EAU Guidelines on
Bladder Stones

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1. INTRODUCTION

1.1 Aims and Scope
The European Association of Urology (EAU) Bladder Stones Guidelines Panel, a sub-panel of the EAU Urolithiasis Guidelines Panel, has prepared these guidelines to help urologists assess evidence-based management of calculi in native urinary bladders and urinary tract reconstructions and to incorporate recommendations into clinical practice. The management of upper urinary tract stone is addressed in a separate document: the EAU Guidelines on Urolithiasis.

It must be emphasised that clinical guidelines present the best evidence available to the experts but following guideline recommendations will not necessarily result in the best outcome. Guidelines can never replace clinical expertise when making treatment decisions for individual patients, but rather help to focus decisions - also taking personal values and preferences/individual circumstances of patients into account. Guidelines are not mandates and do not purport to be a legal standard of care.

1.2 Panel Composition
The EAU Bladder Stones Guidelines Panel consists of an international group of clinicians with particular expertise in this area. All experts involved in the production of this document have submitted potential conflict of interest statements which can be viewed on the EAU website Uroweb: http://uroweb.org/guideline/bladderstones/.

1.3 Available Publications
A quick reference document (Pocket Guidelines) is available, both in print and as an app for iOS and Android devices. These are abridged versions, which may require consultation together with the full text versions. The EAU Urolithiasis Panel has also published a number of scientific publications in the EAU journal European Urology [1-3]. All documents can be accessed through the EAU website: http://uroweb.org/guideline/bladderstones/.

1.4 Publication History and Summary of Changes
1.4.1 ***Publication History***
The EAU Bladder stones Guidelines were first published in 2019. This 2020 document presents a full update of the 2019 text.

1.4.2 ***Summary of Changes***
The literature throughout the entire document has been reassessed and updated (see Methods section below).

For 2020, the content of each chapter has been rephrased and reassessed; in particular the discussion of metabolic factors in section 3.1, Prevalence, aetiology and risk factors has seen significant revision. The summary of evidence and recommendations tables have been completely revised and updated.

2. METHODS

2.1 Data Identification
For the 2019 Bladder Stones guideline, a structured assessment of the literature including lower levels of evidence was performed to assess all aspects of bladder stones, examining publications from 1970 until December 2018. For the 2020 guideline the searches were updated to February 2019. A detailed search strategy is available online: http://uroweb.org/guideline/bladder-stones/?type=appendices-publications.

The chapters on the treatment of bladder stones in adults and children are based on a systematic review [4].

All methodological information can be found in the general Methodology section of this print, and online at the EAU website; http://www.uroweb.org/guideline/. A list of associations endorsing the EAU Guidelines can also be viewed online at the above address.

For each recommendation within the guidelines there is an accompanying online strength rating form, the basis of which is a modified GRADE methodology [5, 6, 7]. Each strength-rating form addresses a number of key elements, namely:

1. the overall quality of the evidence which exists for the recommendation, references used in this text are graded according to a classification system modified from the Oxford Centre for Evidence-Based Medicine Levels of Evidence [8];
2. the magnitude of the effect (individual or combined effects);
3. the certainty of the results (precision, consistency, heterogeneity and other statistical or study related factors);
4. the balance between desirable and undesirable outcomes;
5. the impact of patient values and preferences on the intervention;
6. the certainty of those patient values and preferences.

These key elements are the basis which panels use to define the strength rating of each recommendation. The strength of each recommendation is represented by the words 'strong' or 'weak' [8]. The strength of each recommendation is determined by the balance between desirable and undesirable consequences of alternative management strategies, the quality of the evidence (including certainty of estimates), and nature and variability of patient values and preferences.

2.2 Review

This document was peer reviewed prior to its first publication in 2019.

3. GUIDELINES

3.1 Prevalence, aetiology and risk factors

Bladder stones constitute only approximately 5% of all urinary tract stones [9], yet are responsible for 8% of urolithiasis-related mortalities in developed nations [10]. The incidence is higher in developing countries [11]. The prevalence of bladder stones is higher in males, with a reported male:female ratio between 10:1 and 4:1 [12, 13]. The age distribution is bimodal: incidence peaks at three years in children in developing countries [12, 14], and 60 years in adulthood [13].

The aetiology of bladder stones is typically multi-factorial [13]. Bladder stones can be classified as primary, secondary or migratory [15]. Primary or endemic bladder stones occur in the absence of other urinary tract pathology, typically seen in children in areas with poor hydration, recurrent diarrhoea and a diet deficient in animal protein [16].

Secondary bladder stones occur in the presence of other urinary tract abnormalities, which include: bladder outlet obstruction (BOO), neurogenic bladder dysfunction, chronic bacteriuria, foreign bodies (including catheters), bladder diverticula and bladder augmentation or urinary diversion. In adults, BOO is the most common predisposing factor for bladder stone formation and accounts for 45-79% of vesical calculi [13, 17-20].

Migratory bladder stones are those which have passed from the upper urinary tract where they formed and may then serve as a nidus for bladder stone growth; patients with bladder calculi are more likely to have a history of upper tract stones and risk factors for their formation [21].

A wide range of metabolic urinary abnormalities can predispose to calculi anywhere in the urinary tract, which is covered in more detail in the EAU Urolithiasis Guideline [22]. There is a paucity of studies on the specific metabolic abnormalities which predispose to bladder stones.

Bladder stones will form in 3-4.7% of men undergoing surgery for benign prostatic obstruction BPO [23, 24], 15-36% of spinal cord injury patients [25-27], and 2.2% of patients with long-term catheters [28]. Of 57 men with chronic urinary retention secondary to BPO, the urine of the 30 men with bladder stones had a higher uric acid concentration (2.2 vs. 0.6 mmol/L, $p < 0.01$), lower magnesium (106 vs. 167 mmol/L, $p = 0.01$) and lower pH (5.9 vs. 6.4, $p = 0.02$) than the 27 men without bladder stones [21]. It is therefore likely that patients with these conditions who form bladder stones also have an abnormal urine composition which pre-disposes them to bladder stone formation.

The metabolic abnormalities which pre-dispose patients to form secondary bladder stones are poorly understood. Stone analysis of 86 men with a BPO-related bladder stone demonstrated 42% had calcium based stones (oxalate, phosphate), 33% had magnesium ammonium phosphate, 10% had mixed stones and 14% had urate stones [13]. Similar findings were reported in more recent studies [29-31] and it is therefore likely that multiple metabolic factors pre-dispose patients to secondary bladder stone formation.

The exact metabolic basis for primary bladder stones is poorly understood and likely multi-factorial. Low urine volume (poor hydration) is the most consistently demonstrable abnormality [32-34]. Twenty-four hour urine analysis in children with endemic bladder stones is reported in two studies. Of 57 children in Pakistan, 89.5% had hypocitraturia, 49% had a low urine volume, 44% had hyperoxaluria and 42% had hypokaluria [32]. Of 61 children in India, stone formers had higher urine calcium and uromucoid concentrations than controls [33]. One study from Thailand compared 24 hour urine analyses from children from a rural area with a high prevalence of bladder stones with those from an urban area: rural children had lower urine volumes and, despite equal calcium, oxalate and uric acid concentrations, crystalluria with uric acid and calcium oxalate crystals was more prevalent in rural children [34].

3.2 Presentation

The symptoms most commonly associated with bladder stones are urinary frequency, haematuria (which is typically terminal) and dysuria or suprapubic pain, which are worst towards the end of micturition. Sudden movement and exercise may exacerbate these symptoms. Detrusor over-activity is found in over two thirds of adult male patients with vesical calculi and is significantly more common in patients with larger stones (> 4 cm). However, recurrent urinary tract infections (UTIs) may be the only symptom [18, 19].

In children, symptoms may also include pulling of the penis, difficulties in micturition, urinary retention, enuresis and rectal prolapse (resulting from straining due to bladder spasms). Bladder stones may also be an incidental finding in 10% of cases [16, 35].

3.3 Diagnostic evaluation

3.3.1 ***Diagnostic investigations for bladder stones***

Plain X-ray of kidney ureter bladder (KUB) has a reported sensitivity of 21%-78% for cystoscopically detected bladder stones in adults [18, 36]. Larger (> 2.0 cm) stones are more likely to be radiopaque [36]. However, plain X-Ray provides information on radio-opacity which may guide treatment and follow-up [22].

Ultrasound (US) has a reported sensitivity and specificity of 20-83% and 98-100%, respectively for the detection of bladder stones in adults [37, 38]. Computer tomography (CT) and cystoscopy have a higher sensitivity for detecting bladder stones than US or X-Ray in adults [37, 38]. No study compares cystoscopy and CT for the diagnosis of bladder stones. Cystoscopy has the advantage of detecting other potential causes for a patient’s symptoms (e.g. bladder cancer), whilst CT can also assess upper tract urolithiasis [22, 39].

There is a paucity of evidence for the investigation of bladder stones, particularly in children [40, 41]. See also EAU Guidelines on Urolithiasis, Section 3.3, for further information on diagnostic imaging for urolithiasis [22]. The principle of ALARA (As Low As Reasonably Achievable) should be applied, especially in children [42].

3.3.2 ***Diagnosing the cause of bladder stones***

The cause of the bladder stone should be considered prior to bladder stone treatment as eliminating the underlying cause will reduce recurrence rates [43]. The following should be performed where possible prior to (or at the time of) bladder stone treatment:

- physical examination of external genitalia, peripheral nervous system (including digital rectal examination, peri-anal tone and sensation in men);
- uroflowmetry and post-void residual urine assessment;
- urine dipstick to include pH ± culture;
- metabolic assessment (see also EAU Guideline on Urolithiasis section 3.3.2.3) including: serum (creatinine, (ionised) calcium, uric acid, sodium, potassium, blood cell count);
- urine pH;
- stone analysis: in first-time formers using a valid procedure (X-ray diffraction or infrared spectroscopy).

The following investigations should also be considered for selected patients:

- upper tract imaging (in patients with a history of urolithiasis or loin pain);
- cysto-urethroscopy or urethrogram.

3.4 Disease Management

3.4.1 Conservative treatment and Indications for active stone removal

Migratory bladder stones in adults may typically be left untreated, especially asymptomatic small stones. Rates of spontaneous stone passage are unknown, but data on ureteric stones suggest stones < 1 cm are likely to pass in the absence of BOO, bladder dysfunction or long-term catheterisation [22].

Primary and secondary bladder stones are usually symptomatic and are unlikely to pass spontaneously: active treatment of such stones is usually indicated.

3.4.2 Medical management of bladder stones

There is a paucity of evidence on chemolitholysis of bladder stones. However, guidance on the medical management of urinary tract stones in Chapter 3.4.9 of the EAU Urolithiasis Guidelines [22] can be applied to urinary stones in all locations. Uric acid stones can be dissolved by oral urinary alkalinisation when a pH > 6.5 is consistently achieved, typically using an alkaline citrate or sodium bicarbonate. Regular monitoring is required during therapy [22]. Irrigation chemolysis is also possible using a catheter; however, this is time consuming and may cause chemical cystitis and is therefore not commonly employed [44, 45].

3.4.3 Bladder stone interventions

Minimally invasive techniques for the removal of bladder stones have been widely adopted to reduce the risk of complications and shorten hospital stay and convalescence. Bladder stones can be treated with open, laparoscopic, robotic assisted laparoscopic, endoscopic (transurethral or percutaneous) surgery or extracorporeal shock wave lithotripsy (ESWL) [4].

3.4.3.1 Suprapubic cystolithotomy

Open suprapubic cystolithotomy is very effective, but is associated with a need for catheterisation and longer hospital stay in both adults and children compared to all other stone removal modalities [4]. In children, a non-randomised study found that, if the bladder was closed meticulously in two layers, "tubeless" (drain-less and catheter-less) cystolithotomy was associated with a significantly shorter length of hospital stay compared with traditional cystolithotomy, without significant differences regarding late or intra-operative complications provided that children with prior UTI, recurrent stones, or with previous surgery for anorectal malformation (or other relevant surgery) were excluded [46].

3.4.3.2 Transurethral cystolithotripsy

In both adults and children, transurethral cystolithotripsy provides high stone-free rates (SFR) and appears to be safe, with a very low risk of unplanned procedures and major post-operative and late complications [4].

3.4.3.2.1 Transurethral cystolithotripsy in adults:

In adults, meta-analysis of four randomised controlled trials (RCTs) including 409 patients demonstrated that transurethral cystolithotripsy has a shorter hospital stay and convalescence with less pain, but equivalent SFR and complications compared to percutaneous cystolithotripsy [4]. Transurethral cystolithotripsy with a nephroscope was quicker than percutaneous cystolithotripsy in three RCTs, although transurethral cystolithotripsy with a cystoscope was slower than percutaneous cystolithotripsy [4].

One small RCT demonstrated a shorter duration of catheterisation, hospital stay and procedure with transurethral cystolithotripsy than open cystolithotomy with similar SFR [4]. Meta-analysis of four RCTs found shorter procedure duration for transurethral cystolithotripsy using a nephroscope vs. cystoscope with similar SFRs, hospital stay, convalescence, pain and complications [4, 29, 47-49]. A retrospective study (n=107) reported that using a resectoscope was associated with a shorter procedure duration ($p < 0.05$) than a cystoscope for transurethral cystolithotripsy [50]. This suggests that transurethral cystolithotripsy is quicker when using a continuous flow instrument.

3.4.3.2.1.1 Lithotripsy modalities used during transurethral cystolithotripsy in adults

When considering lithotripsy modalities for transurethral cystolithotripsy, our systematic review found very low quality evidence from five non-randomised studies (n=385) which found no difference in SFR between modalities (mechanical, laser, pneumatic, ultrasonic, electrohydraulic lithotripsy (EHL) or washout alone) [4]. Unplanned procedures and major postoperative complications were low rate events and were not significantly different between lithotripsy modalities, although one non-randomised study (NRS) suggested these might be higher with EHL or mechanical lithotripsy than pneumatic or ultrasonic lithotripsy [51]. All outcomes had very low quality of evidence (GRADE) [4].

While the laser power setting (30W vs. 100W) does not seem to influence lithotripsy time significantly [30], laser lithotripsy was faster than pneumatic lithotripsy (MD 16.6 minutes; CI 23.51-9.69, $p < 0.0001$) in one NRS (n=62); however, a laser was used with a resectoscope and the pneumatic device with a cystoscope [52]. Continuous vs. intermittent irrigating instrument may affect the operation time more significantly than the choice of lithotripsy device [4].

Transurethral cystolithotripsy in children:
In children, three NRS suggest that transurethral cystolithotripsy has a shorter hospital stay and catheterisation time than open cystolithotomy, but similar stone-free and complication rates [4, 53]. One small quasi RCT found a shorter procedure time using laser vs. pneumatic lithotripsy for < 1.5 cm bladder stones with no difference in SFR or other outcomes [4, 54].

3.4.3.3 Percutaneous cystolithotripsy

3.4.3.3.1 Percutaneous cystolithotripsy in adults:
One NRS found a shorter duration of procedure and catheterisation and less blood loss for percutaneous, compared with open surgery in adult male patients with urethral strictures; all patients in both groups were rendered stone-free [31].

Meta-analysis of four RCTs comparing transurethral and percutaneous cystolithotripsy found a shorter hospital stay for transurethral cystolithotripsy over percutaneous surgery. Transurethral cystolithotripsy was quicker when using a nephroscope. There were no significant differences in SFRs, major post-operative complications, urethral strictures or re-treatment [4].

3.4.3.3.2 Percutaneous cystolithotripsy in children:
In children, three NRS suggest that percutaneous cystolithotripsy has a shorter hospital stay and catheterisation time but a longer procedure duration and more peri-operative complications than open cystolithotripsy; SFRs were similar [4, 35, 53].

Two small NRS compared percutaneous and transurethral cystolithotripsy and both found similar SFRs, but that transurethral surgery offers a shorter duration of catheterisation and hospital stay [35, 53]. One small NRS found a non-significant increased risk of unplanned procedures (within 30 days of primary procedure) and major post-operative complications for percutaneous operations compared with transurethral procedures; however, age and stone size determined which intervention children underwent and all patients were rendered stone-free [35]. Urethral stricture rates were not robustly compared in either study.

3.4.3.4 Extracorporeal shock wave lithotripsy

Extracorporeal SWL is the least invasive therapeutic procedure [55].

3.4.3.4.1 Shock wave lithotripsy in adults
In adults, NRS found a lower SFR and higher rate of unplanned procedures for SWL vs. transurethral cystolithotripsy, despite continuous irrigation in all patients and fragment evacuation in 16% of cases [4, 56].

3.4.3.4.2 Shock wave lithotripsy in children
One large NRS found lower SFR for SWL than both transurethral cystolithotripsy and open cystolithotomy, despite treating smaller stones with SWL. However, the length of hospital stay favoured SWL over cystolithotomy, although this appeared to be comparable between SWL and transurethral cystolithotripsy [57].

3.4.3.5 Laparoscopic cystolithotomy

Laparoscopic cystolithotomy has been described in adults, and is typically performed in combination with simple prostatectomy using either traditional laparoscopy or with robotic-assistance [58, 59]. A SR found no studies comparing laparoscopic surgery with other procedures [4].

*3.4.4 **Treatment for bladder stones secondary to bladder outlet obstruction in adult men***

Bladder stones in men aged over 40 years are typically related to BPO, the management of which should also be considered. Bladder stones were traditionally an indication for a surgical intervention for BPO: a doctrine which has been questioned by recent studies. One NRS compared 64 men undergoing transurethral cystolithotripsy with either transurethral resection of prostate (TURP) or medical management for BPO (α-blocker with or without 5-alpha reductase inhibitor). After 28 months follow-up, no men on medication had had a recurrence, but 34% underwent TURP: a high post-void residual urine volume predicted the need for subsequent TURP [60]. Another observational study of 23 men undergoing cystolithotripsy and commencing medical management for BPO found 22% developed a BPO related complication, including 17% who had recurrent stones [43].

Large studies support the safety of performing BPO and bladder stone procedures during the same operation with no difference in major complications compared to a BPO procedure alone [61, 62]. An observational study on 2,271 patients undergoing TURP found no difference in complications except UTIs, which occurred slightly more frequently in patients with simultaneously treated bladder stones: 0% vs. 0.6%, p = 0.044 [61]. An observational study of 321 men undergoing Holmium laser enucleation of the prostate (HoLEP) found a higher rate of early post-operative incontinence (26.8% vs. 12.5%, p = 0.03) in men having concomitant transurethral cystolithotripsy, but no difference in long-term continence rates [62].

3.4.5 ***Special situations***

3.4.5.1 Neurogenic bladder and stone formation

Patients with neurogenic bladder secondary to spinal cord injury or myelomeningocele are at increased risk of forming bladder stones. Within eight to ten years, 15-36% of patients with spinal cord injury will develop a bladder stone [25-27]. The absolute annual risk of stone formation in spinal cord injury patients with an indwelling catheter is 4% compared with 0.2% for those voiding with clean intermittent self-catheterisation (CISC) [63]. Bladder stones are no more likely to form in patients with suprapubic catheters compared to those with indwelling urethral catheters [63]. Spinal cord injury patients with an indwelling urethral catheter are approximately six times more likely to develop bladder stones than patients with normal micturition [27].

The risk of stone recurrence in these patients is 16% per year [63]. An RCT of 78 spinal cord injury patients who perform CISC found a significant reduction in bladder stone formation when twice weekly manual bladder irrigations were performed for 6 months (49% vs. 0%, p = <0.0001), as well as less symptomatic UTIs (41% vs. 8%; p = 0.001) [64]. However, this study excluded patients who developed autonomic dysreflexia during bladder irrigations.

3.4.5.2 Bladder Augmentation

The incidence of vesical calculus formation after bladder augmentation is 2-44% in adults [65-73], and 4-53% in children [74-86]. The reported cumulative incidence of bladder stone formation after ten years is 36% [87]. Following cystoplasty, stones form after 24-31 months in adults [66, 68, 73], and after 25-68 months in children [78, 80, 82, 86, 88-90].

Drainage by vesico-entero-cystostomy (Mitrofanoff or Monti) is associated with an increased risk of bladder stone formation [66, 71, 72, 77, 78, 80, 87, 91]. The risk of bladder stone formation is elevated in patients voiding by CISC compared with those voiding spontaneously [70]. Gastric segment augmentation confers a lower risk of bladder stones than ileal or colononic segment cystoplasty [74, 77, 78, 80].

In previous stone formers, the rate of recurrence is 15-44% in adults [66-68, 70, 73], and 19-56% in children [74, 77, 78, 80, 82-84, 90, 91]. The risk of recurrence is greatest during the first two years, at about 12% per patient per year, with the risk decreasing with time [90]. Daily bladder irrigation with 250 mL of saline solution significantly reduces the incidence of recurrent stone formation and bacterial colonisation compared to lower volume bladder irrigations [69]. A paediatric study reported that patients placed on an irrigation protocol using 240 mL saline solution twice a week and gentamicin sulphate solution once a week (240–480 mg gentamicin/L saline, at 120–240 mL per irrigation, depending on patient age and reservoir size), was associated with a significantly lower risk of vesical calculus formation [91].

3.4.5.3 Urinary diversion

The incidence of stone formation after urinary diversion with an ileal or colon conduit is 0-3% [92, 93]. The incidence of stone formation is 0-34% in orthotopic ileal neobladders (Hautmann, hemi-Kock, Studer, T-pouch or w-neobladder) [70, 92, 94-102], and 4-6% in orthotopic sigmoid neobladders (Reddy) [98, 103]. The risk of pouch stone formation is 4-43% in adults with an ileocaecal continent cutaneous urinary diversion (Indiana, modified Indiana, Kock or Mainz I) [70, 92, 93, 101, 104, 105]. The average interval from construction of the urinary diversion to stone detection is 71-99 months [97, 106]. In children, the incidence of neobladder stone formation is 30% after Mainz II diversion (rectosigmoid reservoir) [75], and 27% after Kock ileal reservoir construction [85].

3.4.5.4 Treatment of stones in patients with bladder augmentation or urinary diversion

Stones may be removed by open or endoscopic surgery in patients with bladder augmentation or diversion

[84]. However, often access cannot be obtained through a continent vesico-entero-cystostomy without damaging the continence apparatus; hence a percutaneous or open approach is typically preferred [84].

No studies comparing outcomes following procedures for stones in reconstructed or augmented bladders were found. Two observational studies indicate that percutaneous lithotomy can be safely performed with US or CT guidance in patients with reconstructed or augmented bladders [107, 108] and is proposed to offer similar advantages over open surgery to those for percutaneous native bladder surgery. Stone recurrence after successful removal has been reported to be 10-42% [107, 108], but appears to be unrelated to the modality used for stone removal [73, 77, 78, 80, 83, 90].

4. FOLLOW-UP

There are no studies examining the merits of differing follow-up modalities or frequencies following conservative, medical or operative treatment of bladder stones in adults or children. Identification and prevention of the cause of bladder stone formation will be crucial to prevent recurrence (see section 3.3.2).

In adults, there is a paucity of evidence on dietary modification or medical treatment for the prevention of bladder stone recurrence. Recommendations in the EAU Guideline on Urolithiasis, based on evidence from upper tract stones, constitutes the best available recommendations, especially for migratory bladder stones (see chapter 4 in the main EAU Urolithiasis guideline) [22].

Where it is possible to address the cause of secondary bladder stones (e.g. treatment of BPO), it is unclear whether metabolic intervention would offer any significant additional benefit in preventing stone recurrence. However, especially where the secondary cause cannot be addressed (e.g. indwelling catheter, neuropathic bladder, bladder augmentation or urinary diversion); metabolic interventions are likely to reduce bladder stone recurrence rates.

Regular bladder irrigation reduces the chances of bladder stone recurrence in adults and children with bladder augmentation or continent cutaneous urinary diversion and adults with spinal cord injury who perform CISC (see section 3.3.5) [64, 69, 91].

In children with primary (endemic) bladder stones maintenance of hydration, avoidance of diarrhoea and a mixed cereal diet with milk and Vitamins A and B supplements, with the addition of eggs, meat and boiled cows' milk after one year of age are recommended to prevent recurrence [32].

Finally, there are contradictory reports on a possible association between bladder calculi and future development of bladder cancer [109-111]. The need for follow-up with regular cystoscopy therefore remains controversial.

Summary of evidence	LE
The incidence of bladder stones peaks at three years in children (endemic/primary stones in developing countries) and 60 years in adults.	2c
The aetiology of bladder stones is typically multi-factorial. Bladder stones can be classified as primary (endemic), secondary (associated with lower urinary tract abnormalities e.g. BPO, neuropathic bladder, foreign body, chronic bactiuria) or migratory (having formed in the upper tract).	4
In adults, bladder outlet obstruction (BOO) is the most common predisposing factor for bladder stone formation.	2c
Metabolic abnormalities are also likely to contribute to bladder stone formation in patients with secondary bladder stones.	2b
In adults, US has a sensitivity of 20-83% for diagnosing bladder stones.	2b
In adults, X-Ray kidney ureter bladder (XR-KUB) has a sensitivity of 21-78%; sensitivity increases with stone size.	2b
Computer tomography has a higher sensitivity than US for the detection of bladder stones.	2b
Cystoscopy has a higher sensitivity than XR-KUB or US for the detection of bladder stones.	2b
Endoscopic bladder stone treatments are associated with comparable stone-free rates (SFRs) but a shorter length of hospital stay, duration of procedure and duration of catheterisation compared to open cystolithotomy in adults.	1a
Stone-free rates are lower in patients treated with shock wave lithotripsy (SWL) than those treated with open or endoscopic procedures in both adults and children.	2a
Transurethral cystolithotripsy is associated with a shorter length of hospital stay, less pain and a shorter convalescence period than percutaneous cystolithotripsy in adults.	1b
Transurethral cystolithotripsy with a nephroscope is quicker than when using a cystoscope with no difference in SFR in adults.	1a
Transurethral cystolithotripsy with a resectoscope is quicker than when using a cystoscope with no difference in SFR in adults.	2a
Mechanical, pneumatic and laser appear equivalent lithotripsy modalities for use in endoscopic bladder stone treatments in adults and children.	2a
Open cystolithotomy without a retropubic drain or urethral catheter ("tubeless") is associated with a shorter length of hospital stay than traditional cystolithotomy and can be performed safely in children with primary stones and no prior bladder surgery or infections.	2b
Bladder stone removal with concomitant treatment for BOO is associated with no significant difference in major post-operative complications when compared to BOO treatment alone in adults. However, concomitant bladder stone treatment does increase the rates of short-term post-operative incontinence and urinary infection.	2b
The absolute annual risk of stone formation in spinal cord injury patients is significantly higher with an indwelling catheter compared to those voiding with CISC. Suprapubic and urethral catheters have equal rates of bladder stone formation in spinal cord injury patients.	2b
The incidence of bladder stone formation after bladder augmentation or vesico-entero-cystostomy is between 2-53% in adults and children.	2b
Urinary diversion including orthotopic ileal neobladders, ileocaecal continent cutaneous urinary diversion and rectosigmoid reservoirs is associated with stone formation in 0-43%.	2b
Primary (endemic) bladder stones typically occur in children in areas with poor hydration, recurrent diarrhoea and a diet deficient in animal protein. The following measures are proposed to reduce their incidence: maintenance of hydration, avoidance of diarrhoea, and a mixed cereal diet with milk and Vitamins A and B supplements; with the addition of eggs, meat and boiled cows' milk after one year of age.	5

Recommendations	Strength rating
Use ultrasound (US) as first-line imaging in adults with symptoms suggestive of a bladder stone.	Strong
Use cystoscopy or computer tomography (CT) kidney ureter bladder (KUB) to investigate adults with persistent symptoms suggestive of a bladder stone if US is negative.	Strong
Use US as first-line imaging in children with symptoms suggestive of a bladder stone.	Strong
Use X-Ray KUB for adults with confirmed bladder stones to guide treatment options and follow-up.	Weak
All patients with bladder stones should be examined and investigated for the cause of bladder stone formation, including: • uroflowmetry and post-void residual; • urine dipstick, pH, ± culture • metabolic assessment and stone analysis (see sections 3.3.2.3 and 4.1 of the Urolithiasis guideline for further details). In selected patients, consider: • upper tract imaging (in patients with a history of urolithiasis or loin pain); • cysto-urethroscopy or urethrogram.	Weak
Offer oral chemolitholysis for radio-lucent or known uric acid bladder stones in adults.	Weak
Offer adults with bladder stones transurethral cystolithotripsy where possible.	Strong
Perform transurethral cystolithotripsy with a continuous flow instrument in adults (e.g. nephroscope or resectoscope) where possible.	Weak
Offer adults percutaneous cystolithotripsy where transurethral cystolithotripsy is not possible or advisable.	Strong
Suggest open cystolithotomy as an option for very large bladder stones in adults and children.	Weak
Offer children with bladder stones transurethral cystolithotripsy where possible.	Weak
Offer children percutaneous cystolithotripsy where transurethral cystolithotripsy is not possible or is associated with a high risk of urethral stricture (e.g. young children, previous urethral reconstruction and spinal cord injury).	Weak
Open, laparoscopic and extracorporeal shock wave lithotripsies are alternative treatments where endoscopic treatment is not possible in adults and children.	Weak
Prefer “tubeless” procedure (without placing a catheter or drain) for children with primary bladder stones and no prior infection, surgery or bladder dysfunction where open cystolithotomy is indicated.	Weak
Perform procedures for the stone and underlying BOO simultaneously in adults with bladder stones secondary to bladder outlet obstruction (BOO), where possible.	Strong
Individualise imaging follow up for each patient as there is a paucity of evidence. Factors affecting follow up will include : • whether the underlying functional predisposition to stone formation can be treated (e.g. TURP); • metabolic risk.	Weak
Recommend regular irrigation therapy with saline solution to adults and children with bladder augmentation, continent cutaneous urinary reservoir or neuropathic bladder dysfunction, and no history of autonomic dysreflexia, to reduce the risk of recurrence.	Weak

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6. CONFLICT OF INTEREST

All members of the Bladder Stones Guidelines working group have provided disclosure statements of all relationships that they have that might be perceived as a potential source of a conflict of interest. This information is publically accessible through the European Association of Urology website: http://www.uroweb.org/guidelines. This guidelines document was developed with the financial support of the European Association of Urology. No external sources of funding and support have been involved. The EAU is a non-profit organisation and funding is limited to administrative assistance and travel and meeting expenses. No honoraria or other reimbursements have been provided.

7. CITATION INFORMATION

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