

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 ($\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$)
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)
Hyperparathyroidism
Metabolic syndrome

Nephrocalcinosis
Gastrointestinal diseases (i.e., jejunio-ileal bypass, intestinal resection, Crohn's disease, malabsorptive conditions, enteric hyperoxaluria after urinary diversion) and bariatric surgery
Sarcoidosis
Genetically determined stone formation
Cystinuria
Primary hyperoxaluria (PH)
Renal tubular acidosis (RTA) type I
2,8-Dihydroxyadeninuria
Xanthinuria
Lesch-Nyhan syndrome
Cystic fibrosis
Drugs associated with 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

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.

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

Evaluation of patients with acute flank pain

Recommendation	LE	GR
NCCT, following ultrasound, should be used to confirm stone diagnosis in patients with acute flank pain, because it is superior to IVU.	1a	A

NCCT = non-contrast enhanced computed tomography.

Recommendations	LE	GR
A contrast study is recommended if stone removal is planned and the anatomy of the renal collecting system needs to be assessed.	3	A*
Enhanced CT is preferable in complex cases because it enables 3D reconstruction of the collecting system, as well as measurement of stone density and skin-to-stone distance. IVU may also be used.	4	C

*Upgraded following panel consensus.

IVU = intravenous urography.

Diagnosics – 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 analysis emergency stone patient	GR
Urine	
Urinary dipstick test out of spot urine sample for: red cells/white cells/nitrite/urine pH level by approximation.	A*
Urine microscopy and/or culture.	A
Blood	
Serum blood sample creatinine/uric acid (ionized) calcium/sodium/potassium/CRP.	A*
Blood cell count.	A*
If intervention is likely or planned: Coagulation test (PTT and INR).	A*

*Upgraded following panel consensus.

INR = international normalised ratio; PTT = partial thromboplastin time.

Examination of sodium, potassium, CRP, and blood coagulation time can be omitted in the non-emergency stone patient. Patients at high risk for stone recurrences should undergo a more specific analytical programme (see Section on Metabolic Evaluation below).

Analysis of stone composition should be performed in all first-time stone formers (GR: A) and will need redoing if changes are expected. The preferred analytical procedures are:

- X-ray diffraction (XRD);
- Infrared spectroscopy (IRS).

Diagnosis for special groups/conditions

Pregnancy

Recommendation	LE	GR
In pregnant women, ultrasound is the imaging method of choice.	1a	A*
In pregnant women, MRI should be used as a second-line imaging modality.	3	C
In pregnant women, low-dose CT should be considered as a last-line option. The exposure should be less than 0.05 Gy.	3	C

**Upgraded following panel consensus.*

CT = computed tomography; MRI = magnetic resonance imaging.

Children

Paediatric patients with urinary stones have a high risk of recurrence; therefore, standard diagnostic procedures for high-risk patients apply.

Recommendations	GR
In all paediatric patients, efforts should be made to complete a metabolic evaluation based on stone analysis.	A
All efforts should be made to collect stone material, which should then be analysed to classify the stone type.	A*
In children, US is the first-line imaging modality when a stone is suspected.	B
If US does not provide the required information, KUB radiography (or NCCT) should be performed.	B

KUB = kidney, ureter, bladder; NCCT = non-contrast enhanced computer tomography; US = ultrasound.

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
First choice: start with diclofenac*, indomethacin or ibuprofen.**	1b	A
Second choice: hydromorphone, pentazocine and tramadol.	4	C
Use α -blockers to reduce recurrent colic.	1a	A

*Caution: Diclofenac sodium affects GFR in patients with reduced renal function, but not in patients with normal renal function (LE: 2a).

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

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
For sepsis with obstructing stones, the collecting system should be urgently decompressed, using either percutaneous drainage or ureteral stenting.	1b	A
Definitive treatment of the stone should be delayed 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 urine for antibiogram following decompression.	A*
Start antibiotics immediately thereafter (+ intensive care if necessary).	
Revisit antibiotic treatment regimen following antibiogram findings.	

* Upgraded based on panel consensus.

Stone relief

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 ureteral stones (≤ 6 mm), and if active stone removal is not indicated, observation with periodic evaluation is an optional initial treatment.	1a	A
Appropriate medical therapy should be offered to these patients to facilitate stone passage during observation.*		

*see also Section MET.

Observation of kidney stones

It is still debatable whether kidney stones should be treated, or whether annual follow-up is sufficient for asymptomatic caliceal stones that have remained stable for 6 months.

Recommendations	GR
Kidney stones should be treated in case of growth, formation of de novo obstruction, associated infection, and acute or chronic pain.	A*
Comorbidity and patient preference need to be taken into consideration when making treatment decisions.	C
If kidney stones are not treated, periodic evaluation is needed.	A

* Upgraded following panel consensus.

Medical expulsive therapy (MET)

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

Recommendations for MET	LE	GR
For MET, α -blockers are recommended.	1a	A
Patients should be counselled regarding the attendant risks of MET, including associated drug side effects, and should be informed that it is administered as 'off-label.' ^{†**}		A*
Patients, who elect for an attempt at spontaneous passage or MET, should have well-controlled pain, no clinical evidence of sepsis, and adequate renal functional reserve.		A
Patients should be followed once between 1 and 14 days to monitor stone position and assessed 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.

Recommendations - Oral chemolysis	GR
The dosage of alkalinising medication must be modified by the patient according to urine pH, which is a direct consequence of such medication (for chemolysis pH 7.0 - 7.2).	A
Dipstick monitoring of urine pH by the patient is required three times a day (at regular intervals). Morning urine must be included.	A
The physician should clearly inform the patient of the significance of compliance.	A*

**Upgraded based on panel consensus.*

Percutaneous irrigation chemolysis is rarely used any more.

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 h before, and 48 h 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

Treating kidney stones, a JJ stent reduces the risk of renal colic and obstruction, but does not reduce formation of steinstrasse or infective complications.

Recommendations	LE	GR
Routine stenting is not recommended as part of SWL treatment of ureteral stones.	1b	A
Alpha-blocker therapy is recommended in the case of stent-related symptoms.	1a	A

SWL = shock wave lithotripsy.

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 (and SWL sequence) ramping prevents renal injury.
- Clinical experience has shown that repeat sessions are feasible (within 1 day for ureteral stones).

Recommendation - Shock wave rate	LE	GR
The optimal shock wave frequency is 1.0 to 1.5 Hz.	1a	A

Procedural control

Recommendation - Procedural control	LE	GR
Maintain careful fluoroscopic and/or ultrasonographic monitoring during the procedure.		B
Ensure correct use of the coupling agent because this is crucial for effective shock wave transportation.	2a	B

Pain control

Careful control of pain during treatment is necessary to limit pain-induced movements and excessive respiratory excursions.

Antibiotic prophylaxis

No standard prophylaxis prior to SWL is recommended.

Recommendation	LE	GR
In case of infected stones or bacteriuria, antibiotics should be given prior to SWL.	4	C

SWL = shock wave lithotripsy.

Percutaneous nephrolithotomy (PNL)

Contraindications:

- Untreated UTI;
- Atypical bowel interposition;
- Tumour in the presumptive access tract area;
- Potential malignant kidney tumour;
- Pregnancy.

Best clinical practice

Recommendation - Preoperative imaging	GR
Preprocedural imaging, including contrast medium, where possible, or retrograde study when starting the procedure, is mandatory to assess stone comprehensiveness, view the anatomy of the collecting system, and ensure safe access to the kidney stone.	A*

* *Upgraded based on panel consensus.*

Recommendations	GR
Ultrasonic, ballistic and Ho:YAG devices are recommended for intracorporeal lithotripsy during PNL.	A*
When using flexible instruments, the Ho:YAG laser is currently the most effective device available.	

* *Upgraded following panel consensus.*

Nephrostomy and stents after PNL

Recommendation - Nephrostomy and stents after PNL	LE	GR
In uncomplicated cases, tubeless (without nephrostomy tube) or totally tubeless (without nephrostomy tube and without ureteral stent) PNL procedures provide a safe alternative.	1b	A

Ureterorenoscopy (URS) (including retrograde access to renal collecting system)

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

Recommendations	GR
Placement of a safety wire is recommended.	A*
Stone extraction using a basket without endoscopic visualisation of the stone (blind basketing) should not be performed.	A*
Ho:YAG laser lithotripsy is the preferred method for (flexible) URS.	B

*Upgraded following panel consensus.

Ho:YAG = holmium:yttrium-aluminium-garnet (laser);

URS = ureterorenoscopy; US ultrasound.

In uncomplicated URS, a stent need not be inserted. An α -blocker can reduce stent-related symptoms.

Open and laparoscopic surgery

Recommendations	LE	GR
Laparoscopic or open surgical stone removal may be considered in rare cases in which SWL, URS, and PNL fail or are unlikely to be successful.	3	C
When expertise is available, laparoscopic surgery should be the preferred option before proceeding to open surgery.	3	C
For ureterolithotomy, laparoscopy is recommended for large impacted stones when endoscopic lithotripsy or SWL have 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.

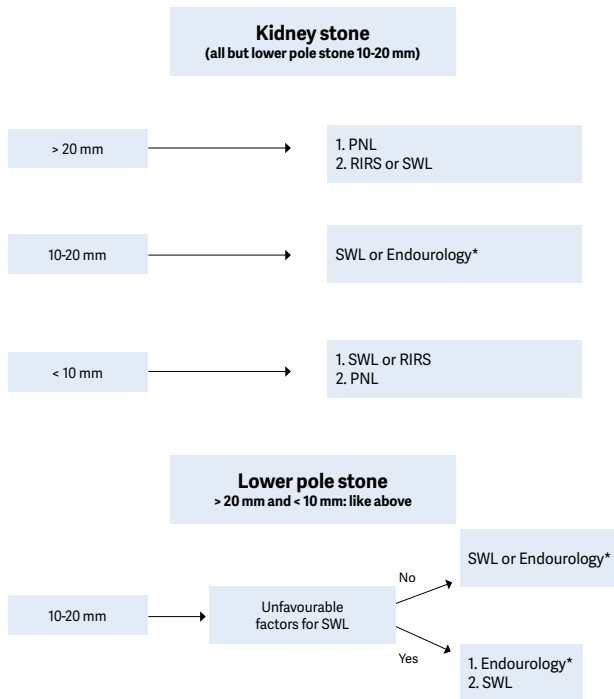
STONE REMOVAL

Recommendations	GR
Urine culture or urinary microscopy is mandatory before any treatment is planned and urinary infection should be treated ahead of stone removal.	A*
In all patients perioperative antibiotic prophylaxis is recommended in case of endourologic stone removal.	A*
In patient at high risk for complications (due to anti-thrombotic therapy) in the presence of an asymptomatic caliceal stone, active surveillance should be offered.	B
Temporary discontinuation, or bridging, of antithrombotic therapy in high-risk patients, should be decided in consultation with the internist.	B
Antithrombotic therapy should be stopped before stone removal after weighting the thrombotic risk.	B
If stone removal is essential and antithrombotic therapy cannot be discontinued, retrograde (flexible) ureterorenoscopy is the preferred approach since it is associated with less morbidity.	A*

**Upgraded based on panel consensus.*

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

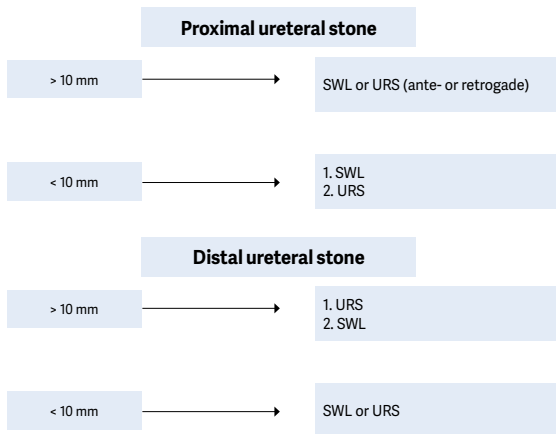
Fig. 1: Treatment algorithm for renal calculi



*The term 'Endourology' encompasses all PNL and URS interventions

Recommendation	GR
In case PNL is not an option, larger stones, even larger than 2 cm, may be treated with flexible URS. 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, open or laparoscopic approaches are possible alternatives.	B

Figure 2: Recommended treatment options (if indicated for active stone removal) (GR: A*)



SWL = shock wave lithotripsy; URS = ureterorenoscopy.

Recommendation	GR
Percutaneous antegrade removal of proximal ureteral stones is an alternative when SWL is not indicated or has failed, and when the upper urinary tract is not amenable to retrograde URS.	A

SWL = shock wave lithotripsy; URS = ureterorenoscopy.

Steinstrasse

Steinstrasse occurs in 4% to 7% of cases after SWL, the major factor in steinstrasse formation is stone size.

Recommendations	LE	GR
Medical expulsion therapy increases the stone expulsion rate of steinstrasse.	1b	A
Percutaneous nephrostomy is indicated for steinstrasse associated with Urinary tract infection/fever.	4	C
Shockwave lithotripsy or URS are indicated for steinstrasse when large stone fragments are present.	4	C
Ureteroscopy is indicated for symptomatic steinstrasse and treatment failure.	4	C

Management of patients with residual stones

Recommendations	LE	GR
Identification of biochemical risk factors and appropriate stone prevention is particularly indicated in patients with residual fragments or stones.	1b	A
Patients with residual fragments or stones should be followed up regularly to monitor disease course.	4	C
After SWL and URS, and in the presence of residual fragments, MET is recommended using an α -blocker to improve fragment clearance.	1a	A

MET = medical expulsive therapy; SWL = shock wave lithotripsy; URS = ureterorenoscopy.

Management of specific patient groups

Management of urinary stones and related problems during pregnancy

Recommendation	GR
Conservative management should be the first-line treatment for all non-complicated cases of urolithiasis in pregnancy (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.	A*
Ureteroscopy is a reasonable alternative to avoid long-term stenting/drainage.	A
Regular follow-up until final stone removal is necessary due to the higher encrustation tendency of stents during pregnancy.	B*

**Upgraded following panel consensus.*

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	GR
PNL is the preferred treatment for removal of 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 SWL.	A*

PNL = *percutaneous nephrolithotomy*; SWL = *shock wave lithotripsy*.

Management of stones in patients with neurogenic bladder

Patients with neurogenic bladder develop urinary calculi because of additional risk factors such as bacteriuria, pelvicaliectasis, vesicoureteral reflux, renal scarring, lower urinary tract reconstruction, and thoracic spinal defect. Treatment is identical to stones in transplanted kidneys.

In myelomeningocele patients, latex allergy is common so that appropriate measures need to be taken regardless of the treatment. For surgical interventions, general anaesthesia remains the only option.

Management of stones in transplanted kidneys

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

Recommendation	LE	GR
In patients with transplanted kidneys, unexplained fever, or unexplained failure to thrive (particularly in children), US or NCCT should be performed to rule out calculi.	4	B
In patients with transplanted kidneys, all contemporary treatment modalities, including shockwave therapy, (flexible) ureteroscopy, and percutaneous nephrolithotomy are management options.		B
Metabolic evaluation should be completed after stone removal.		A*

NCCT = non-contrast enhanced computed tomography;

US = ultrasound.

Special problems in stone removal

Caliceal diverticulum stones	<ul style="list-style-type: none"> • SWL, PNL (if possible) or 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 caliceal neck.
Horseshoe kidneys	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • SWL, RIRS, PNL or laparoscopic surgery. • For obese patients, the options are RIRS, PNL or open surgery.
Patients with obstruction of the ureteropelvic junction	<ul style="list-style-type: none"> • When outflow abnormality requires correction, stones can be removed by PNL together with percutaneous endopyelotomy or open/laparoscopic reconstructive surgery. • URS together with endopyelotomy with Ho:YAG. • Incision with an Acucise balloon catheter might be considered, provided the stones can be prevented from falling into the pelvi-ureteral incision.

*Ho:YAG = holmium:yttrium-aluminium-garnet (laser);
 PNL = percutaneous nephrolithotomy; SWL = shockwave lithotripsy; URS = ureterorenoscopy; RIRS = retrograde renal surgery.*

Management of 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.

Recommendation	GR
In children, PNL is recommended for treatment of renal pelvic or caliceal stones with a diameter > 20 mm (~ 300 mm ²).	C
For intracorporeal lithotripsy, the same devices as in adults can be used (Ho:YAG laser, pneumatic and US lithotripters).	C

Ho:YAG holmium:yttrium-aluminium-garnet (laser);

PNL = percutaneous nephrolithotomy.

Follow-up

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
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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.*

Recommendations for recurrence prevention		LE	GR
The aim should be to obtain a 24-h urine volume \geq 2.5 L.		1b	A
Hyperoxaluria	Oxalate restriction	2b	B
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

Recommendations for pharmacological treatment of patients with specific abnormalities in urine composition		LE	GR
Urinary risk factor	Suggested treatment		
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

Calcium oxalate stones

(Hyperparathyroidism excluded by blood examination)

Fig. 3: Diagnostic and therapeutic algorithm for calcium oxalate stones

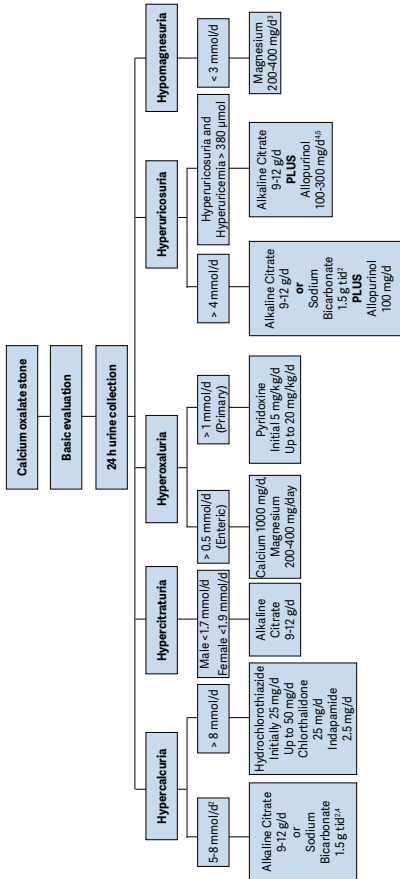
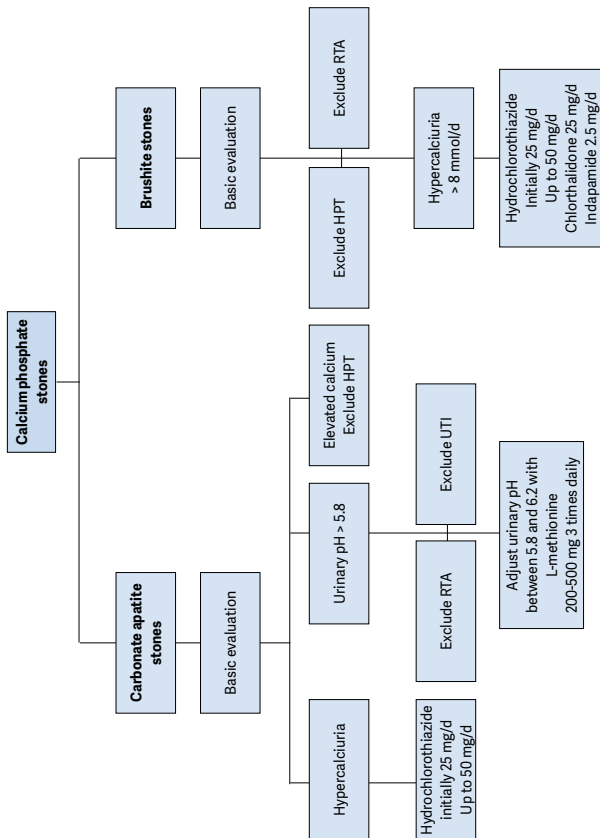


Fig. 4: Diagnostic and therapeutic algorithm for calcium phosphate stones

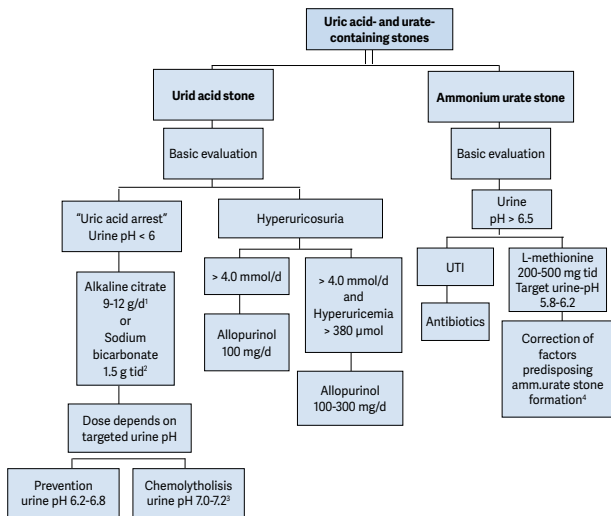


Hyperparathyroidism

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 HPT can only be cured by surgery.

Uric acid and ammonium urate stones

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



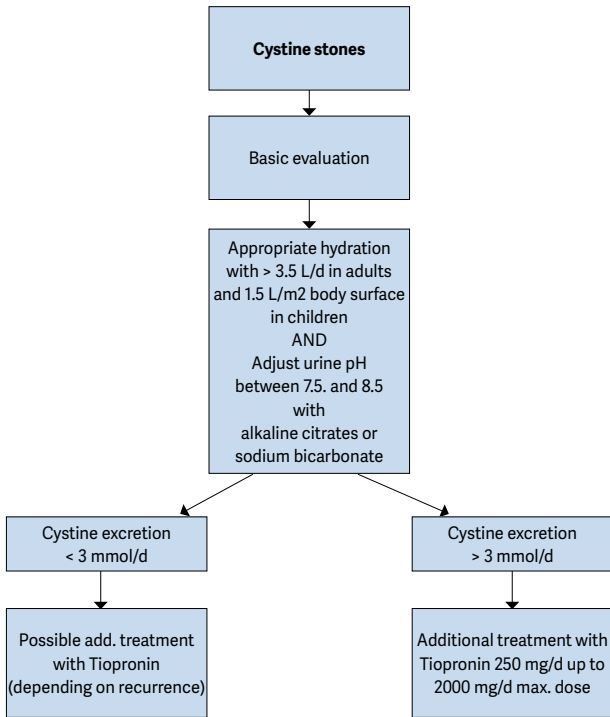
¹ d: day.

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.

Fig. 6: Metabolic management of cystine stones.



Struvite / infection stones

Recommendations for therapeutic measures of infection stones

Recommendations	LE	GR
Surgical removal of the stone material as completely as possible	3-4	A*
Short-term antibiotic course	3	B
Long-term antibiotic course	3	B
Urinary acidification: ammonium chloride, 1 g, 2 or 3 times daily	3	B
Urinary acidification: methionine, 200-500 mg, 1-3 times daily	3	B
Urease inhibition	1b	A

*Upgraded following panel consensus.

2,8-dihydroxyadenine 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	<ul style="list-style-type: none">• Stone history (former stone events, family history)• Dietary habits• Medication chart
Diagnostic imaging	<ul style="list-style-type: none">• Ultrasound in the case of a suspected stone• Unenhanced helical CT• (Determination of Hounsfield units provides information on the possible stone composition)
Blood analysis	<ul style="list-style-type: none">• Creatinine• Calcium (ionised calcium or total calcium + albumin)• Uric acid
Urinalysis	<ul style="list-style-type: none">• Urine pH profile (measurement after each voiding, minimum 4 times daily)• Dipstick test: leukocytes, erythrocytes, nitrite, protein, urine pH, specific weight• Urine culture• 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 978-90-79754-80-9) available to all members of the European Association of Urology at their website, <http://www.uroweb.org>.