithiasis is substantial, with healthcare costs exceeding billions annually. In the United States alone, the direct cost of kidney stones treatment was estimated at $3.79 billion in 2007, with projections indicating an annual increase of $1.24 billion by 2030 [3]. Frequent medical consultations, repeated surgical interventions, and a decline in patients' quality of life contribute to substantial healthcare costs [3,4,5]. Unlike many chronic conditions, kidney stones predominantly affect working-age individuals between 20 and 60 years old. This exacerbates economic costs, as the condition also results in productivity losses due to missed workdays and decreased efficiency in the workforce [3].

Despite advancements in treatment, metaphylaxis—the prevention of recurrence—remains a critical yet underexplored area. Current strategies, including lifestyle modification, dietary interventions, pharmacotherapy, and regular health monitoring, are often debated. For instance, the efficacy of pharmacological treatments like thiazides and allopurinol is questioned due to potential side effects and inconsistent outcomes [6]. Similarly, the role of dietary modifications, such as calcium restriction, remains controversial, as excessive restriction may actually increase stone formation risk [7]. These controversies highlight the need for a more personalized and evidence-based approach. This study aims to address these gaps by exploring innovative and tailored metaphylaxis strategies, considering metabolic, environmental, and genetic factors contributing to kidney stone formation.

2. Methods

To ensure a comprehensive and systematic review of the literature on metaphylaxis for recurrent urolithiasis, several academic databases were searched, including PubMed, Embase, the Cochrane Library, Web of Science, and Google Scholar. The search focused on articles published between 2010-2024, with no restrictions on geographical region but limited to studies published in English, Russian and Kazakh languages. The search terms included combinations of "urolithiasis", "kidney stones", "recurrent", "recurrence", "metaphylaxis", "prevention", "diet therapy", "pharmacotherapy", and "lifestyle modifications" among others. Boolean operators (AND, OR) were used to refine the search and capture studies covering various aspects of metaphylaxis, including dietary interventions, pharmacological approaches, and monitoring strategies.

As illustrated in Figure 1, a total of 1,254 studies were initially identified based on titles and abstracts. After removing duplicates, 1,041 records remained, of which 568 were excluded during title screening. The remaining 473 articles underwent abstract screening, resulting in the exclusion of an additional 295 studies. Consequently, 178 full-text articles were assessed for eligibility. Following the application of strict inclusion and exclusion criteria, 34 studies were ultimately included in the final analysis. The inclusion criteria were clinical studies, randomized controlled trials (RCTs), systematic reviews, meta-analyses, and large prospective studies, focusing on metaphylaxis strategies. Exclusion criteria included studies focused solely on surgical interventions for kidney stones and those not addressing recurrence prevention publications. Studies were also excluded if they consisted of case reports or small case series, as these provide limited generalizability for recurrence prevention. Additionally, articles were excluded if they lacked specific data on recurrence outcomes or were non-peer-reviewed, such as conference abstracts and opinion pieces, to maintain the rigor and relevance of the review. Citation tracking was also employed to identify additional relevant sources through forward and backward searching of key papers.

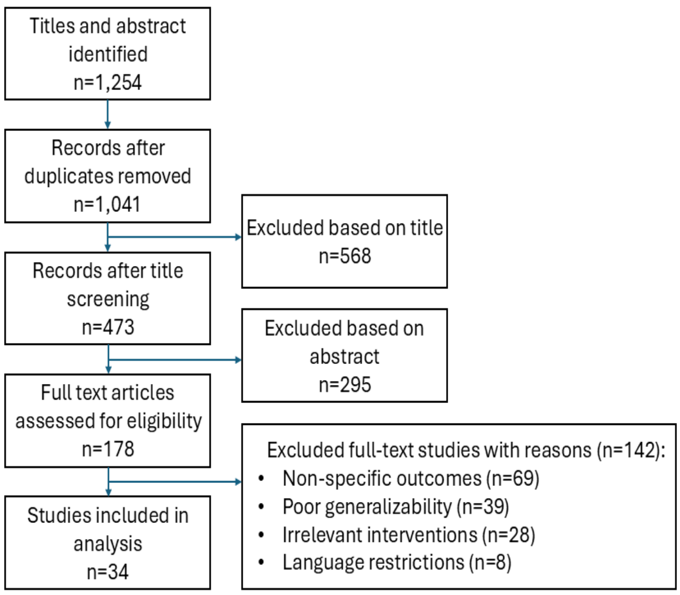

Figure 1 - Critical review selection flowchart

3. Results and discussion

Metaphylaxis for urolithiasis involves various strategies aimed at preventing the recurrence of kidney stones. The main strategies include:

Dietary Modifications

Increased *fluid intake* is one of the most basic strategies to reduce stone formation by diluting urine. Adults should aim to consume at least 2.5 to 3 liters of fluid per day [8]. Adequate fluid intake is essential to produce a urine volume of at least 2.5 liters per day, which helps dilute the concentration of stone-forming solutes such as calcium, oxalate, and uric acid [9]. Although there is no definitive threshold for urine volume and the risk of kidney stones recurrence, as the relationship is continuous and may not be linear. Increased urine volume reduces the supersaturation of these solutes, thereby decreasing the risk of crystal formation and stone growth [10]. Studies have shown that higher fluid intake is associated with a lower risk of stone recurrence [8,11]. While water is the most recommended fluid, other beverages can also contribute to fluid intake. Alkalizing beverages, such as citrus juices, can be particularly beneficial as they increase urinary citrate levels, which inhibit stone formation [12]. A recent systematic review has demonstrated that citrus-based products, such as lemonade, orange juice, and grapefruit juice, can increase urinary citrate levels and urine pH. The data indicates that citrus-based products raised urine pH (mean difference, 0.16; 95% confidence interval [CI] 0.01-0.32) and urinary citrate (mean difference 124.49; 95% CI 80.24-168.74) more significantly than the control treatment [13]. However, not all beverages are equally effective in lowering the risk of kidney stones. Conversely, consumption of sugar-sweetened sodas and punches is linked to an increased risk of kidney stone formation. One study depicted that drinking sugar-sweetened cola regularly increases the risk of developing kidney stones by 23% compared to those in the rarely drink [14].

Dietary adjustments may vary based on the type of stone and may include reducing or increasing the consumption of specific types of foods.

For *calcium oxalate stones,* it is recommended to maintain a balanced calcium intake of 1,000 to 1,200 mg daily from dietary sources, such as dairy products and leafy greens [15,16]. Additionally, limiting the intake of high-oxalate foods like spinach, nuts, chocolate, and tea can help reduce oxalate absorption [17,18]. For individuals with calcium kidney stones, it is crucial to limit salt intake to reduce the risk of stone formation. The excess of sodium reduces the kidney's ability to reabsorb calcium, resulting in higher calcium levels in the urine [19]. Current guidelines recommend consuming less than 2,300 mg of sodium per day, with a further reduction to 1,500 mg per day for those with a history of kidney stones [10]. High-sodium foods, such as processed and packaged items, should be avoided, and it is important to read nutrition labels to choose lower-sodium options. Cooking at home can also help control the amount of salt added to meals [20,21].

For *calcium phosphate stones,* maintaining balanced calcium intake from dietary sources is crucial, while avoiding excessive calcium supplementation, as excess calcium can increase the risk of phosphate stone formation [15,16]. Epidemiological evidence from a large study shows that the prevalence of stones progressively increases as dietary calcium intake falls below approximately 720 mg/day [22]. Like previous recommendations, reducing sodium intake to below 2,300 mg per day is advised, as high sodium consumption leads to elevated urinary calcium excretion [15,16]. Limiting animal protein intake is found to be beneficial, as animal protein diet is highly acidogenic due to its higher acid-ash content from sulfur, compared to plant-based proteins. This increased acidity causes urine to become more acidic, leading to higher urinary calcium [23,24,25]. Evidence distinguishing between the impacts of red meat, white meat, fish, and poultry on kidney stone formation, as well as the recommended amounts of protein, is sparse. [25]. Incorporating more fruits and vegetables into the diet helps maintain an alkaline urine pH, which is favorable for reducing the risk of calcium phosphate stone formation [24]. A diet rich in fruits, vegetables, and low in saturated fat significantly lowered the risk of kidney stones by 31%, according to a meta-analysis [26].

Uric acid stones form when urine remains consistently acidic, often due to a diet rich in purines - compounds found in foods such as red meat, organ meats, and certain fish. To reduce the risk of uric acid stones, limiting the intake of these high-purine foods is strongly recommended [27,28]. Same as with phosphate stones, increasing the consumption of fruits and vegetables helps to alkalize the urine, making it less favorable for uric acid stone formation [24]. Additionally, reducing alcohol intake, particularly beer, is advised since it can elevate uric acid levels [29]. Animal studies indicate that ethanol treatment in rats leads to crystal formation [30]. Yet, human studies show inconsistent evidence on the influence of alcohol on uric acid stone formation, particularly regarding the type and amount of alcohol consumed [29,31].

Key Points on Dietary Modifications

Dietary modifications play a crucial role in reducing the risk of kidney stones. Increasing daily fluid intake to at least 2.5–3 liters helps dilute urine and decreases the risk of crystal formation. Citrus-based beverages, like lemonade and orange juice, boost urinary citrate levels, which inhibit stone formation, while sugary drinks increase the risk. For calcium oxalate stones, maintaining a balanced calcium intake (1,000–1,200 mg) and limiting salt and high-oxalate foods are key. Similarly, calcium phosphate stones require moderate calcium intake, low sodium, and reduced animal protein consumption, alongside a diet rich in fruits and vegetables to maintain an alkaline urine pH. For uric acid stones, reducing purine-rich foods like red meat, increasing plant-based foods, and moderating alcohol intake are advised. Overall, individual dietary strategies depend on the specific type of kidney stone.

Pharmacotherapy

Pharmacological prophylaxis is an essential component of treatment for patients with confirmed metabolic abnormalities. Medications are tailored to each individual, taking into account both the composition of the kidney stones and the results of the patient's metabolic evaluation.

Thiazide Diuretics are used to reduce calcium excretion in patients with recurrent calcium-based stones. In a meta-analysis, the pooled relative risk (RR) for the incidence of kidney stones in patients treated with thiazide diuretics was 0.44 (95% CI 0.33–0.58, $P < 0.0001$) compared to placebo and untreated groups. The pooled risk difference (RD) was −0.23 (95% CI −0.30 to −0.16, $P < 0.0001$). Additionally, the pooled standardized mean difference (SMD) for 24-hour urinary calcium levels was −18.59 (95% CI −25.11 to −12.08, $P < 0.0001$) [32]. When prescribing thiazides, it is crucial to continue dietary recommendations, particularly sodium restriction, to enhance the hypocalciuric effect and minimize potassium loss [33]. Due to the potential for hypokalemia induced by thiazide therapy, potassium supplementation (such as potassium citrate or potassium chloride) may be necessary [34].

Allopurinol is used to prevent recurrent urolithiasis, particularly in adults who form uric acid stones or calcium oxalate stones associated with elevated uric acid levels. It is prescribed for patients who have recurrent stones despite other preventive measures or who have underlying conditions such as hyperuricosuria [10,35]. Moderate-quality evidence from four trials comparing allopurinol monotherapy with placebo or control in patients with calcium oxalate stones demonstrated a reduced risk of composite stone recurrence with allopurinol [36,37]. Two trials reported that the recurrence risk was lower in patients treated with allopurinol compared to placebo (33.3% vs. 55.4%). Additionally, one fair-quality study showed a reduction in symptomatic stone recurrence (10.3% vs. 29.0%) [36].

Regular monitoring of uric acid and kidney function is recommended during treatment [38].

Citrates are commonly used to prevent the recurrence of calcium oxalate and uric acid stones. Citrates increase urinary citrate levels, which helps bind calcium and reduce the formation of calcium-based stones, while also alkalinizing the urine, making it less conducive to uric acid stone formation [39]. In a critical review, citrate therapy was found to significantly reduce stone size, as evidenced by RCTs (RR 2.35, 95% CI 1.36 to 4.05). Additionally, the incidence of new stone formation was markedly lower with citrate therapy compared to the control group, according to seven RCTs (RR 0.26, 95% CI 0.10 to 0.68) [40]. Potassium citrate is particularly effective in patients with hypocitraturia [41,42]. A meta-analysis demonstrated that potassium citrate supplementation significantly reduced the recurrence of nephrolithiasis [RR; 95% CI 0.21 (0.13, 0.31)] [43].

Bisphosphonates, primarily known for treating osteoporosis, may also help prevent kidney stones, especially in individuals with low bone density. These medications work by inhibiting bone resorption, which can lower urinary calcium levels, a key factor in the formation of calcium-based kidney stones [44]. Additionally, bisphosphonates can inhibit the crystallization of calcium oxalate and calcium phosphate in the urine, further reducing the risk of stone formation [45]. Clinical studies have shown promising results, suggesting that bisphosphonates could be beneficial in reducing kidney stone recurrence in patients with conditions like osteoporosis or hypercalciuria [44,45]. In a study involving participants with low bone density, the use of bisphosphonates was linked to a reduced risk of kidney stone formation. Specifically, bisphosphonate use resulted in a multivariate-adjusted relative risk of 0.68 (95% CI 0.48-0.98) for kidney stone formation compared to those not using bisphosphonates [46].

Key Points on Pharmacotherapy

Pharmacotherapy is a vital part of managing kidney stones for patients with metabolic abnormalities. Thiazide diuretics lower calcium excretion and risk of recurrence in calcium-based stones, with sodium restriction and potassium supplementation enhancing their effect. Allopurinol reduces the recurrence of uric acid and calcium oxalate stones, especially in patients with elevated uric acid levels, requiring regular monitoring of uric acid and kidney function. Citrates increase urinary citrate levels to prevent calcium-based and uric acid stones and are particularly effective for patients with hypocitraturia. Bisphosphonates, primarily used for osteoporosis, also help prevent kidney stones by reducing urinary calcium levels and crystal formation, showing promising results for patients with low bone density or hypercalciuria. Each medication is tailored to the individual's metabolic profile and stone type for effective prevention.

Lifestyle Modifications

Regular *exercise* can play a significant role in preventing the recurrence of kidney stones. By helping to maintain a healthy body weight, exercise reduces the risk factors associated with obesity, which is known to contribute to stone formation [47,48,49,50]. Examining body fatness in relation to kidney stone risk, a meta-analysis found a 21% increase in relative risk for every 5-unit increase in BMI, a 16% increase for every 10 cm increase in waist circumference, and 6% and 12% increases in relative risk for every 5 kg increment in weight and weight gain, respectively [48]. Physical activity further promotes proper digestion and metabolism, which can help reduce the accumulation of substances that lead to stone development [47]. It’s important to stay well-hydrated during and after exercise to counteract the effects of sweating, which can lead to dehydration and increase the risk of stones [51]. Light to moderate activities, such as walking, jogging, or yoga, are particularly beneficial and can even help move existing stones along naturally [49].

Smoking has been identified as a significant risk factor for the development of kidney stones [52, 53]. Research indicates that active cigarette smoking is associated with a 30% increased risk of kidney stones compared to non-smokers [52]. Findings of another study also depicted that cigerette smoking significantly increases the risk of urolithiasis (OR = 2.06, 95% CI: 1.06-4.01, P = 0.034) [54]. The harmful chemicals in tobacco contribute to oxidative stress and reduce urine output, both of which are conducive to stone formation [52]. Cigarette smoking might also contribute to the development of urolithiasis by reducing urinary flow and elevating serum cadmium levels in healthy individuals [53]. Additionally, exposure to secondhand smoke has also been linked to an elevated risk of kidney stones, further underscoring the detrimental impact of smoking on renal health [55]. These findings highlight the importance of smoking cessation and avoidance of secondhand smoke as preventive measures against kidney stone formation.

Key Points on Lifestyle modifications

Lifestyle modifications significantly impact the prevention of kidney stones. Regular exercise helps maintain a healthy weight, reducing obesity-related risk factors for stone formation, while promoting proper digestion and metabolism. Staying well-hydrated during physical activities prevents dehydration, a key factor in stone development, with light to moderate exercises like walking and yoga proving especially beneficial. Smoking cessation is crucial, as both active smoking and secondhand smoke exposure elevate the risk of kidney stones by contributing to oxidative stress and impaired urinary flow. Overall, a combination of healthy physical activity and avoidance of smoking plays a vital role in preventing kidney stone recurrence.

Regular monitoring and follow-up

Monitoring and follow-up are essential for preventing the recurrence of kidney stones. Patients with a history of kidney stones should undergo periodic imaging studies, such as ultrasonography or low-dose computed tomography (CT), to detect new stone formation or growth of existing stones [56]. These follow-up assessments help in identifying any changes early, allowing for timely intervention. Additionally, regular laboratory evaluations, including urinalysis and blood tests, are crucial to monitor risk factors such as hypercalciuria, hyperuricosuria, and other metabolic abnormalities [57]. By maintaining consistent follow-up appointments, healthcare providers can tailor preventive strategies, adjust medications, and recommend lifestyle modifications to reduce the risk of recurrence. This proactive approach ensures that any potential issues are addressed promptly, thereby minimizing complications and improving patient outcomes.

Key Points on Regular monitoring and follow-up

Consistent check-ups allow healthcare providers to personalize preventive measures, adjust medications, and recommend lifestyle modifications tailored to the patient's needs. This proactive approach not only minimizes complications but also ensures optimal care and improved long-term outcomes for patients.

Individualized Treatment Based on Metabolic Evaluation

Personalized prevention of recurrent kidney stones is an increasingly important aspect of urolithiasis management, given the heterogeneous nature of stone formation and the variety of metabolic abnormalities contributing to their development. Individualized strategies are grounded in a detailed metabolic evaluation, typically involving urine and blood analyses, which help identify specific risk factors for recurrence [58]. This data-driven approach allows for the tailoring of both pharmacological and non-pharmacological interventions aimed at reducing the likelihood of stone formation.

Recent literature highlights the need for targeted interventions, as generalized treatment protocols may not address the underlying metabolic disorders unique to each patient. Personalized prevention may include adjustments in dietary intake, such as tailored recommendations regarding fluid, calcium, sodium, and oxalate intake, as well as the use of pharmacological agents based on the patient's metabolic profile. The goal of these interventions is not only to reduce stone formation but also to correct the metabolic derangements that predispose individuals to recurrence [58, 59]. Regular monitoring and individualized follow-up schedules further enhance the effectiveness of these strategies, ensuring that therapeutic adjustments can be made as needed to maintain the patient's metabolic stability over time.

Emerging research continues to support the efficacy of personalized approaches in preventing stone recurrence, advocating for their integration into standard nephrology practice.

Key Points on Individualized treatment

Individualized treatment for kidney stones focuses on tailoring prevention strategies to each patient's metabolic profile. Based on urine and blood analyses, specific risk factors are identified to guide personalized dietary and pharmacological interventions. Adjustments in fluid, calcium, sodium, and oxalate intake, alongside targeted medications, aim to reduce stone formation and correct underlying metabolic issues. Regular monitoring and follow-ups ensure effective adjustments over time, reinforcing the importance of personalized care in preventing recurrence.

New technologies

Recent advancements in technology have introduced promising methods for preventing the recurrence of kidney stones. One notable innovation is the use of a handheld ultrasound device to *reposition kidney stone fragments*. This technique, known as ultrasonic propulsion, helps move residual stone fragments closer to the ureter, facilitating their natural expulsion from the body [60, 61, 62]. Studies have shown that this method can reduce the risk of recurrence by up to 70%, significantly lowering the need for additional surgical interventions [60].

Traditionally, metabolic evaluation for kidney stones requires cumbersome 24-hour urine collections. However, newer *wearable* and smart technology devices are being developed to allow for real-time monitoring of key urinary parameters, such as pH, calcium, and uric acid concentrations. Latest studies revealed that urinary dipsticks are limited in both precision and accuracy for home monitoring, while portable electronic pH meters offer a more accurate, user-friendly, and cost-effective alternative [63, 64]. Providing continuous data and allowing independent use, these devices enable earlier intervention when stone-forming conditions arise and improve patient adherence to preventive measures, making them a reliable tool for reducing urolithiasis recurrence.

Mobile health (mHealth) technologies and telemedicine play a significant role in the metaphylaxis of kidney stones by enhancing patient monitoring, improving adherence to preventive measures, and facilitating timely medical interventions. mHealth applications allow patients to track their fluid intake, dietary habits, and medication schedules, which are crucial for preventing stone recurrence [65, 66]. These apps can provide reminders and educational content, helping patients stay informed and engaged in their care [67].

Telemedicine offers convenient access to healthcare providers, enabling regular follow-up appointments without the need for in-person visits. This is particularly beneficial for patients in remote areas or those with mobility issues [68]. Through telemedicine, healthcare providers can review patients' progress, adjust treatment plans, and provide immediate support for any concerns [69]. The integration of these technologies ensures continuous and personalized care, ultimately reducing the risk of kidney stone recurrence and improving patient outcomes.

Precision medicine is becoming more prevalent in nephrolithiasis management through the use of *genomic and proteomic technologies*. These approaches allow for the identification of genetic predispositions to stone formation, helping to tailor prevention strategies to the individual's metabolic and genetic makeup. For instance, integrated proteomic and transcriptomic analyses have identified distinct gene expression profiles and protein modifications associated with kidney stone disease [70]. Such studies have revealed key biomarkers and potential therapeutic targets, including specific genes and proteins that are dysregulated in stone-forming individuals.

Additionally, bioinformatics tools are being used to analyze large datasets, identifying differentially expressed genes and constructing interaction networks that highlight critical pathways involved in stone formation [71,72]. These insights further facilitate the development of personalized treatment strategies, targeting the unique genetic and proteomic landscape of each patient. By leveraging these advanced technologies, researchers and clinicians can better predict stone recurrence and tailor preventive measures more effectively, ultimately improving patient outcomes. One major finding is the identification of differentially expressed genes (DEGs) associated with kidney stone formation [71]. Additionally, bioinformatics analyses have constructed protein-protein interaction networks, revealing critical hub genes like LCN2, which are implicated in the occurrence and development of kidney stones [72].

Advanced *3D imaging* and reconstruction techniques, such as CT scans and MRIs, are pivotal in the accurate diagnosis and treatment planning for kidney stones. These imaging methods provide detailed, high-resolution images of the kidney and urinary tract, which can be converted into precise 3D models. Such models allow healthcare professionals to visualize the exact size, shape, and location of kidney stones, as well as the anatomy of the surrounding tissues [73,74]. Detailed visualization aids in developing personalized treatment plans, whether for surgical intervention or other therapeutic approaches. By enhancing the accuracy of diagnosis and treatment planning, 3D imaging, and reconstruction significantly improve patient outcomes and reduce the risk of complications during procedures [74].

Key Points on New Technologies

Advancements in technology offer innovative solutions for kidney stone management. Ultrasonic propulsion, a handheld ultrasound method, aids in expelling fragments and reduces recurrence. Wearable devices and portable pH meters now allow real-time monitoring of urinary parameters, enhancing early intervention and adherence. mHealth apps and telemedicine improve patient tracking, education, and access to care. Precision medicine leverages genomic and proteomic tools to tailor prevention strategies based on genetic profiles. Advanced 3D imaging enhances the precision of diagnosis and personalized treatment planning, ultimately improving outcomes. These breakthroughs collectively transform kidney stone prevention and care.

Table 1 - Summary review of articles

	Author(s)	Design	Results	Reference
1	Kiremit MC, Boyuk A, Petkova K.	Critical review	Drink >=2.5l of fluids; Avoid sugary drinks; Lower sodium intake; Reduce intake of oxalate-rich foods; Limit animal protein consumption.	Kiremit MC, Boyuk A, Petkova K. Fluid intake recommendations in urolithiasis and general advice to patients without metabolic risk factors. World J Urol. 2023; 41: 1251-9. https://doi.org/10.1007/s00345-023-04285-3
2	Pearle MS, Goldfarb DS, Assimos DG, Curhan G, Denu-Ciocca CJ, Matlaga BR, et al.	Systematic review	Drink >=2.5l of fluids; Lower sodium intake; Reduce intake of oxalate-rich foods; Limit animal protein consumption.	Pearle MS, Goldfarb DS, Assimos DG, Curhan G, Denu-Ciocca CJ, Matlaga BR, et al. Medical Management of Kidney Stones: AUA Guideline. J Urol [Internet]. 2014 Aug 1; 192(2): 316–324. https://doi.org/10.1016/j.juro.2014.05.006
3	Siener R.	Narrative review	Inadequate fluid intake is a major dietary risk factor; High oxalate intake increases the risk of calcium oxalate stones.	Siener R. Nutrition and Kidney Stone Disease. Nutrients. 2021; 13(6): 1917. https://doi.org/10.3390/nu13061917
4	Barghouthy Y, Somani BK.	Narrative review	Citrus fruit juices, particularly lemon and orange juices, can increase urinary citrate levels, which may help prevent kidney stone formation.	Barghouthy Y, Somani BK. Role of Citrus Fruit Juices in Prevention of Kidney Stone Disease (KSD): A Narrative Review. Nutrients. 2021; 13(11): 4117. https://doi.org/10.3390/nu13114117
5	Rahman F, Birowo P, Widyahening IS, Rasyid N.	Systematic review and meta-analysis	Significant increase in urinary citrate levels (mean difference, 124.49; 95% CI 80.24-168.74) compared to control group.	Rahman F, Birowo P, Widyahening IS, Rasyid N. Effect of citrus-based products on urine profile: A systematic review and meta-analysis. F1000Res. 2017 Mar 6; 6: 220. https://doi.org/10.12688/f1000research.10976.1 PMID: 28529700; PMCID: PMC5428529
6	Moe SM.	Critical review	Calcium intake in the form of diet and binders should not exceed 800–1000 mg/day to achieve neutral calcium balance in adult patients.	Moe SM. Rationale to reduce calcium intake in adult patients with chronic kidney disease. Curr Opin Nephrol Hypertens. 2018;27(4):251-7
7	Ferraro PM, Curhan GC, D'Addessi A, Gambaro G.	Systematic review	The median recurrence rate of kidney stones was 15 per 100 person-years; Recurrence rates were higher in untreated patients or those	Ferraro PM, Curhan GC, D'Addessi A, Gambaro G. Risk of recurrence of idiopathic calcium kidney stones: analysis of data from the literature. J Nephrol. 2017; 30: 227-33

			treated with dietary changes compared to those treated with drugs (26 vs. 23 vs. 9 per 100 person-years, $p < 0.001$).	
8	Lin BB, Lin ME, Huang RH, et al.	Systematic review and meta-analysis	Prominent risk factors for incident stones included body mass index (BMI), dietary sodium, fructose, meat, animal protein, and soda; Vitamin D and calcium supplementation alone increased the risk of stones in observational studies but not in RCTs.	Lin BB, Lin ME, Huang RH, et al. Dietary and lifestyle factors for primary prevention of nephrolithiasis: a systematic review and meta-analysis. BMC Nephrol. 2020; 21: 267. https://doi.org/10.1186/s12882-020-01925-3
9	Ferraro PM, Bargagli M, Trinchieri A, Gambaro G.	Critical review	A balanced vegetarian diet with dairy products is the most protective against kidney stones.	Ferraro PM, Bargagli M, Trinchieri A, Gambaro G. Risk of Kidney Stones: Influence of Dietary Factors, Dietary Patterns, and Vegetarian–Vegan Diets. Nutrients. 2020; 12: 779. https://doi.org/10.3390/nu12030779
10	Tracy CR, Best S, Bagrodia A, et al.	Randomized, crossover metabolic study	Fish associated with higher urinary uric acid than beef or chicken; Saturation index for calcium oxalate was highest for beef, indicating a marginally higher stone-forming propensity compared to chicken or fish.	Tracy CR, Best S, Bagrodia A, et al. Animal protein and the risk of kidney stones: a comparative metabolic study of animal protein sources. J Urol. 2014 Jul; 192(1): 137-141. https://doi.org/10.1016/j.juro.2014.01.093 PMID: 24518789
11	Jones P, Karim Sulaiman S, Gamage KN, Tokas T, Jamnadass E, Somani BK.	Systematic review	Four studies found a significant association between smoking and renal stone formation; The relationship between physical activity and KSD appears to be equivocal.	Jones P, Karim Sulaiman S, Gamage KN, Tokas T, Jamnadass E, Somani BK. Do lifestyle factors including smoking, alcohol, and exercise impact your risk of developing kidney stone disease? Outcomes of a systematic review. J Endourol. 2021 Jan; 35(1): 1-7. https://doi.org/10.1089/end.2020.0378 Epub 2020 Sep 9. PMID: 32808537
12	Wang H, Fan J, Yu C, Guo Y, Pei P, Yang L, Chen Y, Du H, Meng F, Chen J, et al.	Prospective cohort study	Tea, alcohol, and fruit consumption were found to be negatively associated with kidney stone risk; The linear trend was observed only in tea and fruit consumption; Participants who drank ≥7 cups of tea per day had a	Wang H, Fan J, Yu C, Guo Y, Pei P, Yang L, Chen Y, Du H, Meng F, Chen J, et al. Consumption of tea, alcohol, and fruits and risk of kidney stones: a prospective cohort study in 0.5 million Chinese adults. Nutrients. 2021; 13(4): 1119. https://doi.org/10.3390/nu13041119

			lower risk of kidney stones (HR: 0.73; 95% CI: 0.65–0.83) compared to non-tea consumers.	
13	Li DF, Gao YL, Liu HC, et al.	Systematic Review and Meta-Analysis	Thiazide diuretics significantly reduced the incidence of recurrent kidney calculi (pooled risk ratio: 0.44; 95% CI: 0.33–0.58); Thiazide diuretics decreased 24-hour urinary calcium levels (pooled standardized mean difference: -18.59; 95% CI: -25.11 to -12.08).	Li DF, Gao YL, Liu HC, et al. Use of thiazide diuretics for the prevention of recurrent kidney calculi: a systematic review and meta-analysis. J Transl Med. 2020; 18: 106. https://doi.org/10.1186/s12967-020-02270-7
14	Fink HA, Wilt TJ, Eidman KE, et al.	Systematic review	Soft-drink reduction decreased recurrent symptomatic stone risk (RR, 0.83 [CI, 0.71 to 0.98]); Thiazides, citrates, and allopurinol reduced composite stone recurrence risk in patients with multiple past calcium stones: Thiazides: RR, 0.52 [CI, 0.39 to 0.69] Citrates: RR, 0.25 [CI, 0.14 to 0.44] Allopurinol: RR, 0.59 [CI, 0.42 to 0.84].	Fink HA, Wilt TJ, Eidman KE, et al. Medical management to prevent recurrent nephrolithiasis in adults: a systematic review for an American College of Physicians Clinical Guideline. Ann Intern Med. 2013; 158(7): 535-43.
15	Fink HA, Wilt TJ, Eidman KE, et al.	Comparative effectiveness review	Low animal protein, normal to high calcium, and low sodium diet reduced composite stone recurrence (RR, 0.52 [CI, 0.29 to 0.95]); Low animal protein, high fruit and fiber, and low purine diet increased composite stone recurrence (RR, 5.88 [CI, 1.39 to 24.92]).	Fink HA, Wilt TJ, Eidman KE, et al. Recurrent nephrolithiasis in adults: Comparative effectiveness of preventive medical strategies. AHRQ Comparative Effectiveness Reviews; No. 61. 2012.
16	Lojanapiwat B, Tanthanuch M, Pripathanont C, et al.	Randomized controlled trial	Oral potassium-sodium citrate (81 mEq/day) vs. control (12 months):	Lojanapiwat B, Tanthanuch M, Pripathanont C, et al. Alkaline citrate reduces stone recurrence and regrowth after shockwave lithotripsy and percutaneous nephrolithotomy. Int Braz J Urol. 2011;37(5):611-6.

			Reduced hypocitraturia in treated group (7.69%) vs. control (37.83%) (p=0.007); Stone-free rate in treated group (92.3%) vs. control (57.7%).	https://doi.org/10.1590/S1677-55382011000500007
17	Phillips R, Hanchanale VS, Myatt A, Somani B, Nabi G, Biyani CS.	Systematic review	Citrate salts vs. placebo significantly reduced stone size and prevented new stone formation (RR, 0.26 [95% CI, 0.16 to 0.42]); Citrate salts vs. placebo increased urinary citrate levels, inhibiting crystallization (RR, 0.25 [CI, 0.14 to 0.44]); Citrate salts vs. placebo reduced need for retreatment for stone removal (RR, 0.52 [CI, 0.29 to 0.95]).	Phillips R, Hanchanale VS, Myatt A, Somani B, Nabi G, Biyani CS. Citrate salts for preventing and treating calcium containing kidney stones in adults. Cochrane Database Syst Rev. 2015 Oct 6; 2015(10): CD010057. https://doi.org/10.1002/14651858 CD010057.pub2. PMID: 26439475; PMCID: PMC9578669.
18	Zisman AL.	Critical review	Adequate dietary calcium vs. low calcium intake reduced stone recurrence (RR, 0.52 [CI, 0.29 to 0.95]); Citrate salts vs. no citrate salts reduced stone recurrence (RR, 0.25 [CI, 0.14 to 0.44]); Thiazides vs. no thiazides reduced stone recurrence (RR, 0.52 [CI, 0.39 to 0.69]).	Zisman AL. Effectiveness of treatment modalities on kidney stone recurrence. Clin J Am Soc Nephrol. 2017 Oct; 12(10): 1699-1708. https://doi.org/10.2215/CJN.11201016
19	Carvalho M, Erbano BO, Kuwaki E, et al.	Systematic review and meta-analysis	Potassium citrate vs. control significantly reduced stone recurrence (RR, 0.21 [95% CI, 0.13 to 0.31]); Potassium citrate vs. control increased stone-free rate (RR, 0.21 [CI, 0.13 to 0.31]); Potassium citrate vs. control showed no significant heterogeneity across studies (p = 0.224).	Carvalho M, Erbano BO, Kuwaki E, et al. Effect of potassium citrate supplement on stone recurrence before or after lithotripsy: systematic review and meta-analysis. Urolithiasis. 2017;45:449-455. https://doi.org/10.1007/s00240-016-0950-1
20	Kovacevic L, Lu H, Kovacevic N, Lakshmanan Y.	Experimental study	Risedronate vs. control induced the highest	Kovacevic L, Lu H, Kovacevic N, Lakshmanan Y. Effect of bisphosphonates on the crystallization of

			inhibitory activity (IA) of 37% on CaP at 0.001 mg/mL; Ibandronate vs. control had the strongest IA on COM (24%) at 0.001 mg/mL; Risedronate vs. control required a two-fold higher concentration (0.002 mg/mL) to inhibit MAP crystallization (30% IA); Etidronate vs. control required a four-fold higher concentration (0.004 mg/mL) to inhibit MAP crystallization (42% IA).	stone-forming salts in synthetic urine. Investig Clin Urol. 2020; 61(3): 310-5.
21	Prochaska M, Taylor E, Vaidya A, Curhan G.	Prospective cohort study	Low bone density vs. normal bone density increased risk of incident kidney stones (RR, 1.39 [95% CI, 1.20 to 1.62]); Bisphosphonate use vs. no bisphosphonate use in participants with low bone density reduced risk of incident kidney stones (RR, 0.68 [CI, 0.48 to 0.98]); Low bone density vs. normal bone density associated with higher 24-hour urine calcium excretion (mean difference, 10 mg/d [CI, 1 to 19]).	Prochaska M, Taylor E, Vaidya A, Curhan G. Low bone density and bisphosphonate use and the risk of kidney stones. Clin J Am Soc Nephrol. 2017 Aug 7; 12(8): 1284-1290. https://doi.org/10.2215/CJN.01420217 Epub 2017 Jun 2. PMID: 28576907; PMCID: PMC5544505.
22	Aune D, Mahamat-Saleh Y, Norat T, Riboli E.	Systematic review and meta-analysis	Each 5-unit increase in BMI was associated with a higher risk of kidney stones (RR, 1.21 [95% CI, 1.12 to 1.30]); Each 10 cm increase in waist circumference increased the risk (RR, 1.16 [CI, 1.12 to 1.19]); Participants with diabetes had a higher risk compared to those without (RR, 1.16 [CI, 1.03 to 1.31]); No significant association between high vs. low physical	Aune D, Mahamat-Saleh Y, Norat T, Riboli E. Body fatness, diabetes, physical activity and risk of kidney stones: a systematic review and meta-analysis of cohort studies. Eur J Epidemiol. 2018 Nov; 33(11): 1033-47. https://doi.org/10.1007/s10654-018-0426-4 Epub 2018 Jul 31. PMID: 30066054; PMCID: PMC6208979.

			activity and kidney stone risk (RR, 0.93 [CI, 0.78 to 1.10]).	
23	Ferraro PM, Curhan GC, Sorensen MD, Gambaro G, Taylor EN.	Prospective cohort study	Higher physical activity vs. lower physical activity reduced risk of kidney stones (RR, 0.75 [95% CI, 0.66 to 0.85]); Higher energy intake vs. lower energy intake increased risk of kidney stones (RR, 1.42 [CI, 1.25 to 1.61]); Combined higher physical activity and lower energy intake vs. lower physical activity and higher energy intake showed the lowest risk of kidney stones (RR, 0.58 [CI, 0.49 to 0.69]).	Ferraro PM, Curhan GC, Sorensen MD, Gambaro G, Taylor EN. Physical activity, energy intake and the risk of incident kidney stones. J Urol. 2015 Mar; 193(3): 864-8. https://doi.org/10.1016/j.juro.2014.09.010 Epub 2014 Sep 16. PMID: 25229560; PMCID: PMC4378568
24	Chen CH, Lee JI, Jhan JH, et al.	Prospective cohort study	Secondhand smoke exposure vs. no exposure increased risk of kidney stones (OR, 1.64 [95% CI, 1.21 to 2.23]).	Chen CH, Lee JI, Jhan JH, et al. Secondhand smoke increases the risk of developing kidney stone disease. Sci Rep. 2021; 11: 17694. https://doi.org/10.1038/s41598-021-97254-y
25	Sorensen MD, Dunmire B, Thiel J, et al.	Randomized controlled trial	Ultrasonic propulsion vs. observation increased time to relapse (1530 ± 92 days vs. 1009 ± 118 days) ($p < 0.003$); Ultrasonic propulsion vs. observation reduced risk of relapse (HR, 0.30 [95% CI, 0.13 to 0.68]); Ultrasonic propulsion vs. observation increased fragment passage within 3 weeks (63% vs. 5%) (OR, 30.00 [CI, 6.34 to 142.00]).	Sorensen MD, Dunmire B, Thiel J, et al. Randomized Controlled Trial of Ultrasonic Propulsion–Facilitated Clearance of Residual Kidney Stone Fragments vs Observation. J Urol. [cited 2024 Oct 24]; 0(0). Available from: https://doi.org/10.1097/JU.0000000000004186
26	Janssen KM, Brand TC, Cunitz BW, Wang YN, Simon JC, Starr F, Liggitt HD, Thiel J, Sorensen MD, Harper JD, Bailey MR, Dunmire B.	Experimental study	The technique successfully repositioned urinary stones and fragments in 100% of cases, improving patient outcomes; The study supports the use of longer focal beam and burst duration in ultrasonic propulsion as a safe and	Janssen KM, Brand TC, Cunitz BW, Wang YN, Simon JC, Starr F, Liggitt HD, Thiel J, Sorensen MD, Harper JD, Bailey MR, Dunmire B. Safety and effectiveness of a longer focal beam and burst duration in ultrasonic propulsion for repositioning urinary stones and fragments. J Endourol. 2017 Aug; 31(8): 793-799. https://doi.org/10.1089/end.2017.0167 Epub 2017 Jun 26. PMID: 28537452; PMCID: PMC5567608

			effective method for managing urinary stones and fragments.	
27	Sanz-Gómez I, Angerri O, Baboudjian M, et al.	Systematic review	Portable electronic pH meters showed a sensitivity of 85% (95% CI: 80-90%) and specificity of 90% (95% CI: 85-95%), making them more accurate than urinary dipsticks; Portable electronic pH meters were found to be cost-effective, with a cost per measurement of $0.50 (95% CI: $0.45-$0.55); These meters are reliable for home use, with a patient adherence rate of 75% (95% CI: 70-80%).	Sanz-Gómez I, Angerri O, Baboudjian M, et al. Role, Cost, and Availability of Urinary pH Monitoring for Kidney Stone Disease—A Systematic Review of the Literature. Curr Urol Rep. 2023; 24: 381-388. https://doi.org/10.1007/s11934-023-01166-5
28	Ungerer GN, Winoker JS, Healy KA, et al.	Systematic review	Smart" water bottles and mobile apps increased fluid intake in most studies.; Platforms improved the rate of long-term retained stents, with an improvement rate of 30% (95% CI: 25-35%); Virtual stone clinics increased access, lowered costs, and had satisfactory outcomes, with a cost reduction of 25% (95% CI: 20-30%); Smartphone-based endoscopy offered cost-effective image quality in resource-limited settings, with a cost-effectiveness of $100 per procedure (95% CI: $90-$110).	Ungerer GN, Winoker JS, Healy KA, et al. Mobile and eHealth technologies in the management and prevention of nephrolithiasis: A systematic review. Actas Urol Esp (Engl Ed). 2024 Jan-Feb; 48(1): 25-41. https://doi.org/10.1016/j.acuroe.2023.06.010 Epub 2023 Jun 25. PMID: 37364768
29	Young A, Orchanian-Cheff A, Chan CT, Wald R, Ong SW.	Scoping review	Patient satisfaction rate video-based telemedicine was 85% (95% CI: 80-90%); Improvement in clinical outcomes by 70% (95% CI: 65-75%);	Young A, Orchanian-Cheff A, Chan CT, Wald R, Ong SW. Video-based telemedicine for kidney disease care: a scoping review. Clin J Am Soc Nephrol. 2021 Dec; 16(12): 1813-1823. https://doi.org/10.2215/CJN.06660521

			Reduced in-person visits by 30% (95% CI: 25-35%).	
30	Zhu W, Qiong D, Yanli G, et al.	Experimental study	Six distinct gene clusters were identified in calculi rats. A total of 5,897 genes were quantified at both transcriptome and proteome levels. The study found increased expression of injured and apoptotic markers, immune molecules, and decreased expression of solute carriers, transporters, and metabolic-related factors.	Zhu W, Qiong D, Yanli G, et al. Proteomics and transcriptomics profiling reveals distinct aspects of kidney stone-related genes in calculi rats. BMC Genomics. 2023; 24: 127. https://doi.org/10.1186/s12864-023-09222-7
31	Gao Y, Liu D, Zhou H, et al.	Bioinformatics study	The study identified 44 upregulated DEGs and 1 downregulated DEG. Signaling pathways such as leukocyte migration, chemokine activity, NF-κB, TNF, and IL-17 were identified. Ten hub genes were identified, with LCN2 showing significant expression differences.	Gao Y, Liu D, Zhou H, et al. Identification of biomarkers and potential therapeutic targets of kidney stone disease using bioinformatics. World J Urol. 2024; 42: 17. https://doi.org/10.1007/s00345-023-04704-5
32	Khan SR, Canales BK, Dominguez-Gutierrez PR.	Review article	Urine supersaturation promotes kidney damage by inducing reactive oxygen species and oxidative stress, leading to Randall's plaque initiation and calcium stone formation. Kidney tissue surrounding Randall's plaques is associated with pro-inflammatory macrophages (M1) and downregulation of anti-inflammatory macrophages (M2). Increased expression of molecules implicated in the inflammatory cascade, including osteopontin, matrix Gla protein, and fetuin A, was observed.	Khan SR, Canales BK, Dominguez-Gutierrez PR. Randall's plaque and calcium oxalate stone formation: role for immunity and inflammation. Nat Rev Nephrol. 2021 Jun; 17(6): 417-433. https://doi.org/10.1038/s41581-020-00392-1 Epub 2021 Jan 29. PMID: 33514941

33	Seol YJ, Kang HW, Lee SJ, Atala A, Yoo JJ.	Review article	Bioprinting technology allows precise placement of cells, biomaterials, and biomolecules within 3D structures. It has been successfully used to construct tissues and organs for implantation, including heart valves, myocardial tissue, trachea, and blood vessels. Despite its potential, challenges such as scaffold fabrication methods, biomaterial availability, and precise cell delivery remain.	Seol YJ, Kang HW, Lee SJ, Atala A, Yoo JJ. Bioprinting technology and its applications. Eur J Cardiothorac Surg. 2014; 46: 342–348.
34	Esperto F, Prata F, Autrán-Gómez AM, et al.	Review article	3D printing and augmented reality technologies have significantly improved preoperative surgical planning, patient education, and surgical training. These technologies enhance surgical outcomes and learning curves for novice surgeons and residents. Future perspectives include broader intraoperative applications of augmented reality to further improve surgical precision and patient outcomes.	Esperto F, Prata F, Autrán-Gómez AM, et al. New technologies for kidney surgery planning: 3D, impression, augmented reality 3D, reconstruction—current realities and expectations. Curr Urol Rep. 2021; 22: 35. https://doi.org/10.1007/s11934-021-01052-y

4. Conclusion

Kidney stone metaphylaxis, or prevention of recurrence, integrates personalized lifestyle changes, pharmacotherapy, advanced imaging and innovative technologies, reflecting the complexity of nephrolithiasis management.

Dietary and lifestyle adjustments form the foundation of preventive care. Increasing fluid intake is universally recommended, as studies link high water consumption with a decrease in stone formation by diluting urinary solutes that contribute to stone crystallization. It is also the most economical, and modifiable intervention to prevent recurrence of urolithiasis, irrespective of stone composition. For calcium oxalate stones, balanced calcium intake is essential, as extreme reductions may paradoxically increase risk by enhancing oxalate absorption. Meanwhile, those with uric acid stones benefit from a diet low in purine-rich foods and increased intake of fruits and vegetables to alkalize urine. Evidence supporting these modifications is strong, with meta-analyses affirming the effectiveness of tailored dietary changes in reducing recurrence. Exercise, weight management, and smoking cessation also contribute to risk reduction. Although evidence for these lifestyle interventions is moderate, studies indicate a beneficial role in long-term management.

Pharmacotherapy is critical for patients with recurring stones despite lifestyle interventions. Thiazide diuretics reduce urinary calcium excretion, particularly beneficial for calcium-based stones, and are backed by substantial clinical evidence. Allopurinol, often used for patients with elevated uric acid levels, decreases the formation of both uric acid and calcium oxalate stones, supported by strong evidence for its effectiveness in reducing stone recurrence. Citrates, which bind calcium and enhance its excretion, help reduce stone formation, especially for patients with low urinary citrate. Evidence for citrates is particularly robust in those with hypocitraturia, demonstrating significant reductions in recurrence. Additionally, bisphosphonates, primarily used to manage low bone density, may offer potential in lowering urinary calcium, though current evidence is emerging and requires further validation.

Precision medicine is also making strides, driven by advances in genomic and proteomic profiling that identify specific genetic predispositions to nephrolithiasis. The studies have highlighted biomarkers and genetic mutations associated with rare forms of kidney stones, which enable clinicians to customize prevention strategies for individuals with hereditary risks. Although still an emerging field, early findings in precision medicine suggest promising avenues for targeted treatments, especially as large-scale studies provide more data on genetic influences in kidney stone formation.

Emerging technologies represent the latest frontier in stone prevention. Ultrasonic propulsion devices, which are still under research, allow for non-invasive repositioning of stone fragments in the urinary tract to facilitate natural expulsion, with studies reporting moderate to strong support for their effectiveness. Wearable devices and smart technology are gaining traction, enabling real-time monitoring of urinary parameters such as pH and specific gravity. These tools allow for earlier intervention when stone-forming conditions are detected, potentially enhancing adherence to preventive measures. Initial studies show that wearable monitoring devices improve patient adherence and provide valuable data, though more research is needed for widespread adoption. Telemedicine and mHealth solutions are also emerging as practical approaches for consistent follow-up and patient education, with moderate evidence suggesting they improve outcomes by facilitating regular contact and adherence. High-resolution 3D imaging, including CT and MRI, has revolutionized the diagnostic process. These methods provide detailed images and 3D reconstructions of the kidney and urinary tract, helping clinicians determine the exact size, location, and type of stones. Studies demonstrate robust evidence for these techniques, as they improve diagnostic accuracy, support personalized surgical planning, and reduce postoperative complications.

In summary, the field of kidney stone metaphylaxis has evolved into a multifaceted, evidence-based approach combining traditional preventive measures with cutting-edge technology. Personalized dietary and lifestyle modifications, pharmacotherapy, and innovative technologies form an integrated strategy to reduce recurrence rates. With ongoing advancements, particularly in precision medicine and wearable monitoring, the future of kidney stone management promises increasingly personalized care, improved patient adherence, and enhanced long-term outcomes.

Conflicts of Interest: The authors confirm the absence of any conflicts of interest.

Funding: This article is funded by the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. BR24992814).

References

1. Uribarri, J., Oh, M. S., Carroll, H. J. (1989). The first kidney stone. Annals of internal medicine, 111(12), 1006-1009. https://doi.org/10.7326/0003-4819-111-12-1006
2. Ferraro, P. M., Curhan, G. C., D'Addessi, A., Gambaro, G. (2017). Risk of recurrence of idiopathic calcium kidney stones: analysis of data from the literature. Journal of nephrology, *30*(2), 227-233. https://doi.org/10.1007/s40620-016-0283-8
3. Hyams, E. S., Matlaga, B. R. (2014). Economic impact of urinary stones. Translational andrology and urology, *3*(3), 278. https://doi.org/10.3978/j.issn.2223-4683.2014.07.02
4. New, F., Somani, B. K. (2016). A complete world literature review of quality of life (QOL) in patients with kidney stone disease (KSD). Current urology reports, *17*(12), 88. https://doi.org/10.1007/s11934-016-0647-6
5. Litwin, M. S., Saigal, C. S., Yano, E. M., Avila, C., Geschwind, S. A., Hanley, J. M., Urologic Diseases in America Project. (2005). Urologic diseases in America Project: analytical methods and principal findings. The Journal of urology, *173*(3), 933-937. https://doi.org/10.1097/01.ju.0000152365.43125.3b
6. Roudakova, K., Monga, M. (2014). The evolving epidemiology of stone disease. Indian Journal of Urology, *30*(1), 44-48. https://doi.org/10.4103/0970-1591.124206
7. Banov, P., Ceban, E. (2017). The efficacy of metaphylaxis in treatment of recurrent urolithiasis. Journal of medicine and life, *10*(3), 188. https://pubmed.ncbi.nlm.nih.gov/29075349/
8. Kiremit, M. C., Boyuk, A., Petkova, K. (2023). Fluid intake recommendations in urolithiasis and general advice to patients without metabolic risk factors. World Journal of Urology, *41*(5), 1251-1259. https://doi.org/10.1007/s00345-023-04285-3
9. Bernard, J., Song, L., Henderson, B., Tasian, G. E. (2020). Association between daily water intake and 24-hour urine volume among adolescents with kidney stones. Urology, *140*, 150-154. https://doi.org/10.1016/j.urology.2020.01.024
10. Pearle, M. S., Goldfarb, D. S., Assimos, D. G., Curhan, G., Denu-Ciocca, C. J., Matlaga, B. R., White, J. R. (2014). Medical management of kidney stones: AUA guideline. The Journal of urology, 192(2), 316-324. https://doi.org/10.1016/j.juro.2014.05.006
11. Siener, R. (2021). Nutrition and kidney stone disease. Nutrients, 13(6), 1917. https://doi.org/10.3390/nu13061917
12. Barghouthy, Y., Somani, B. K. (2021). Role of citrus fruit juices in prevention of kidney stone disease (KSD): A narrative review. Nutrients, *13*(11), 4117. https://doi.org/10.3390/nu13114117
13. Rahman, F., Birowo, P., Widyahening, I. S., Rasyid, N. (2017). Effect of citrus-based products on urine profile: A systematic review and meta-analysis. F1000Research, 6, 220. https://doi.org/10.12688/f1000research.10976.1
14. Ferraro, P. M., Taylor, E. N., Gambaro, G., Curhan, G. C. (2013). Soda and other beverages and the risk of kidney stones. Clinical Journal of the American Society of Nephrology, *8*(8), 1389-1395. https://doi.org/10.2215/CJN.11661112
15. Moe, S. M. (2018). Rationale to reduce calcium intake in adult patients with chronic kidney disease. Current opinion in nephrology and hypertension, *27*(4), 251-257. https://doi.org/10.1097/MNH.0000000000000416
16. Jayedi, A., Zargar, M. S. (2019). Dietary calcium intake and hypertension risk: a dose–response meta-analysis of prospective cohort studies. European journal of clinical nutrition, *73*(7), 969-978. https://doi.org/10.1038/s41430-018-0275-y
17. Coello, I., Sanchis, P., Pieras, E. C., Grases, F. (2023). Diet in different calcium oxalate kidney stones. Nutrients, *15*(11), 2607. https://doi.org/10.3390/nu15112607

18. Mitchell, T., Kumar, P., Reddy, T., Wood, K. D., Knight, J., Assimos, D. G., Holmes, R. P. (2019). Dietary oxalate and kidney stone formation. American Journal of Physiology-Renal Physiology, *316*(3), F409-F413. https://doi.org/10.1152/ajprenal.00373.2018

19. Ticinesi, A., Nouvenne, A., Maalouf, N. M., Borghi, L., Meschi, T. (2016). Salt and nephrolithiasis. Nephrology Dialysis Transplantation, *31*(1), 39-45. https://doi.org/10.1093/ndt/gfu243

20. Friedlander, J. I., Antonelli, J. A., Pearle, M. S. (2015). Diet: from food to stone. World journal of urology, *33*(2), 179-185. https://doi.org/10.1007/s00345-014-1344-z

21. Han, H., Segal, A. M., Seifter, J. L., Dwyer, J. T. (2015). Nutritional management of kidney stones (nephrolithiasis). Clinical nutrition research, *4*(3), 137-152. https://doi.org/10.7762/cnr.2015.4.3.137

22. Robertson, W. G. (2016). Dietary recommendations and treatment of patients with recurrent idiopathic calcium stone disease. Urolithiasis, *44*(1), 9-26. https://doi.org/10.1007/s00240-015-0849-2

23. Turney, B. W., Appleby, P. N., Reynard, J. M., Noble, J. G., Key, T. J., Allen, N. E. (2014). Diet and risk of kidney stones in the Oxford cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC). European journal of epidemiology, *29*(5), 363-369. https://doi.org/10.1007/s10654-014-9904-5

24. Lin, B. B., Lin, M. E., Huang, R. H., Hong, Y. K., Lin, B. L., He, X. J. (2020). Dietary and lifestyle factors for primary prevention of nephrolithiasis: a systematic review and meta-analysis. BMC nephrology, *21*(1), 267. https://doi.org/10.1186/s12882-020-01925-3

25. Tracy, C. R., Best, S., Bagrodia, A., Poindexter, J. R., Adams-Huet, B., Sakhaee, K., Pearle, M. S. (2014). Animal protein and the risk of kidney stones: a comparative metabolic study of animal protein sources. The Journal of urology, *192*(1), 137-141. https://doi.org/10.1016/j.juro.2014.01.093

26. Eckel, R. H., Jakicic, J. M., Ard, J. D., de Jesus, J. M., Houston Miller, N., Hubbard, V. S., Yanovski, S. Z. (2014). 2013 AHA/ACC guideline on lifestyle management to reduce cardiovascular risk: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Journal of the American college of cardiology, *63*(25 Part B), 2960-2984. https://www.jacc.org/doi/abs/10.1016/j.jacc.2013.11.003

27. Ferraro, P. M., Bargagli, M., Trinchieri, A., Gambaro, G. (2020). Risk of kidney stones: influence of dietary factors, dietary patterns, and vegetarian–vegan diets. Nutrients, *12*(3), 779. https://www.mdpi.com/2072-6643/12/3/779

28. Tracy, C. R., Best, S., Bagrodia, A., Poindexter, J. R., Adams-Huet, B., Sakhaee, K., Pearle, M. S. (2014). Animal protein and the risk of kidney stones: a comparative metabolic study of animal protein sources. The Journal of urology, *192*(1), 137-141. https://doi.org/10.1016/j.juro.2014.01.093

29. Shringi, S., Raker, C. A., Chonchol, M., Tang, J. (2024). Alcohol Intake and Prevalent Kidney Stone: The National Health and Nutrition Examination Survey 2007–2018. Nutrients, *16*(17), 2928. https://doi.org/10.3390/nu16172928

30. Jones, P., Karim Sulaiman, S., Gamage, K. N., Tokas, T., Jamnadass, E., Somani, B. K. (2021). Do lifestyle factors including smoking, alcohol, and exercise impact your risk of developing kidney stone disease? Outcomes of a systematic review. Journal of endourology, *35*(1), 1-7. https://doi.org/10.1089/end.2020.0378

31. Wang, H., Fan, J., Yu, C., Guo, Y., Pei, P., Yang, L., China Kadoorie Biobank Collaborative Group. (2021). Consumption of tea, alcohol, and fruits and risk of kidney stones: a prospective cohort study in 0.5 million Chinese adults. Nutrients, *13*(4), 1119. https://www.mdpi.com/2072-6643/13/4/1119#

32. Li, D. F., Gao, Y. L., Liu, H. C., Huang, X. C., Zhu, R. F., Zhu, C. T. (2020). Use of thiazide diuretics for the prevention of recurrent kidney calculi: a systematic review and meta-analysis. Journal of Translational Medicine, *18*(1), 106. https://doi.org/10.1186/s12967-020-02270-7

33. Türk, C., Petřík, A., Sarica, K., Seitz, C., Skolarikos, A., Straub, M., Knoll, T. (2016). EAU guidelines on interventional treatment for urolithiasis. European urology, *69*(3), 475-482. https://doi.org/10.1016/j.eururo.2015.07.041

34. Raffin, E. P., Penniston, K. L., Antonelli, J. A., Viprakasit, D. P., Averch, T. D., Bird, V. G., Pais Jr, V. M. (2018). The effect of thiazide and potassium citrate use on the health related quality of life of patients with urolithiasis. The Journal of Urology, *200*(6), 1290-1294. https://doi.org/10.1016/j.juro.2018.06.023

35. Fink, H. A., Wilt, T. J., Eidman, K. E., Garimella, P. S., MacDonald, R., Rutks, I. R., Monga, M. (2013). Medical management to prevent recurrent nephrolithiasis in adults: a systematic review for an American College of Physicians Clinical Guideline. Annals of internal medicine, *158*(7), 535-543. https://doi.org/10.7326/0003-4819-158-7-201304020-00005

36. Qaseem, A., Dallas, P., Forciea, M. A., Starkey, M., Denberg, T. D., Clinical Guidelines Committee of the American College of Physicians*. (2014). Dietary and pharmacologic management to prevent recurrent nephrolithiasis in adults: a clinical practice guideline from the American College of Physicians. Annals of internal medicine, *161*(9), 659-667. https://doi.org/10.7326/M13-2908

37. Skolarikos, A., Straub, M., Knoll, T., Sarica, K., Seitz, C., Petřík, A., Türk, C. (2015). Metabolic evaluation and recurrence prevention for urinary stone patients: EAU guidelines. European urology, *67*(4), 750-763. https://doi.org/10.1016/j.eururo.2014.10.029

38. Fink, H. A., Wilt, T. J., Eidman, K. E., Garimella, P. S., MacDonald, R., Rutks, I. R., Monga, M. (2012). Recurrent nephrolithiasis in adults: comparative effectiveness of preventive medical strategies. https://europepmc.org/article/nbk/nbk99762

39. Lojanapiwat, B., Tanthanuch, M., Pripathanont, C., Ratchanon, S., Srinualnad, S., Taweemonkongsap, T., Lammongkolkul, S. (2011). Alkaline citrate reduces stone recurrence and regrowth after shockwave lithotripsy and percutaneous nephrolithotomy. International braz j urol, *37*, 611-616. https://doi.org/10.1590/S1677-55382011000500007

40. Hanchanale, V. S., Myatt, A., Somani, B., Nabi, G., Biyani, C. S. (2015). Citrate salts for preventing and treating calcium containing kidney stones in adults. Cochrane Database of Systematic Reviews, (10). https://doi.org/10.1002/14651858.CD010057.pub2

41. Assimos, D. G. (2019). Re: The Impact of Potassium Citrate Therapy in the Natural Course of Medullary Sponge Kidney with Associated Nephrolithiasis. Journal of Urology, 202(6), 1091-1092. https://doi.org/10.1097/01.JU.0000585776.57180.54

42. Zisman, A. L. (2017). Effectiveness of treatment modalities on kidney stone recurrence. Clinical Journal of the American Society of Nephrology, *12*(10), 1699-1708. https://doi.org/10.2215/CJN.11201016

43. Carvalho, M., Erbano, B. O., Kuwaki, E. Y., Pontes, H. P., Liu, J. W. T. W., Boros, L. H., Baena, C. P. (2017). Effect of potassium citrate supplement on stone recurrence before or after lithotripsy: systematic review and meta-analysis. Urolithiasis, *45*(5), 449-455. https://doi.org/10.1007/s00240-016-0950-1

44. Prochaska, M. (2021). Bisphosphonates and management of kidney stones and bone disease. Current Opinion in Nephrology and Hypertension, *30*(2), 184-189. https://doi.org/10.1097/MNH.0000000000000682

45. Kovacevic, L., Lu, H., Kovacevic, N., Lakshmanan, Y. (2020). Effect of bisphosphonates on the crystallization of stone-forming salts in synthetic urine. Investigative and Clinical Urology, *61*(3), 310. https://doi.org/10.4111/icu.2020.61.3.310

46. Prochaska, M., Taylor, E., Vaidya, A., Curhan, G. (2017). Low bone density and bisphosphonate use and the risk of kidney stones. Clinical Journal of the American Society of Nephrology, *12*(8), 1284-1290. https://doi.org/10.2215/CJN.01420217

47. Yoshimura, E., Sawada, S. S., Lee, I. M., Gando, Y., Kamada, M., Matsushita, M., Blair, S. N. (2016). Body mass index and kidney stones: a cohort study of Japanese men. Journal of epidemiology, *26*(3), 131-136. https://doi.org/10.2188/jea.JE20150049

48. Aune, D., Mahamat-Saleh, Y., Norat, T., Riboli, E. (2018). Body fatness, diabetes, physical activity and risk of kidney stones: a systematic review and meta-analysis of cohort studies. European journal of epidemiology, *33*(11), 1033-1047. https://doi.org/10.1007/s10654-018-0426-4

49. Sorensen, M. D., Chi, T., Shara, N. M., Wang, H., Hsi, R. S., Orchard, T., Stoller, M. L. (2014). Activity, energy intake, obesity, and the risk of incident kidney stones in postmenopausal women: a report from the Women's Health Initiative. Journal of the American Society of Nephrology, *25*(2), 362-369. https://doi.org/10.1681/ASN.2013050548

50. Ferraro, P. M., Curhan, G. C., Sorensen, M. D., Gambaro, G., Taylor, E. N. (2015). Physical activity, energy intake and the risk of incident kidney stones. The Journal of urology, 193(3), 864-868. https://doi.org/10.1016/j.juro.2014.09.010

51. Feng, X., Wu, W., Zhao, F., Xu, F., Han, D., Guo, X., Lyu, J. (2020). Association between physical activity and kidney stones based on dose–response analyses using restricted cubic splines. European Journal of Public Health, 30(6), 1206-1211. https://doi.org/10.1093/eurpub/ckaa162

52. Tang, J., Chonchol, M., Raker, C. A., Sammartino, C. (2023). Cigarette Smoking and Prevalent Kidney Stone: The National Health and Nutrition Examination Survey 2011-2018: FR-PO831. Journal of the American Society of Nephrology, *34*(11S), 635. https://journals.lww.com/jasn/_layouts/15/oaks.journals/downloadpdf.aspx?an=00001751-202311001-02246

53. Sofia, N. H., Walter, T. M., Sanatorium, T. (2016). Prevalence and risk factors of kidney stone. Global Journal For Research Analysis, *5*(3), 183-187. https://www.academia.edu/download/107428932/March_2016_1459425668664.pdf

54. Tamadon, M. R., Nassaji, M., Ghorbani, R. (2012). Cigarette smoking and nephrolitiasis in adult individuals. Nephro-urology monthly, *5*(1), 702. https://doi.org/10.5812/numonthly.5251

55. Chen, C. H., Lee, J. I., Jhan, J. H., Lee, Y. C., Geng, J. H., Chen, S. C., Kuo, C. H. (2021). Secondhand smoke increases the risk of developing kidney stone disease. Scientific reports, *11*(1), 17694. https://doi.org/10.1038/s41598-021-97254-y

56. Fontenelle, L. F., Sarti, T. D. (2019). Kidney stones: treatment and prevention. American family physician, 99(8), 490-496. https://www.aafp.org/pubs/afp/issues/2019/0415/p490.html

57. Vaughan, L. E., Enders, F. T., Lieske, J. C., Pais, V. M., Rivera, M. E., Mehta, R. A., Rule, A. D. (2019, February). Predictors of symptomatic kidney stone recurrence after the first and subsequent episodes. In *Mayo* Clinic Proceedings (Vol. 94, No. 2, pp. 202-210). Elsevier. https://doi.org/10.1016/j.mayocp.2018.09.016

58. Hsi, R. S., Yan, P. L., Goldfarb, D. S., Egbuji, A., Si, Y., Shahinian, V., Hollingsworth, J. M. (2021). Comparison of selective versus empiric pharmacologic preventative therapy with kidney stone recurrence. Urology, *149*, 81-88. https://doi.org/10.1016/j.urology.2020.11.054

59. Assimos, D. (2013). Re: Recurrent Nephrolithiasis in Adults: Comparative Effectiveness of Preventive Medical Strategies [Internet]. The Journal of Urology, *189*(4), 1358-1359. https://doi.org/10.1016/j.juro.2012.12.033

60. Sorensen, M. D., Dunmire, B., Thiel, J., Cunitz, B. W., Burke, B. H., Levchak, B. J., Harper, J. D. (2024). Randomized controlled trial of ultrasonic propulsion–facilitated clearance of residual kidney stone fragments vs observation. Journal of Urology, 10-1097. https://journals.lww.com/auajuro/_layouts/15/oaks.journals/downloadpdf.aspx?an=00076734-990000000-01234

61. Janssen, K. M., Brand, T. C., Cunitz, B. W., Wang, Y. N., Simon, J. C., Starr, F., Dunmire, B. (2017). Safety and effectiveness of a longer focal beam and burst duration in ultrasonic propulsion for repositioning urinary stones and fragments. Journal of Endourology, *31*(8), 793-799. https://doi.org/10.1089/end.2017.0167

62. Hall, M. K., Thiel, J., Dunmire, B., Samson, P. C., Kessler, R., Sunaryo, P., Harper, J. D. (2022). First series using ultrasonic propulsion and burst wave lithotripsy to treat ureteral stones. The Journal of urology, *208*(5), 1075-1082. https://doi.org/10.1097/JU.0000000000002864

63. Sanz-Gomez, I., Angerri, O., Baboudjian, M., Kanashiro, A., Gracia, S., Millan, F., Emiliani, E. (2023). Role, Cost, and Availably of Urinary pH Monitoring for Kidney Stone Disease—A Systematic Review of the Literature. Current Urology Reports, *24*(8), 381-388. https://doi.org/10.1007/s11934-023-01166-5

64. Omar, M., Sarkissian, C., Jianbo, L., Calle, J., Monga, M. (2016). Dipstick Spot urine pH does not accurately represent 24 hour urine PH measured by an electrode. International braz j urol, *42*(3), 546-549. https://doi.org/10.1590/S1677-5538.IBJU.2015.0071

65. Ungerer, G. N., Winoker, J. S., Healy, K. A., Shah, O., Koo, K. (2024). Mobile and eHealth technologies in the management and prevention of nephrolithiasis: A systematic review. Actas Urológicas Españolas (English Edition), *48*(1), 25-41. https://doi.org/10.1016/j.acuroe.2023.06.010

66. Conroy, D. E., Dubansky, A., Remillard, J., Murray, R., Pellegrini, C. A., Phillips, S. M., Streeper, N. M. (2017). Using behavior change techniques to guide selections of mobile applications to promote fluid consumption. Urology, *99*, 33-37. https://doi.org/10.1016/j.urology.2016.09.015

67. Shahmoradi, L., Azizpour, A., Bejani, M., Shadpour, P., Rezayi, S. (2021). Prevention and control of urinary tract stones using a smartphone-based self-care application: design and evaluation. BMC medical informatics and decision making, 21(1), 299. https://doi.org/10.1186/s12911-021-01661-0

68. Young, A., Orchanian-Cheff, A., Chan, C. T., Wald, R., Ong, S. W. (2021). Video-based telemedicine for kidney disease care: a scoping review. Clinical Journal of the American Society of Nephrology, *16*(12), 1813-1823. https://doi.org/10.2215/CJN.06660521

69. Taha, A. R., Shehadeh, M., Alshehhi, A., Altamimi, T., Housser, E., Simsekler, M. C. E., Alhajri, N. (2022). The integration of mHealth technologies in telemedicine during the COVID-19 era: A cross-sectional study. PLoS One, 17(2), e0264436. https://doi.org/10.1371/journal.pone.0264436

70. Zhu, W., Qiong, D., Yanli, G., Min, L., Ying, Z., Qiyi, H., Hui, L. (2023). Proteomics and transcriptomics profiling reveals distinct aspects of kidney stone related genes in calculi rats. BMC genomics, *24*(1), 127. https://doi.org/10.1186/s12864-023-09222-7

71. Gao, Y., Liu, D., Zhou, H., Dong, Y., Xu, X., Zhan, X., Xu, Y. (2024). Identification of biomarkers and potential therapeutic targets of kidney stone disease using bioinformatics. World Journal of Urology, *42*(1), 17. https://doi.org/10.1007/s00345-023-04704-5

72. Khan, S. R., Canales, B. K., Dominguez-Gutierrez, P. R. (2021). Randall's plaque and calcium oxalate stone formation: role for immunity and inflammation. Nature Reviews Nephrology, *17*(6), 417-433. https://doi.org/10.1038/s41581-020-00392-1

73. Seol, Y. J., Kang, H. W., Lee, S. J., Atala, A., Yoo, J. J. (2014). Bioprinting technology and its applications. European Journal of Cardio-Thoracic Surgery, *46*(3), 342-348. https://doi.org/10.1093/ejcts/ezu148

Esperto, F., Prata, F., Autrán-Gómez, A. M., Rivas, J. G., Socarras, M., Marchioni, M., Papalia, R. (2021). New technologies for kidney surgery planning 3D, impression, augmented reality 3D, reconstruction: current realities and expectations. Current urology reports, *22*(7), 35. https://doi.org/10.1007/s11934-021-01052-y

Бүйрек тас ауруы қайталануының метафилактикасының заманауи аспектілері

Тагаева Ж.А. [1], Накипова Ж.Ж. [2], Кырыкбаева С.С. [3], Ошибаева А.Е. [4], Нускабаева Г.О. [5], Каримбаев К.К. [6]

[1] Докторант, Қожа Ахмет Ясауи атындағы Халықаралық қазақ-түрік университеті, Түркістан, Қазақстан

[2] Докторант, Қожа Ахмет Ясауи атындағы Халықаралық қазақ-түрік университеті, Түркістан, Қазақстан

[3] Стратегиялық даму, рейтинг және сапа орталығының басшысы, Қожа Ахмет Ясауи атындағы Халықаралық қазақ-түрік университеті, Түркістан, Қазақстан

[4] Ғылым және стратегиялық даму вице-ректоры, Қожа Ахмет Ясауи атындағы Халықаралық қазақ-түрік университеті, Түркістан, Қазақстан

[5] Қауымдастырылған профессор, Медицина факультетінің деканы, Қожа Ахмет Ясауи атындағы Халықаралық қазақ-түрік университеті, Түркістан, Қазақстан

[6] Хирургиялық аурулар кафедрасының профессоры, Қожа Ахмет Ясауи атындағы Халықаралық қазақ-түрік университеті, Түркістан, Қазақстан

Түйіндеме

Уролитиаз немесе бүйрек тас ауруы - зәр шығару жолдарында тастардың пайда болуымен сипатталатын кең таралған ауру. Бастапқы эпизодтан кейінгі алғашқы 5-10 жыл ішінде қайталану деңгейі шамамен 50% құрайды, бұл қайталанудың алдын алу медицинаның маңызды міндетіне айналды. Метафилактика, тастардың қайта пайда болуының алдын алудың кешенді тәсілі ретінде өмір сүру салтын түзетуді, диеталық ұсыныстарды, дәрі-дәрмек терапиясын және пациенттің жағдайын үнемі бақылауды қамтиды. Бұл тәсіл тастардың пайда болуына ықпал ететін жеке метаболикалық, генетикалық және экологиялық факторларды ескеруге мүмкіндік береді.

Бұл шолудың мақсаты – ересектер арасындағы қайталанатын бүйрек тас ауруының метафилактикасының негізгі әдістері туралы әдебиеттерді жалпылау.

PubMed, Embase, Cochrane Library, Web of Science және Google Scholar сияқты дерекқорларды пайдалана отырып, қайталанатын бүйрек тас ауруы кезіндегі метафилактика әдістері бойынша жүйелі шолу жұмысы жүргізілді. 2010-2024 жылдар аралығында ағылшын, орыс және қазақ тілдерінде жарияланған зерттеулер енгізілді. Іздеу уролитиаз, бүйрек тас ауруы, қайталану, алдын алу, диеталық терапия, фармакотерапия және өмір сүру салтын өзгертуге қатысты терминдерге бағытталған. Клиникалық зерттеулер, РКЗ, жүйелі шолулар және мета-талдаулар таңдалды. Қосымша тиісті дереккөздерді табу үшін дәйексөздерді қадағалау әдісі де қолданылды.

Бүйрек тас метафилактикасының негізгі стратегияларына сұйықтықты тұтынуды арттыру, диетаны түзету және дәрі-дәрмекпен емдеу кіреді. Күніне кем дегенде 2,5 литр су тұтыну зәрдегі тұздардың концентрациясын төмендетеді, тас пайда болу қаупін азайтады. Тиазидтерді, цитраттарды және аллопуринолды қолданатын фармакотерапия қайталану жиілігін төмендетуде тиімді екенін дәлелдеді. Заманауи технологиялар, соның ішінде киілетін құрылғылар мен 3D кескіндері пациенттердің жағдайын бақылауға көмектеседі және дәлірек емдеуді қамтамасыз етеді.

Тас ауруының метафилактикасы өмір сүру салтын өзгертуге, фармакотерапияға және жаңа технологияларды қолдануға негізделген кешенді тәсіл болып табылады. Сұйықтықты көп тұтынуды, диетаны өзгертуді және тұрақты бақылауды қоса алғанда, жекелендірілген стратегиялар бүйрек тастарының қайталану жылдамдығын төмендетуде тиімді екенін дәлелдеді. Киілуге болатын құрылғылар мен телемедицина сияқты технологиялық жетістіктер емдеу нәтижелерін одан әрі жақсартуға және пациенттердің профилактикалық шараларды сақтауын арттыруға мүмкіндіктер береді.

Кілт сөздер: уролитиаз, бүйрек тас ауруы, қайталану, метафилактика, диеталық терапия, фармакотерапия, өмір сүру салтын өзгерту.

Современные аспекты метафилактики рецидивов мочекаменной болезни

Тагаева Ж.А. [1], Накипова Ж.Ж. [2], Кырыкбаева С.С. [3], Ошибаева А.Е. [4], Нускабаева Г.О. [5], Каримбаев К.К. [6]

[1] Докторант, Международный казахско-турецкий университет имени Ходжи Ахмеда Ясави, Туркестан, Казахстан

[2] Докторант, Международный казахско-турецкий университет имени Ходжи Ахмеда Ясави, Туркестан, Казахстан

[3] Руководитель центра стратегического развития, рейтинга и качества, Международный казахско-турецкий университет имени Ходжи Ахмеда Ясави, Туркестан, Казахстан

[4] Проректор по науке и стратегическому развитию, Международный казахско-турецкий университет имени Ходжи Ахмеда Ясави, Туркестан, Казахстан

[5] Ассоциированный профессор, декан Медицинского факультета, Международный казахско-турецкий университет имени Ходжи Ахмеда Ясави, Туркестан, Казахстан

[6] Профессор кафедры «Хирургические болезни», Международный казахско-турецкий университет имени Ходжи Ахмеда Ясави, Туркестан, Казахстан

Резюме

Уролитиаз, или мочекаменная болезнь - распространенное заболевание, характеризующееся образованием камней в почках и мочевыводящих путях. Частота рецидивов составляет около 50% в течение первых 5–10 лет после начального эпизода, что делает профилактику рецидивов важной задачей медицины. Метафилактика, комплексный подход к предотвращению повторного образования камней, включает коррекцию образа жизни, диетические рекомендации, медикаментозную терапию и регулярный мониторинг состояния пациента. Такой подход позволяет учитывать индивидуальные метаболические, генетические и экологические факторы, способствующие образованию камней.

Целью данного обзора является обобщение литературы по основным методам метафилактики рецидивирующей мочекаменной болезни у взрослых.

Была проведена систематическая обзорная работа по литературе по метафилактике при рецидивирующем уролитиазе с использованием баз данных, таких как PubMed, Embase, Cochrane Library, Web of Science и Google Scholar. Включены исследования, опубликованные в период с 2010 по 2024 год на английском, русском и казахском языках. Поиск был сосредоточен на терминах, связанных с уролитиазом, рецидивами, профилактикой, диетотерапией, фармакотерапией и изменениями образа жизни. Были выбраны клинические исследования, РКИ, систематические обзоры и мета-анализы. Также использовался метод отслеживания цитат для поиска дополнительных релевантных источников.

Основные стратегии метафилактики уролитиаза включают повышение потребления жидкости, коррекцию диеты и медикаментозное лечение. Потребление не менее 2,5 литров воды в день снижает концентрацию солей в моче, уменьшая риск камнеобразования. Фармакотерапия с использованием тиазидов, цитратов и аллопуринола доказала эффективность в снижении частоты рецидивов. Современные технологии, включая носимые устройства и 3D-изображения, помогают в мониторинге состояния пациентов и обеспечивают более точное лечение.

Метафилактика уролитиаза представляет собой комплексный подход, основанный на изменении образа жизни, фармакотерапии и применении новых технологий. Персонализированные стратегии, включая поддержание высокого уровня потребления жидкости, изменения в диете и регулярный мониторинг, доказали свою эффективность в снижении частоты рецидивов камней в почках. Технологические достижения, такие как

носимые устройства и телемедицина, обещают дальнейшее улучшение результатов лечения и повышение приверженности пациентов к профилактическим мерам.

Ключевые слова: уролитиаз, камни в почках, рецидив, метафилактика, диетическая терапия, фармакотерапия и изменения образа жизни.