EAU GUIDELINES ON UROLITHIASIS

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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 risk of stone formation, but prevention of stone recurrence is of more importance)

Diseases associated with stone formation
Hyperparathyroidism
Metabolic syndrome
Nephrocalcinosis
Gastrointestinal diseases (i.e., jejuno-ileal bypass, intestinal resection, Crohn's disease, malabsorptive conditions, enteric hyperoxaluria after urinary diversion) and bariatric surgery
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
Chronic lead 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	LE	GR
With fever or solitary kidney, and when diagnosis is doubtful, immediate imaging is indicated.	4	A*

**Upgraded following panel consensus.*

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

Evaluation of patients with acute flank pain

Recommendation for radiologic examinations of patients with acute flank pain/suspected ureteral stones	LE	GR
Following initial ultrasound assessment, use non-contrast-enhanced computed tomography to confirm stone diagnosis in patients with acute flank pain, as it is superior to intravenous urography.	1a	A

Recommendations for radiologic examination of patients with renal stones	LE	GR
Perform a contrast study if stone removal is planned and the anatomy of the renal collecting system needs to be assessed.	3	A*
Use enhanced computed tomography in complex cases because it enables 3D reconstruction of the collecting system, as well as measurement of stone density and skin-to-stone distance. Intravenous urography may also be used.	4	C

**Upgraded following panel consensus.*

Diagnostics - Metabolism-related

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

Recommendations: basic laboratory analysis - emergency stone patient	GR
Urine	
Dipstick test of spot urine sample	A*
• red cells • white cells • nitrite • approximate urine pH Urine microscopy and/or culture	A
Blood	

Serum blood sample • creatinine • uric acid • (ionised) calcium • sodium • potassium • blood cell count • C-reactive protein	A*
Perform a coagulation test (partial thromboplastin time and international normalised ratio) if intervention is likely or planned.	A*

**Upgraded following panel consensus.*

Examination of sodium, potassium, 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 below).

Recommendations related to stone analysis	**LE**	**GR**
Perform stone analysis in first-time formers using a validated procedure (X-ray diffraction or infrared spectroscopy).	2	A
Repeat stone analysis in patients: • presenting with recurrent stones despite drug therapy; • with early recurrence after complete stone clearance; • with late recurrence after a long stone-free period because stone composition may change.	2	B

Diagnosis for special groups/conditions

Pregnancy

Recommendations	LE	GR
Use ultrasound as the preferred method of imaging in pregnant women.	1a	A*
In pregnant women, use magnetic resonance imaging as a second-line imaging modality.	3	C
In pregnant women, use low-dose computed tomography as a last line option.	3	C

Children

Recommendations	GR
In children, use ultrasound as first-line imaging modality when a stone is suspected; it should include the kidney, fluid-filled bladder and the ureter next to the kidney and the (filled) bladder.	B
If ultrasound will not provide the required information, perform a kidney-ureter-bladder radiography (or low-dose non-contrast-enhanced computer tomography).	B
Collect stone material for analysis to classify the stone type.	A*
In all children, complete a metabolic evaluation based on stone analysis.	A

In children, the most common non-metabolic disorders facilitating stone formation are vesicoureteral reflux, ureteropelvic junction obstruction, neurogenic bladder, and other voiding difficulties.

Disease Management

Acute treatment of a patient with renal colic

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

Recommendations for pain relief during and prevention of recurrent renal colic	LE	GR
Provide immediate pain relief in acute stone episodes.		A
Whenever possible, offer a non-steroidal anti-inflammatory as the first drug of choice. e.g. metamizol (dipyrone); alternatively, depending on cardio-vascular risk factors, diclofenac*, indomethacin or ibuprofen**.	1b	A
Offer hydromorphine, pentazocine or tramadol as a second choice.	4	C

** Affects glomerular filtration rate in patients with reduced renal function (LE: 2a).*

*** Recommended to counteract recurrent pain after renal colic (see extended document).*

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 in the obstructed kidney

The obstructed, infected, kidney is a urological emergency.

Recommendations	LE	GR
Urgently decompress the collecting system in case of sepsis with obstructing stones, using percutaneous drainage or ureteral stenting.	1b	A
Delay definitive treatment of the stone until sepsis is resolved.	1b	A

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

Recommendations - Further measures	GR
Collect (again) urine for antibiogram following decompression.	A*
Start antibiotics immediately (+ intensive care if necessary).	
Re-evaluate antibiotic treatment regimen following antibiogram findings.	

**Upgraded following panel consensus.*

Stone relief

Observation of renal stones

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

Recommendations	GR
Follow-up periodically in cases where renal stones are not treated (initially after six months and then yearly, evaluating symptoms and stone status [either by ultrasound, kidney-ureter-bladder radiography or computed tomography]).	A*
Offer active treatment for renal stones in case of stone growth, *de novo* obstruction, associated infection, and acute and/or chronic pain.	C
Assess comorbidity, stone composition if possible, and patient preference when making treatment decisions.	C

**Upgraded based on panel consensus.*

Observation of ureteral stones

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

Recommendations	LE	GR
In patients with newly diagnosed small* ureteral stones, if active stone removal is not indicated, observe patient initially along with periodic evaluation.	1a	A
Offer patients appropriate medication to facilitate stone passage during observation.		

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

Medical expulsive therapy

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

MET, 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 corticosteroids as MET.

Recommendations for medical expulsive therapy (MET)	LE	GR
Select patients for an attempt at spontaneous passage or MET, based on well-controlled pain, no clinical evidence of sepsis, and adequate renal functional reserve.	4	C
Offer α-blockers as MET as one of the treatment options, in particular for (distal) ureteral stones > 5 mm.	1a	A
Counsel patients regarding the controversies in the literature, attendant risks of MET, including associated drug side effects. Inform the patient that α-blockers as MET are administered off-label[†]**.	1b	A*
Follow up patients in short intervals to monitor stone position and assess for hydronephrosis.	4	A*

[†]*It is not known if tamsulosin harms the human foetus or if it is found in breast milk.*

**Upgraded following panel consensus.*

*** MET using α-blockers in children and during pregnancy cannot be recommended due to the limited data in this specific population.*

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	GR
Inform the patient how to modify the dosage of alkalising medication according to urine pH, which is a direct consequence of such medication.	A
Inform the patient how to monitor urine pH by dipstick three times a day (at regular intervals). Morning urine must be included.	A
Carefully monitor radiolucent stones during/after therapy.	A*
Inform the patient of the significance of compliance.	A

**Upgraded following panel consensus.*

Percutaneous irrigation chemolysis is rarely used any more.

Shockwave 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 to the use of SWL 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 of the stone.

Best clinical practice (best performance) in SWL

Stenting prior to SWL

Routine use of internal stents before SWL does not improve SFRs, 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 shockwave power.
- Starting SWL on a lower energy setting with step-wise power ramping prevents renal injury.
- Optimal shock wave frequency is 1.0 to 1.5Hz.
- Clinical experience has shown that repeat sessions are feasible (within one day for ureteral stones).

Procedural control

Recommendation - Procedural control	LE	GR
Maintain careful fluoroscopic and/or ultrasonographic monitoring during SWL.	3	A*
Ensure correct use of the coupling agent as this is crucial for effective shock wave transportation.	2a	B
Use proper analgesia as it improves treatment results by limiting pain-induced movements and excessive respiratory excursions.	4	C

**Upgraded following panel consensus.*

Antibiotic prophylaxis

No standard prophylaxis prior to SWL is recommended.

Recommendation	LE	GR
In the case of infected stones or bacteriuria, prescribe antibiotics prior to shockwave lithotripsy.	4	C

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:

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

Best clinical practice

Recommendation - Preoperative imaging	GR
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.	A*

**Upgraded following panel consensus.*

Colon interposition in the access tract of PNL can lead to colon injuries. Pre-operative CT or intra-operative US allows identification of the tissue between the skin and kidney and lowers the incidence of bowel injury.

Recommendations - Intracorporeal lithotripsy	GR
Use ultrasonic, ballistic and holmium: yttrium-aluminium-garnet devices for intracorporeal lithotripsy during percutaneous nephrolithotomy.	A*

**Upgraded following panel consensus.*

Nephrostomy and stents after PNL

Recommendation - Nephrostomy and stents after percutaneous nephrolithotomy	LE	GR
In uncomplicated cases, perform a tubeless (without nephrostomy tube) or totally tubeless (without nephrostomy tube and ureteral stent) percutaneous nephrolithotomy procedure, as it is a safe alternative.	1b	A

Ureterorenoscopy (URS) (Including retrograde access to the renal collecting system [RIRS])

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

Pre-stenting has been shown to improve outcome. During URS placement of a safety wire is recommended, even though some groups have demonstrated that URS can be performed without it

Recommendations	LE	GR
Do not perform stone extraction using a basket without endoscopic visualisation of the stone (blind basketing).	4	A*
Use holmium: yttrium-aluminium-garnet laser lithotripsy for flexible ureterorenoscopy.	3	B

**Upgraded following panel consensus.*

In uncomplicated ureterorenoscopy (URS), a stent need not be inserted.

An α-blocker can reduce stent-related symptoms. In the presence of fragments MET following intracorporeal lithotripsy increases SFRs and reduces colic episodes.

Open and laparoscopic surgery

Recommendations	LE	GR
Offer laparoscopic or open surgical stone removal in rare cases in which shockwave lithotripsy (SWL), (flexible) ureterorenoscopy and percutaneous nephrolithotomy fail, or are unlikely to be successful.	3	C
When expertise is available, perform surgery laparoscopically before proceeding to open surgery, especially when the stone mass is centrally located.	3	C
For ureterolithotomy, perform laparoscopy for large impacted stones when endoscopic lithotripsy or shockwave lithotripsy has failed.	2	B

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).

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;
- patient preference;
- comorbidity;
- social situation of the patient (e.g., profession or travelling);
- choice of treatment.

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

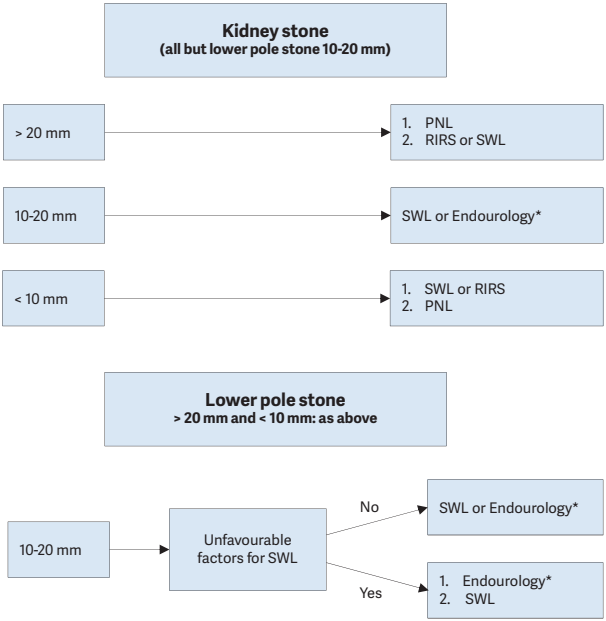
Stone Removal

Recommendations	GR
Obtain a urine culture or perform urinary microscopy before any treatment is planned. Exclude or treat urinary tract infection prior to endourological stone removal.	A*
Offer perioperative antibiotic prophylaxis to all patients undergoing endourological treatment.	A*
Offer active surveillance to patients at high risk for thrombotic complications in the presence of an asymptomatic calyceal stone.	C
Decide on temporary discontinuation, or bridging of antithrombotic therapy in high-risk patients, in consultation with the internist.	B
Perform retrograde (flexible) ureterorenoscopy if stone removal is essential and antithrombotic therapy cannot be discontinued, since it is associated with less morbidity.	A*

**Upgraded following panel consensus.*

Radiolucent uric acid stones, but not sodium urate or ammonium urate stones, can be dissolved by oral chemolysis.

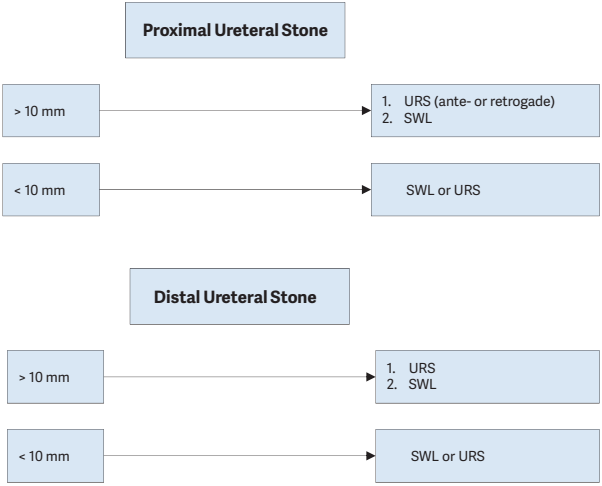
Figure 1: Treatment algorithm for renal calculi



** The term 'Endourology' encompasses all PNL and URS interventions.*
PNL = percutaneous nephrolithotomy; RIRS = retrograde renal surgery; SWL = shockwave lithotripsy; URS = ureterorenoscopy.

Recommendation for the treatment of renal calculi	GR
Use flexible ureterorenoscopy in case percutaneous nephrolithotomy or shockwave lithotripsy are not an option (even for stones > 2 cm). However, in that case there is a higher risk that a follow-up procedure and placement of a ureteral stent may be needed. In complex stone cases, use open or laparoscopic approaches as possible alternatives.	B

Figure 2: Treatment algorithm for ureteral calculi (If indicated for active stone removal) (GR: A*)



SWL = shock wave lithotripsy; URS = ureterorenoscopy.

Recommendation	GR
Use percutaneous antegrade removal of ureteral stones as an alternative when shockwave lithotripsy is not indicated or has failed, and when the upper urinary tract is not amenable to retrograde ureterorenoscopy.	A

Steinstrasse

Steinstrasse occurs in 4% to 7% of cases after SWL, 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	LE	GR
Treat steinstrasse associated with urinary tract infection/fever preferably with percutaneous nephrostomy.	4	C
Treat steinstrasse when large stone fragments are present with shockwave lithotripsy or ureterorenoscopy.	4	C

Management of patients with residual stones

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.

Recommendations in case of residual fragments	LE	GR
Identify biochemical risk factors and offer appropriate stone prevention to patients with residual fragments or stones.	1b	A
Follow-up patients with residual fragments or stones regularly to monitor disease course.	4	C
After SWL and URS, and in the presence of residual fragments, offer MET using an α-blocker to improve fragment clearance.	1a	A

Management of specific patient groups

Management of urinary stones and related problems during pregnancy

Recommendations	GR
Treat all uncomplicated cases of urolithiasis in pregnancy conservatively (except those that have clinical indications for intervention).	A

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.

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.

Recommendations	GR
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.	A*

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, immunsuppresion 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	LE	GR
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).	4	B
Offer patients with transplanted kidneys, any of the contemporary management options, including shockwave therapy, (flexible) ureterorenoscopy, and percutaneous nephrolithotomy.		B
Complete metabolic evaluation after stone removal.		A*

**Upgraded following panel consensus.*

Special problems in stone removal

Calyceal diverticulum stones	• Shockwave lithotripsy (SWL), percutaneous nephrolithotomy (PNL) (if possible) or retrograde renal surgery (RIRS). • Can also be removed using 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 ureterorenoscopy.

Stones in pelvic kidneys	• SWL, RIRS, PNL or laparoscopic surgery. • In obese patients, the options are RIRS, PNL or open surgery.
Patients with obstruction of the ureteropelvic junction	• When outflow abnormality requires correction, stones can be removed by PNL together with percutaneous endopyelotomy or open/laparoscopic reconstructive surgery. • Ureterorenoscopy 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 pyeloureteral incision. • Open surgery with correction of the ureteropelvic junction obstruction (pyloplasty) and stone removal is a feasable 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	GR
In children, perform percutaneous nephrolithotomy for the treatment of renal pelvic or calyceal stones with a diameter > 20 mm (~300 mm^2). For ureteral stones, ureterorenoscopy may be an alternative, in case shockwave lithotripsy does not look promising.	C

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
Nutritional advice for a balanced diet	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
Lifestyle advice to normalise general risk factors	BMI: retain a normal BMI level Adequate physical activity Balancing of excessive fluid loss

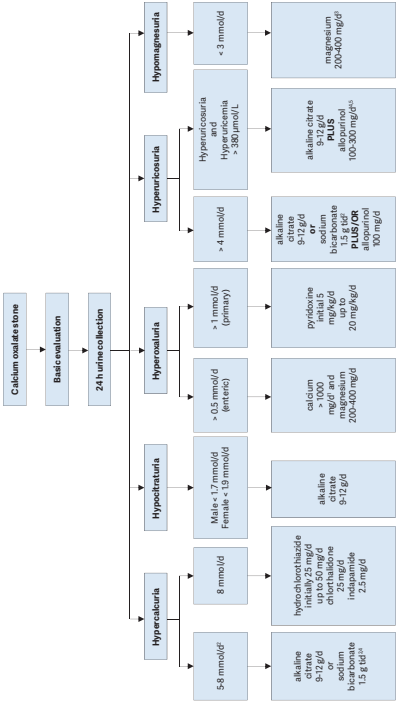
Caution: The protein need is age-group dependent, therefore protein restriction in childhood should be handled carefully.
**Avoid excessive consumption of vitamin supplements.*

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**	**LE**	**GR**
Hypercalciuria	Thiazide + potassium citrate	1a	A
Hyperoxaluria	Oxalate restriction	2b	A
Enteric hyperoxaluria	Potassium citrate	3-4	C
	Calcium supplement	2	B
	Diet reduced in fat and oxalate	3	B
Hypocitraturia	Potassium citrate	1b	A
Hypocitraturia	Sodium bicarbonate if intolerant to potassium citrate	1b	A
Hyperuricosuria	Allopurinol	1a	A
	Febuxostat	1b	A
High sodium excretion	Restricted intake of salt	1b	A
Small urine volume	Increased fluid intake	1b	A
Urea level indicating a high intake of animal protein	Avoid excessive intake of animal protein	1b	A
No abnormality identified	High fluid intake	2b	B

Figure 3: Diagnostic and therapeutic algorithm for calcium oxalate stones



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

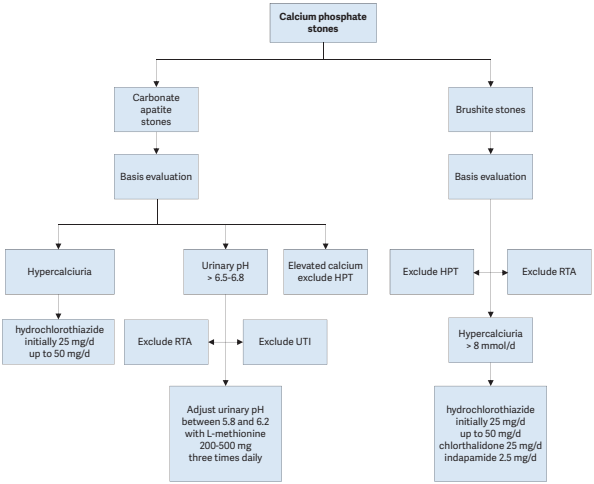
[2] *tid = three times/day (24h).*

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

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

[5] *Febuxostat 80 mg/d.*

Figure 4: Diagnostic and therapeutic algorithm for calcium phosphate stones

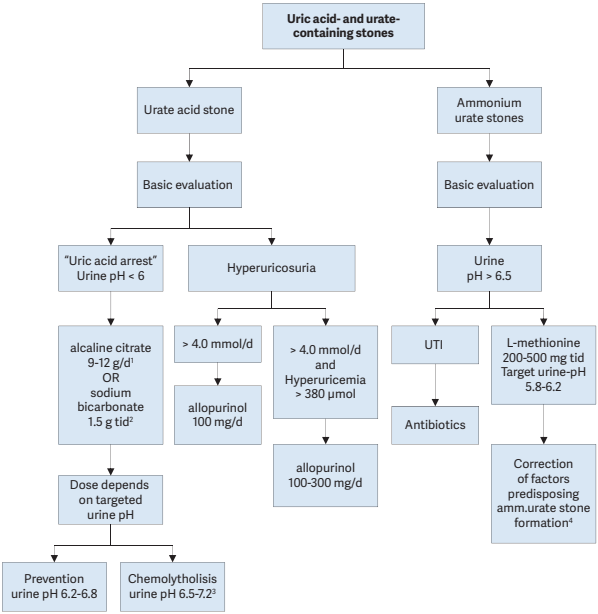


HPT = hyperparathyroidism; RTA = renal tubular acidosis; UTI = urinary tract infection.

Hyperparathyroidism

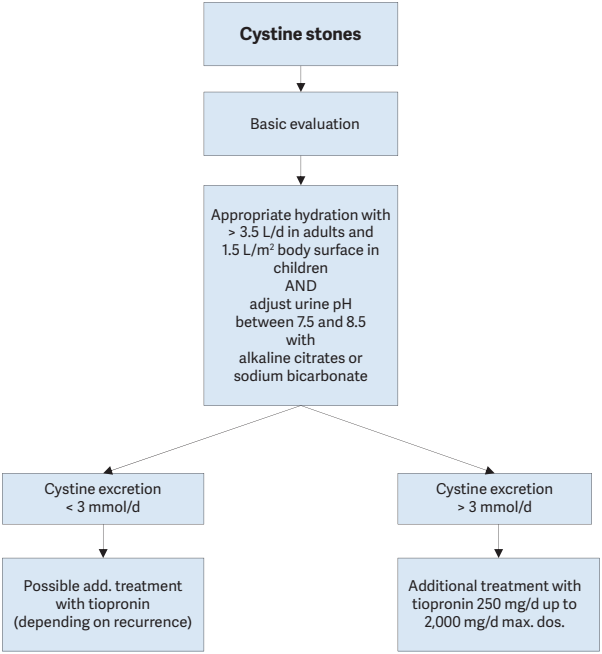
Elevated levels of ionized calcium in serum (or total calcium and albumin) require assessment of intact parathyroid hormone to confirm or exclude suspected hyperparathyroidism (HPT). Primary HTP can only be cured by surgery.

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	LE	GR
Surgically remove the stone material as completely as possible.	3-4	A*
Prescribe a short-term antibiotic course.	3	B
Prescribe a long-term antibiotic course in case of recurrent infections.	3	B
Prescribe ammonium chloride, 1 g, two or three times daily to ensure urinary acidification.	3	B
Prescribe methionine, 200-500 mg, one-three times daily, as an alternative, to ensure urinary acidification.	3	B
Consider prescribing urease inhibitors in case of severe infections (if licensed).	1b	A

**Upgraded following panel consensus*

2,8-Dihydroyadenine stones and xanthine stones

Both stone types are rare. In principle, 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.

Investigating a patient with stones of unknown composition

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 on the possible stone composition
Blood analysis	• Creatinine • Calcium (ionised calcium or total calcium + albumin) • Uric acid
Urinalysis	• Urine pH profile (measurement after each voiding, minimum four times daily) • Dipstick test: leukocytes, erythrocytes, nitrite, protein, urine pH, specific weight • Urine culture • Microscopy of urinary sediment (morning urine) • Cyanide nitroprusside test (cysteine exclusion)

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

This short booklet text is based on the more comprehensive EAU Guidelines (978-90-79754-91-5) available to all members of the European Association of Urology at their website, http://www.uroweb.org/guidelines/.