EAU GUIDELINES ON UROLITHIASIS

(Limited text update March 2019)

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Aetiology and classification

Urinary stones can be classified according to the following aspects: aetiology of stone formation, stone composition (mineralogy), stone size, stone location and X-ray characteristics of the stone. The recurrence risk is basically determined by the disease or disorder causing the stone formation.

Risk groups for stone formation

The risk status of stone formers is of particular interest because it defines the probability of recurrence or regrowth, and is imperative for pharmacological treatment (Table 1).

Table 1: High-risk stone formers

General factors
Early onset of urolithiasis (especially children and teenagers)
Familial stone formation
Brushite-containing stones ($CaHPO_4.2H_2O$)
Uric acid and urate-containing stones
Infection stones
Solitary kidney (the kidney itself does not particularly increase the risk of stone formation, but prevention of stone recurrence is of more importance)

Diseases associated with stone formation
Hyperparathyroidism
Metabolic syndrome
Nephrocalcinosis
Polycystic kidney disease (PKD)
Gastrointestinal diseases (i.e., jejuno-ileal bypass, intestinal resection, Crohn's disease, malabsorptive conditions, enteric hyperoxaluria after urinary diversion) and bariatric surgery
Increased levels of vitamin D
Sarcoidosis
Spinal cord injury, neurogenic bladder
Genetically determined stone formation
Cystinuria (type A, B and AB)
Primary hyperoxaluria (PH)
Renal tubular acidosis (RTA) type I
2,8-Dihydroxyadeninuria
Xanthinuria
Lesch-Nyhan syndrome
Cystic fibrosis
Drug-induced stone formation
Anatomical abnormalities associated with stone formation
Medullary sponge kidney (tubular ectasia)
Ureteropelvic junction (UPJ) obstruction
Calyceal diverticulum, calyceal cyst
Ureteral stricture
Vesico-uretero-renal reflux
Horseshoe kidney
Ureterocele
Environmental factors
High ambient tempertures
Chronic lead and cadmium exposure

Diagnostic Evaluation

Diagnostic imaging

Standard evaluation of a patient includes taking a detailed medical history and physical examination. The clinical diagnosis should be supported by appropriate imaging.

Recommendation	Strength rating
With fever or solitary kidney, and when diagnosis is doubtful, immediate imaging is indicated.	Strong

Ultrasound (US) should be used as the primary diagnostic imaging tool, although pain relief, or any other emergency measures, should not be delayed by imaging assessments.

Kidney-ureter-bladder (KUB) urography should not be performed if non-contrast-enhanced computed tomography (NCCT) is considered, but KUB urography can differentiate between radiolucent and radiopaque stones and be used for comparison during follow up.

Recommendation for radiologic examination of patients with acute flank pain/suspected ureteral stones	Strength rating
Following initial ultrasound assessment, use non-contrast-enhanced computed tomography to confirm stone diagnosis in patients with acute flank pain.	Strong

Recommendation for radiologic examination of patients with renal stones	Strength rating
Perform a contrast study if stone removal is planned and the anatomy of the renal collecting system needs to be assessed.	Strong

Diagnostics: Metabolism-related

Each emergency patient with urolithiasis needs a succinct biochemical work-up of urine and blood; no difference is made between high- and low-risk patients.

Recommendations: basic laboratory analysis - Emergency stone patients	Strength rating
Urine	
Dipstick test of spot urine sample: • red cells; • white cells; • nitrite; • approximate urine pH; • urine microscopy and/or culture.	Strong
Blood	
Serum blood sample: • creatinine; • uric acid; • (ionised) calcium; • sodium; • potassium; • blood cell count; • C-reactive protein.	Strong
Perform a coagulation test (partial thromboplastin time and international normalised ratio) if intervention is likely or planned.	Strong

Examination of sodium, potassium, C-reactive protein (CRP), and blood coagulation time can be omitted if no intervention is planned in non-emergency stone patients. Patients at high risk for stone recurrences should undergo a more specific analytical programme (see section on Metabolic Evaluation).

Recommendations related to non-emergency stone analysis	Strength rating
Perform stone analysis in first-time formers using a valid procedure (X-ray diffraction or infrared spectroscopy).	Strong
Repeat stone analysis in patients presenting with: • recurrent stones despite drug therapy; • early recurrence after complete stone clearance; • late recurrence after a long stone-free period because stone composition may change.	Strong

Diagnosis for special groups/conditions

Pregnancy

Recommendations	Strength rating
Use ultrasound as the preferred method of imaging in pregnant women.	Strong
In pregnant women, use magnetic resonance imaging as a second-line imaging modality.	Strong
In pregnant women, use low-dose computed tomography as a last-line option.	Strong

Children

Recommendations	Strength rating
In all children, complete a metabolic evaluation based on stone analysis.	Strong
Collect stone material for analysis to classify the stone type.	Strong
Perform ultrasound (US) as first-line imaging modality in children when a stone is suspected; it should include the kidney, fluid-filled bladder and the ureter.	Strong
Perform a kidney-ureter-bladder radiography (or low-dose non-contrast-enhanced computed tomography) if US will not provide the required information.	Strong

In children, the most common non-metabolic disorders facilitating stone formation are vesico-ureteral reflux, uretero-pelvic junction obstruction (UPJ), neurogenic bladder, and other voiding difficulties.

The radiation dose for intravenous urography (IVU) is comparable to that for voiding cysto-urethrography, but the need for contrast medium injection is a major drawback.

Disease Management

Acute treatment of a patient with renal colic

Pain relief is the first therapeutic step in patients with an acute stone episode.

Đây là một trường hợp bệnh nhân xuất hiện cơn đau quặn thận trái do sỏi kích thước nhỏ (4-5 mm) ở niệu quản trái đoạn chậu. Xử trí đầu tiên phù hợp nhất trên bệnh nhân này là lựa chọn **(C) Điều trị nội khoa nhằm tống sỏi theo đường tự nhiên**. Theo hướng dẫn của hội niệu khoa Châu Âu 2019, đây là phương pháp nên được lựa chọn khi bệnh nhân có sỏi nhỏ (< 6 mm) và chưa có biến chứng lên đường tiết niệu.

Recommendations	Strength rating
Offer a non-steroidal anti-inflammatory as the first drug of choice. E.g. metamizol*** (dipyrone); alternatively paracetamol or, depending on cardiovascular risk factors, diclofenac*, indomethacin or ibuprofen**.	Strong
Offer opiates (hydromorphine, pentazocine or tramadol) as a second choice.	Weak
Offer renal decompression or uretero-scopic stone removal in case of analgesic refractory colic pain.	Strong

** Affects glomerular filtration rate (GFR) in patients with reduced renal function.*

*** Recommended to counteract recurrent pain after ureteral colic.*

**** Maximum single oral dose recommended 1000 mg, total daily dose up to 5000 mg, not recommended last 3 months of pregnancy and breastfeeding (EMA, Dec. 2018).*

Administration of daily α-blockers seems to reduce colic episodes, although controversy remains in the published literature.

If analgesia cannot be achieved medically, drainage, using stenting or percutaneous nephrostomy or stone removal, should be performed.

Management of sepsis and anuria in the obstructed kidney

The obstructed, infected, kidney is a urological emergency.

Recommendations	Strength rating
Urgently decompress the collecting system in case of sepsis with obstructing stones, using percutaneous drainage or ureteral stenting.	Strong
Delay definitive treatment of the stone until sepsis is resolved.	Strong

In exceptional cases, with severe sepsis and/or the formation of abscesses, an emergency nephrectomy may become necessary.

Recommendations – Further measures	Strength rating
Collect (again) urine for antibiogram test following decompression.	Strong
Start antibiotics immediately (+ intensive care, if necessary).	Strong
Re-evaluate antibiotic regimen following antibiogram findings.	Strong

Medical expulsive therapy (MET)

Medical expulsive therapy should only be used in informed patients. Treatment should be discontinued if complications develop (infection, refractory pain, deterioration of kidney function).

Medical expulsive therapy, using α-blockers, seems to be efficacious treating patients with ureteric stones that are amenable to conservative management. Patients benefitting most might be those with larger (distal) stones.

There is no or insufficient evidence to support the use of phosphodiesterase type 5 inhibitor (PDE-5i) or corticosteroids in combination with α-blockers as a standard adjunct to active stone removal.

Recommendation for medical expulsive therapy	Strength rating
Offer α-blockers as medical expulsive therapy as one of the treatment options for (distal) ureteral stones > 5 mm.	Strong

Chemolytic dissolution of stones

Oral chemolysis of stones or their fragments can be useful in uric acid stones. It is based on alkalinisation of urine by application of alkaline citrate or sodium bicarbonate. The pH should be adjusted to 7.0-7.2.

Recommendations – Oral chemolysis	Strength rating
Inform the patient how to monitor urine-pH by dipstick and to modify the dosage of alkalising medication according to urine pH, as changes in urine pH are a direct consequence of such medication.	Strong
Carefully monitor patients during/after oral chemolysis of uric acid stones.	Strong
Combine oral chemolysis with tamsulosin in case of (larger) ureteral stones (if active intervention is not indicated).	Weak

Percutaneous irrigation chemolysis is rarely used any more.

Shock Wave lithotripsy (SWL)

The success rate for SWL will depend on the efficacy of the lithotripter and on:

- size, location (ureteral, pelvic or calyceal), and composition (hardness) of the stones;
- patient's habitus;
- performance of SWL.

Contraindications of SWL

Contraindications are few, but include:

- pregnancy;
- bleeding diatheses; which should be compensated for at least 24 hours before and 48 hours after treatment;
- untreated urinary tract infections (UTIs);
- severe skeletal malformations and severe obesity, which prevent targeting of the stone;
- arterial aneurysm in the vicinity of the stone;
- anatomical obstruction distal to the stone.

Best clinical practice (best performance) in SWL

Stenting prior to SWL

Routine use of internal stents before SWL does not improve stone-free rates, nor lowers the number of auxiliary treatments. It may, however, reduce formation of steinstrasse.

Pacemaker

Patients with a pacemaker can be treated with SWL. Patients with implanted cardioverter defibrillators must be managed with special care (firing mode temporarily reprogrammed during SWL treatment). However, this might not be necessary with new-generation lithotripters.

Shock waves, energy setting and repeat treatment sessions

- The number of shock waves that can be delivered at each session depends on the type of lithotripter and shock wave power.
- Starting SWL on a lower energy setting with step-wise power ramping prevents renal injury.
- Optimal shock wave frequency is 1.0 to 1.5 Hz.
- Clinical experience has shown that repeat sessions are feasible (within one day for ureteral stones).

Procedural control

Recommendations - Procedural control	Strength rating
Ensure correct use of the coupling agent because this is crucial for effective shock wave transportation.	Strong
Maintain careful fluoroscopic and/or ultrasonographic monitoring during shock wave lithotripsy.	Strong
Use proper analgesia because it improves treatment results by limiting pain-induced movements and excessive respiratory excursions.	Strong

Antibiotic prophylaxis

No standard prophylaxis prior to SWL is recommended.

Recommendation	Strength rating
In the case of infected stones or bacteriuria, prescribe antibiotics prior to shock wave lithotripsy.	Strong

Ureteroscopy (URS) (retrograde and antegrade, retrograde renal surgery)

Apart from general problems, for example with general anaesthesia or untreated UTIs, URS can be performed in all patients without any specific contraindications.

If ureteral access is not possible, insertion of a JJ stent followed by URS after several days is an alternative. During URS, placement of a safety wire is recommended, even though some groups have demonstrated that URS can be performed without it.

Ureteral access sheaths allow easy, multiple, access to the upper urinary tract; however, its insertion may lead to ureteral damage.

Recommendations	Strength rating
Use holmium: yttrium-aluminium-garnet (Ho:YAG) laser lithotripsy for (flexible) ureteroscopy (URS).	Strong
Perform stone extraction only under direct endoscopic visualisation of the stone.	Strong
Do not insert a stent in uncomplicated cases.	Strong
Pre-stenting facilitates URS and improves outcomes of URS (in particular for renal stones).	Strong
Offer medical expulsive therapy for patients suffering from stent-related symptoms and after Ho:YAG laser lithotripsy to facilitate passage of fragments.	Strong

Percutaneous nephrolithotomy (PNL)

Patients with bleeding diathesis or receiving anticoagulant therapy must be monitored carefully pre- and post-operatively. Anticoagulant therapy must be discontinued before PNL. Contraindications to PNL include:

- untreated UTI;
- tumour in the presumptive access tract area;
- potential malignant kidney tumour;
- pregnancy.

Best clinical practice

Both prone and supine positions are equally safe. Percutaneous nephrolithotomy performed with small instruments tends to be associated with significantly lower blood loss, but the duration of procedure tends to be significantly longer.

Recommendations	Strength rating
Perform pre-procedural imaging, including contrast medium where possible or retrograde study when starting the procedure, to assess stone comprehensiveness and anatomy of the collecting system to ensure safe access to the renal stone.	Strong
In uncomplicated cases, perform a tubeless (without nephrostomy tube) or totally tubeless (without nephrostomy tube and ureteral stent) percutaneous nephrolithotomy procedure.	Strong

Stone Removal

Recommendations	Strength rating
Obtain a urine culture or perform urinary microscopy before any treatment is planned.	Strong
Exclude or treat urinary tract infections prior to stone removal.	Strong
Offer peri-operative antibiotic prophylaxis to all patients undergoing endourological treatment.	Strong
Offer active surveillance to patients at high risk of thrombotic complications in the presence of an asymptomatic calyceal stone.	Weak
Decide on temporary discontinuation, or bridging of antithrombotic therapy in high-risk patients, in consultation with the internist.	Strong

Retrograde (flexible) ureteroscopy is the preferred intervention if stone removal is essential and antithrombotic therapy cannot be discontinued, since it is associated with less morbidity.	Strong

Radiolucent uric acid stones can be dissolved by oral chemolysis.

Ureteral stones

Observation of ureteral stones is feasible in informed patients who develop no complications (infection, refractory pain, deterioration of kidney function).

Recommendations	Strength rating
In patients with newly diagnosed small* ureteral stones, if active removal is not indicated, observe patient initially with periodic evaluation.	Strong
Offer α-blockers as medical expulsive therapy as one of the treatment options for (distal) ureteral stones > 5 mm.	Strong
Inform patients that ureteroscopy (URS) has a better chance of achieving stone-free status with a single procedure when compared with shock wave lithotripsy.	Strong
Inform patients that URS has higher complication rates when compared to shock wave lithotripsy.	Strong
In cases of severe obesity use ureteroscopy as first-line therapy for ureteral (and renal) stones.	Strong

**See stratification data (J Urol, 2007. 178: 2418).*

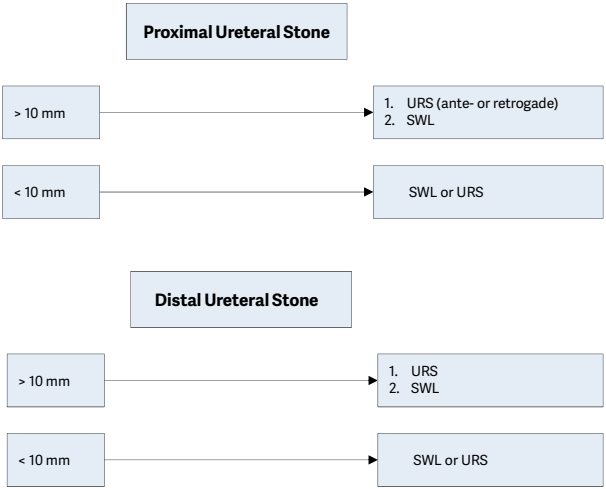
Indication for active stone removal and selection of procedure

Ureter:

- stones with a low likelihood of spontaneous passage;
- persistent pain despite adequate pain medication;
- persistent obstruction;
- renal insufficiency (renal failure, bilateral obstruction, single kidney).

The suspected stone composition might influence the choice of treatment modality.

Figure 1: Treatment algorithm for ureteral stones (If active stone removal is indicated) (Strength rating: Strong)



SWL = shock wave lithotripsy; URS = ureteroscopy.

Recommendation	Strength rating
Use percutaneous antegrade removal of ureteral stones as an alternative when shock wave lithotripsy is not indicated or has failed, and when the upper urinary tract is not amenable to retrograde ureteroscopy.	Strong

Renal stones

It is still debatable whether all stones should be treated, or whether annual follow-up is sufficient for asymptomatic calyceal stones that have remained stable for six months.

Recommendations	Strength rating
Follow-up periodically in cases where renal stones are not treated (initially after six months then yearly, evaluating symptoms and stone status [either by ultrasound, kidney-ureter bladder radiography or computed tomography]).	Strong
Offer active treatment for renal stones in case of stone growth, *de novo* obstruction, associated infection, and acute and/or chronic pain.	Weak
Assess comorbidity and patient preference when making treatment decisions.	Weak
Offer shock wave lithotripsy (SWL) and endourology (percutaneous nephrolithotomy [PNL], retrograde renal surgery [RIRS]) as treatment options for stones < 2 cm within the renal pelvis and upper or middle calices.	Strong
Perform PNL as first-line treatment of larger stones > 2 cm.	Strong

In case PNL is not an option, treat larger stones (> 2 cm) with flexible ureteroscopy or SWL. However, in such instances there is a higher risk that a follow-up procedure and placement of a ureteral stent may be needed.	Strong
For the lower pole, perform PNL or RIRS, even for stones > 1 cm, as the efficacy of SWL is limited (depending on favourable and unfavourable factors for SWL).	Strong

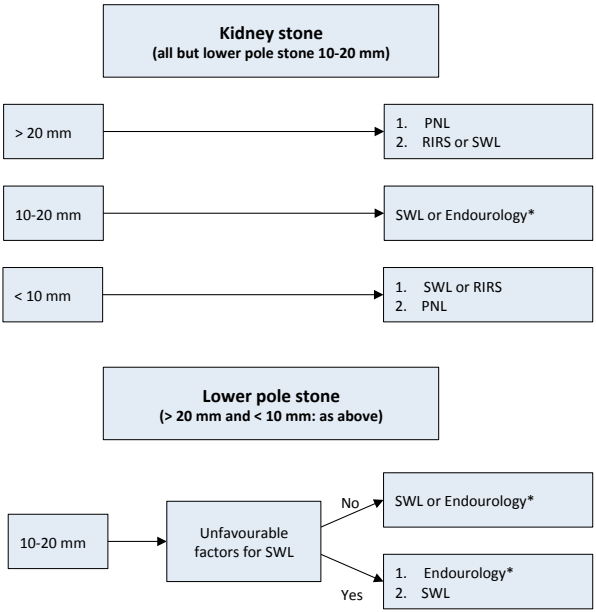
Indication for active stone removal and selection of procedure

Kidney:

- stone growth;
- stones in high-risk patients for stone formation;
- obstruction caused by stones;
- infection;
- symptomatic stones (e.g. pain, haematuria);
- stones > 15 mm;
- stones < 15 mm if observation is not the option of choice;
- choice of treatment;
- patient preference;
- comorbidity;
- social situation of the patient (e.g., profession or travelling).

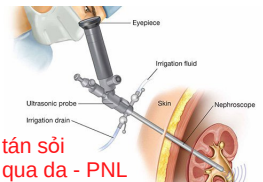
The suspected stone composition might influence the choice of treatment modality.

Figure 2: Treatment algorithm for renal stones (if active treatment is indicated). (Strength rating: Strong)



** The term 'endourology' encompasses all PNL and URS interventions.*

PNL = percutaneous nephrolithotomy; RIRS = retrograde renal surgery; SWL = shock wave lithotripsy; URS = ureteroscopy.



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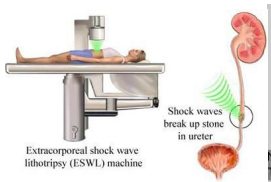
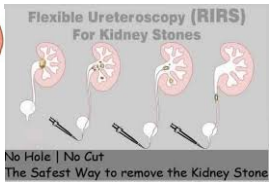




Recommendation	Strength rating
Use flexible ureteroscopy in case percutaneous nephrolithotomy or shock wave lithotripsy are not an option (even for stones > 2 cm). However, in such cases there is a higher risk that a follow-up procedure and placement of a ureteral stent may be needed.	Strong

Open and laparoscopic surgery

Recommendations	Strength rating
Offer laparoscopic or open surgical stone removal in rare cases in which shock wave lithotripsy, retrograde or antegrade ureteroscopy and percutaneous nephrolithotomy fail, or are unlikely to be successful.	Strong

Steinstrasse

The major factor in steinstrasse formation is stone size. Medical expulsion therapy increases the stone expulsion rate of steinstrasse. When spontaneous passage is unlikely, further treatment of steinstrasse is indicated.

Recommendations	Strength rating
Treat steinstrasse associated with urinary tract infection/fever preferably with percutaneous nephrostomy.	Weak
Treat steinstrasse when large stone fragments are present with shock wave lithotripsy or ureteroscopy (in absence of signs of urinary tract infection).	Weak

Management of patients with residual stones

Following initial treatment with SWL, URS or PNL residual fragments may remain and require additional intervention. The indications for active removal of residual stones and selection of the procedure are based on the same criteria as for primary stone treatment. For well-disintegrated stone material in the lower calix, inversion therapy with simultaneous mechanical percussion manoeuvre under enforced diuresis may facilitate stone clearance.

Recommendation	Strength rating
Perform imaging after shock wave lithotripsy, ureteroscopy or percutaneous antegrade ureteroscopy to determine presence of residual fragments.	Strong

Management of urinary stones and related problems during pregnancy

Recommendation	Strength rating
Treat all uncomplicated cases of urolithiasis in pregnancy conservatively (except where there are clinical indications for intervention).	Strong

If intervention becomes necessary, placement of a ureteral stent or a percutaneous nephrostomy tube are readily available primary options. Ureteroscopy is a reasonable alternative to avoid long-term stenting/drainage. There is a higher tendency for stent encrustation during pregnancy.

Management of stones in patients with urinary diversion

Patients with urinary diversion are at high risk for stone formation in the renal collecting system and ureter or in the conduit or continent reservoir.

Recommendation	Strength rating
Perform percutaneous lithotomy to remove large renal stones in patients with urinary diversion, as well as for ureteral stones that cannot be accessed via a retrograde approach, or that are not amenable to shock wave lithotripsy.	Strong

Management of stones in patients with neurogenic bladder

Patients with neurogenic bladder are more prone to development of urinary calculi.

In myelomeningocoele patients, latex allergy is common so that appropriate measures need to be taken regardless of the treatment.

Management of stones in transplanted kidneys

Transplanted patients are at additional risk due to their dependency on a solitary kidney, immunosuppression therapy and possible metabolic impairments. Conservative treatment for small asymptomatic stones is only possible under close surveillance and in absolutely compliant patients.

Stones causing urinary stasis/obstruction require immediate intervention or drainage of the transplanted kidney.

Recommendations	Strength rating
Perform ultrasound or non-contrast-enhanced computed tomography to rule out calculi in patients with transplanted kidneys, unexplained fever, or unexplained failure to thrive (particularly in children).	Strong
Offer patients with transplanted kidneys, any of the contemporary management options, including shock wave lithotripsy, flexible ureteroscopy and percutaneous nephrolithotomy.	Weak

Special problems in stone removal

Calyceal diverticulum stones	• Shock wave lithotripsy (SWL), percutaneous nephrolithotomy (PNL) (if possible) or retrograde renal surgery (RIRS). • Laparoscopic retroperitoneal surgery. • Patients may become asymptomatic due to stone disintegration (SWL), whilst well-disintegrated stone material remains in the original position due to narrow calyceal neck.
Horseshoe kidneys	• Can be treated in line with the options described above. • Passage of fragments after SWL might be poor. • Acceptable stone-free rates can be achieved with flexible ureteroscopy.
Stones in pelvic kidneys	• SWL, RIRS, PNL or laparoscopic surgery. • In obese patients, the options are RIRS, PNL or open surgery.

Stones formed in a continent reservoir	• Each stone must be considered and treated individually.
Patients with obstruction of the uretero-pelvic junction	• When outflow abnormality requires correction, stones can be removed by PNL together with percutaneous endopyelotomy or open/laparoscopic reconstructive surgery. • Ureteroscopy together with endopyelotomy with holmium:yttrium-aluminium-garnet laser. • Incision with an Acucise® balloon catheter might be considered, provided the stones can be prevented from falling into the pelvi-ureteral incision. • Open surgery with correction of the ureteropelvic junction obstruction (pyeloplasty) and stone removal is a feasible option.

Management of urolithiasis in children

In children, the indication for SWL and for PNL is similar to those in adults. Compared to adults, children pass fragments more rapidly after SWL. For endourological procedures, the smaller organs in children must be considered when selecting instruments for PNL or URS.

Children with renal stones of a diameter up to 20 mm (~300 mm^2) are ideal candidates for SWL.

Recommendations	Strength rating
Offer children with single ureteral stones less than 10 mm shock wave lithotripsy if localisation is possible as first-line option.	Strong
Ureteroscopy is a feasible alternative for ureteral stones not amenable to shock wave lithotrpsy (SWL).	Strong
Offer children with renal stones with a diameter of up to 20 mm (~300 mm^2) SWL.	Strong
Offer children with renal pelvic or calyceal stones with a diameter > 20 mm (~300 mm^2) percutaneous nephrolithotomy.	Strong
Retrograde renal surgery (RIRS) is a feasible alternative for renal stones smaller than 20 mm in all locations.	Weak

Metabolic evaluation and recurrence prevention

After stone passage, every patient should be assigned to a low- or high-risk group for stone formation. For correct classification, two analyses are mandatory:

- reliable stone analysis by infrared spectroscopy or X-ray diffraction;
- basic analysis.

Only high-risk stone formers require specific metabolic evaluation. Stone type is the deciding factor for further diagnostic tests. For both groups, general preventive measures apply:

General preventive measures	
Fluid intake (drinking advice)	• Fluid amount: 2.5-3.0 L/day • Circadian drinking • Neutral pH beverages • Diuresis: 2.0-2.5 L/day • Specific weight of urine: < 1010 L/day
Nutritional advice for a balanced diet	• Rich in vegetables and fibre • Normal calcium content: 1-1.2 g/day • Limited NaCl content: 4-5 g/day • Limited animal protein content: 0.8-1.0 g/kg/day • Avoid excessive consumption of vitamin supplements
Lifestyle advice to normalise general risk factors	• Body mass index (BMI): retain a normal BMI level • Adequate physical activity • Balancing of excessive fluid loss

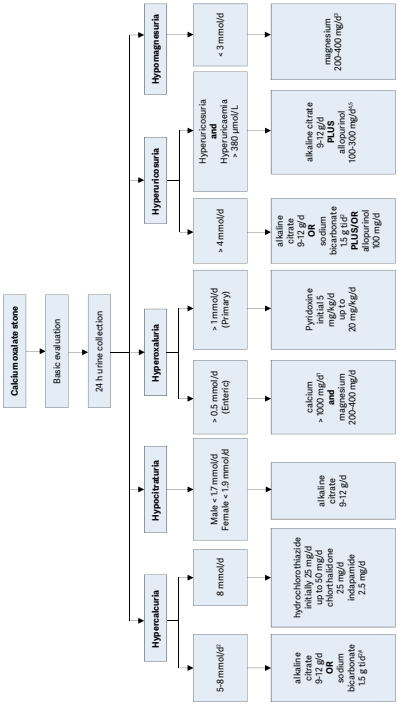
Caution: The protein need is age-group dependent; therefore, protein restriction in childhood should be handled carefully.

Calcium oxalate stones

Hyperparathyroidism is excluded by blood analysis.

Recommendations for pharmacological treatment of patients with specific abnormalities in urine composition (based on 24-hour urine samples)		
Urinary risk factor	**Suggested treatment**	**Strength rating**
Hypercalcuria	Thiazide + potassium citrate	Strong
Hyperoxaluria	Oxalate restriction	Weak
Enteric hyperoxaluria	Potassium citrate	Weak
	Calcium supplement	Weak
	Diet reduced in fat and oxalate	Weak
Hypocitraturia	Potassium citrate	Strong
Hypocitraturia	Sodium bicarbonate if intolerant to potassium citrate	Strong
Hyperuricosuria	Allopurinol	Strong
	Febuxostat	Strong
High sodium excretion	Restricted intake of salt	Strong
Small urine volume	Increased fluid intake	Strong
Urea level indicating a high intake of animal protein	Avoid excessive intake of animal protein	Strong

Figure 3: Diagnostic and therapeutic algorithm for calcium oxalate stones



[1] *Be aware of excess calcium excretion.*

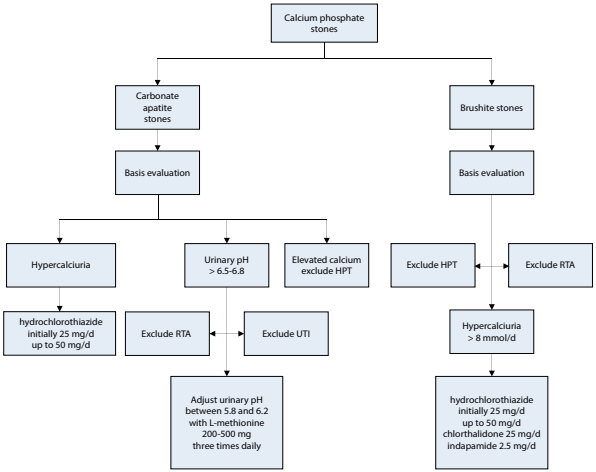
[2] *tid = three times/day (24h).*

[3] *No magnesium therapy for patients with renal insufficiency.*

[4] *There is no evidence that combination therapy (thiazide + citrate or thiazide + allopurinol) is superior to thiazide therapy alone.*

[5] *Febuxostat 80 mg/day.*

Figure 4: Diagnostic and therapeutic algorithm for calcium phosphate stones



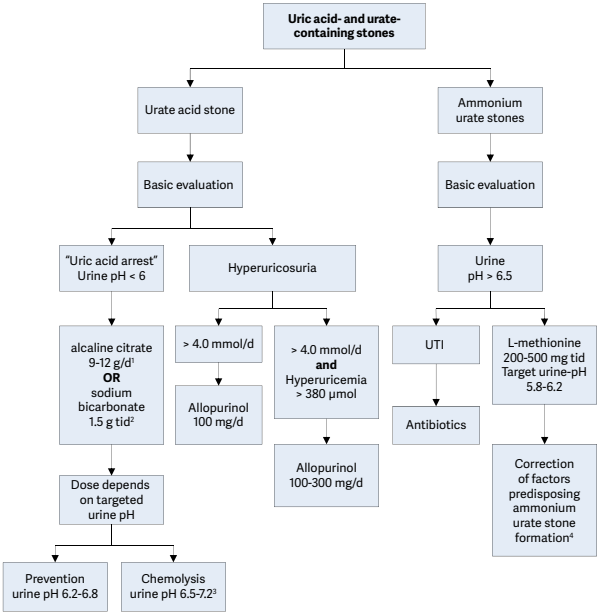
HPT = hyperparathyroidism; RTA = renal tubular acidosis; UTI = urinary tract infection.

Recommendations	Strength rating
Prescribe thiazide in case of hypercalciuria.	Strong
Advise patients to acidify their urine in case of high urine pH.	Weak

Hyperparathyroidism

Elevated levels of ionised calcium in serum (or total calcium and albumin) require assessment of intact parathyroid hormone to confirm or exclude suspected hyperparathyroidism (HPT). Primary HPT can only be cured by surgery.

Figure 5: Diagnostic and therapeutic algorithm for uric acid and urate-containing stones



UTI = urinary tract infection.

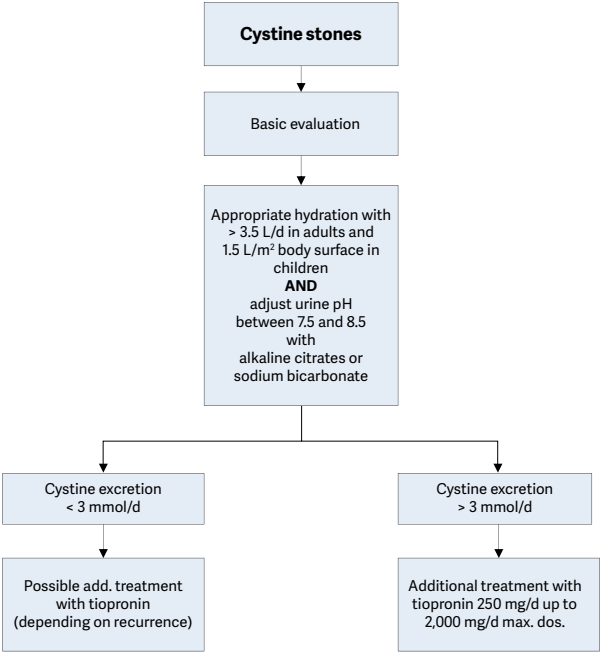
[1] d: day.

[2] tid: three times a day.

[3] A higher pH may lead to calcium phosphate stone formation.

[4] In patients with high uric acid excretion, allopurinol may be helpful.

Figure 6: Metabolic management of cystine stones.



Struvite/infection stones

Recommendations for therapeutic measures of infection stones	Strength rating
Surgically remove the stone material as completely as possible.	Strong
Prescribe antibiotics in case of persistent bacteriuria.	Strong
Prescribe ammonium chloride, 1 g, two or three times daily, to ensure urinary acidification.	Weak
Prescribe methionine, 200-500 mg, one to three times daily, as an alternative, to ensure urinary acidification.	Weak

2,8-Dihydroyadenine stones and xanthine stones

Both stone types are rare. Diagnosis and specific prevention is similar to that of uric acid stones.

Drug stones

Drug stones are induced by pharmacological treatment. Two types exist:

- stones formed by crystallised compounds of the drug;
- stones formed due to unfavourable changes in urine composition under drug therapy.

Treatment includes general preventive measures and the avoidance of the respective drugs.

Investigation	Rationale for investigation
Medical history	• Stone history (former stone events, family history) • Dietary habits • Medication chart
Diagnostic imaging	• Ultrasound in the case of a suspected stone • Unenhanced helical computed tomography • Determination of Hounsfield units provides information about the possible stone composition
Blood analysis	• Creatinine • Calcium (ionised calcium or total calcium + albumin) • Uric acid
Perform a urinalysis	• Urine pH profile (measurement after each voiding, minimum four times daily) • Dipstick test: leukocytes, erythrocytes, nitrite, protein, urine pH, specific weight • Urine cultures • Microscopy of urinary sediment (morning urine) • Cyanide nitroprusside test (cystine exclusion).

Further examinations depend on the results of the investigations listed above.

This short booklet text is based on the more comprehensive EAU Guidelines (ISBN 978-94-92671-04-02) available to all members of the European Association of Urology at their website, http://www.uroweb.org/guidelines/.