Evaluation & Management of Upper Urinary Tract Calculi

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Outline

- Diagnostic imaging
- Analysis of stone composition
- Disease management
  - Medical expulsive therapy (MET)
  - Extracorporeal shock wave lithotripsy (ESWL)
  - Ureteroscopy (retrograde and antegrade)
  - Percutaneous nephrolithotomy
- Preventive medicine

Diagnostic imaging

- Ultrasound (US) should be used as the primary diagnostic imaging tool
  - Ultrasound is safe (no risk of radiation), reproducible and inexpensive.
  - Ultrasound has a sensitivity of 45% and specificity of 94% for ureteral stones and a sensitivity of 45% and specificity of 88% for renal stones
- KUB: sensitivity and specificity is 44-77%
  - it is helpful in differentiating between radiolucent and radiopaque stones
  - used for comparison during follow-up

- Non-contrast-enhanced computed tomography (NCCT) has become the standard for diagnosing acute flank pain and has replaced intravenous urography (IVU).
  - determine stone diameter and density
  - acute urolithiasis: is significantly more accurate than IVU or US
  - detect uric acid and xanthine stones, which are radiolucent on plain films, but not indinavir stones
  - determine stone density, inner structure of the stone, skin-to-stone distance, and surrounding anatomy
  - low-dose CT: body mass index (BMI) < 30 shown to have a sensitivity of 86% for detecting ureteral stones < 3 mm and 100% for calculi > 3 mm
  - pooled sensitivity of 93.1% (95% CI: 91.5-94.4), and a specificity of 96.6% (95% CI: 95.1-97.7%).
  - Dual-energy CT can differentiate uric acid containing stones from calcium-containing stones

Recommendations	Strength rating
Immediate imaging is indicated with fever or solitary kidney, and when diagnosis is doubtful.	Strong
Use non-contrast-enhanced computed tomography to confirm stone diagnosis in patients with acute flank pain following initial ultrasound assessment.	Strong
Perform a contrast study if stone removal is planned and the anatomy of the renal collecting system needs to be assessed.	Strong

Diagnostic imaging during pregnancy

- Ultrasound: primary radiological diagnostic tool when suspected of renal colic.
  - normal physiological changes in pregnancy can mimic ureteral obstruction
- Magnetic resonance imaging can be used, as a second-line option
  - define the level of urinary tract obstruction, and to visualise stones as a filling defect
  - 1.5 Tesla (T) rather than 3T MRI has not been evaluated in pregnancy,
  - The use of gadolinium is not routinely recommended in pregnancy to avoid toxic effects to the embryo
- Low-dose CT as a last-line option
  - higher positive predictive value (95.8%), compared to MRI (80%) and US (77%).

Diagnostic imaging in children

- high risk of recurrence
- Stone analysis was necessary
- The most common non-metabolic disorders facilitating stone formation are vesico-ureteral reflux (VUR), UPJ obstruction, neurogenic bladder, and other voiding difficulties
- Ultrasound is the primary imaging technique in children.
- KUB: identify stones and their radiopacity and facilitate follow-up.
- IVU: the need for contrast medium injection is a major drawback.

- *Non-contrast-enhanced computed tomography*
  - Recent low-dose CT protocols have been shown to significantly reduce radiation exposure
  - only 5% of stones escape detection by NCCT
  - Sedation or anaesthesia is rarely needed with modern high-speed CT equipment.
- Magnetic resonance urography (MRU) cannot be used to detect urinary stones.
  - provide detailed anatomical information: location of an obstruction or stenosis in the ureter, and renal parenchymal morphology

Analysis of stone composition

- Stone analysis should be performed in all first-time stone formers.
- In clinical practice, repeat stone analysis is needed in the case of:
  - recurrence under pharmacological prevention;
  - early recurrence after interventional therapy with complete stone clearance;
  - late recurrence after a prolonged stone-free period

Disease management

- Pain relief
  - Non-steroidal anti-inflammatory drugs (NSAIDs) and paracetamol are effective in patients with acute stone colic, better than opioids
  - Ibuprofen compared to ketorolac is a more rapid acting
  - For ureteral stones expected for spontaneous passage, NSAIDS may help reduce inflammation and the risk of recurrent pain

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

Management of sepsis and/or anuria in obstructed kidney

- Urgent decompression is often necessary

1. Decompression
   - placement of an indwelling ureteral stent;
   - percutaneous placement of a nephrostomy tube.
2. both urine- and blood samples should be sent for culture-antibiogram sensitivity testing and
3. antibiotics should be initiated immediately thereafter or continued
4. Intensive care might become necessary

Recommendations	Strength rating
Urgently decompress the collecting system in case of sepsis with obstructing stones, using percutaneous drainage or ureteral stenting.	Strong
Delay definitive treatment of the stone until sepsis is resolved.	Strong
Collect (again) urine for antibiogram test following decompression.	Strong
Start antibiotics immediately (+ intensive care, if necessary).	Strong
Re-evaluate antibiotic regimen following antibiogram findings.	Strong

Medical expulsive therapy

3.4.3.1. Summary of evidence and guideline for MET

Summary of evidence	LE
Medical expulsive therapy seems to be efficacious for treating patients with ureteral stones who are amenable to conservative management. The greatest benefit might be among those with > 5 mm (distal) ureteral stones.	1a
Insufficient data exist to support the use of PDEI-5 or corticosteroids in combination with α-blockers as an accelerating adjunct.	2a
Alpha-blockers increase stone expulsion rates in distal ureteral stones > 5 mm.	1a
A class effect of α-blockers has been demonstrated.	1a

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

Extracorporeal shock wave lithotripsy (ESWL)

- *Shock wave rate*
  - Lowering shock wave frequency from 120 to 60-90 shock waves/min improves SFRs
- *Number of shock waves, energy setting and repeat treatment sessions*
  - Starting SWL on a lower energy setting with stepwise power (and SWL sequence) ramping can achieve vasoconstriction during treatment which prevents renal injury
- *Improvement of acoustic coupling*
  - Proper acoustic coupling between the cushion of the treatment head and the patient's skin is important. Defects (air pockets) in the coupling gel deflect 99% of shock waves

KEY POINTS: SHOCK WAVE LITHOTRIPSY

- Shock waves fragment stones via multiple different mechanisms, including compressive and tensile forces.
- SWL is associated with anatomic injury to the kidney; however, extensive studies in humans have not indicated long-term adverse effects.
- Adverse outcomes with SWL are associated with high peak pressures at F2.
- The effectiveness of SWL can be enhanced by ensuring optimal coupling of the patient to the lithotripter, treating at a slow to intermediate rates (60 shocks/min), ramping the power settings, and treating with general anesthesia.
- The adverse effects of SWL may be reduced by initiating treatment at low power settings and slowly ramping up the power to standard treatment energy.

Ureteroscopy (retrograde and antegrade)

Ureteroscopy for renal stones (RIRS)

- Antegrade URS is an option for large, impacted, proximal ureteral calculi
- “Dust and go” strategies should be limited to the treatment of large (renal) stones
- The use of ureteral access sheaths improves vision by establishing a continuous outflow, decreases intrarenal pressure, and potentially reduces operating time

Complications of ureteroscopy

- The overall complication rate after URS is 9-25%
- Most complications are minor and do not require intervention.
- post-operative urosepsis of up to 5%
- Ureteral avulsion and strictures are rare (< 1%)
- Previous perforations, pre-operative positive urine cultures and longer operation time are the most important risk factor for complications
- Infectious complications following URS can be minimised using prophylactic antibiotics, limiting stent dwell and procedural time, identification and treatment of UTI, and planning in patients with large stone burden and multiple comorbidities
- High intrarenal pressure (IRP) predisposes to URS complications, and measures should be used to reduce IRP. Currently there are no accurate ways to measure intra-operative IRP

Recommendations	Strength rating
Use holmium: yttrium-aluminium-garnet (Ho:YAG) laser lithotripsy for (flexible) ureteroscopy (URS).	Strong
Perform stone extraction only under direct endoscopic visualisation of the stone.	Strong
Do not insert a stent in uncomplicated cases.	Strong
Offer medical expulsive therapy for patients suffering from stent-related symptoms and after Ho:YAG laser lithotripsy to facilitate the passage of fragments.	Strong
Use percutaneous antegrade removal of ureteral stones as an alternative when shock wave lithotripsy (SWL) is not indicated or has failed, and when the upper urinary tract is not amenable to retrograde URS.	Strong
Use flexible URS in cases where percutaneous nephrolithotomy or SWL are not an option (even for stones > 2 cm). However, in this case there is a higher risk that a follow-up procedure and placement of a ureteral stent may be needed.	Strong

Percutaneous nephrolithotomy

- remains the standard procedure for large renal calculi.
- *Contraindications*
  - anti-coagulant therapy must be monitored carefully pre- and post-operatively. Anti-coagulant therapy must be discontinued before PNL
  - untreated UTI;
  - tumour in the presumptive access tract area
  - potential malignant kidney tumour
  - pregnancy

Nephrostomy and stents

- presence of residual stones;
- likelihood of a second-look procedure;
- significant intra-operative blood loss;
- urine extravasation;
- ureteral obstruction;
- potential persistent bacteriuria due to infected stones;
- solitary kidney;
- bleeding diathesis;
- planned percutaneous chemolitholysis.

Complications of percutaneous nephrolithotomy

- fever 10.8%
- transfusion 7%
- thoracic complication 1.5%
- sepsis 0.5%
- organ injury 0.4%
- embolisation 0.4%
- urinoma 0.2%
- death 0.05%

3.4.7.1. Summary of evidence and guidelines for endourology techniques for renal stone removal

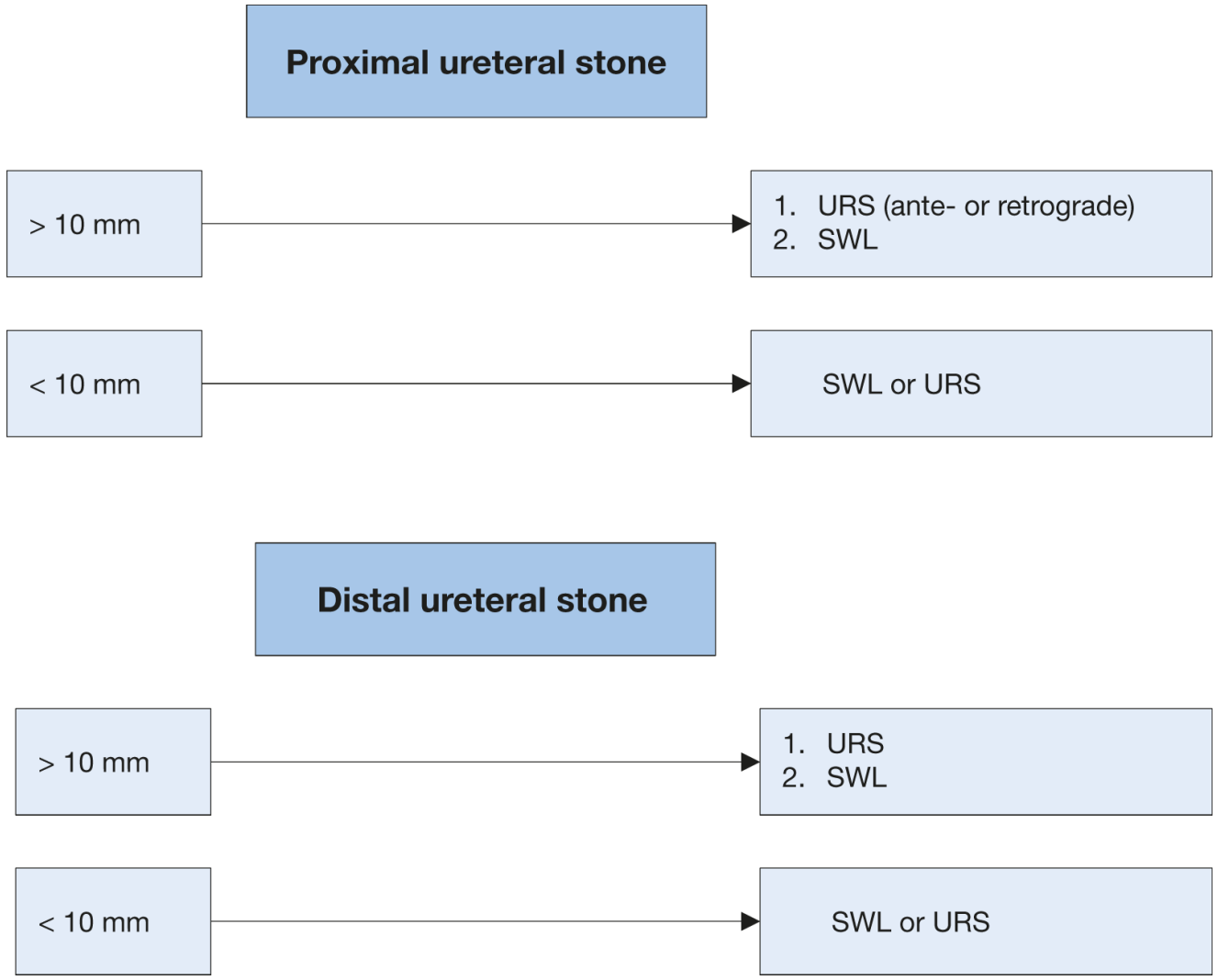
Summary of evidence	LE
Imaging of the kidney with US or CT can provide information regarding inter-positioned organs within the planned percutaneous path (e.g., spleen, liver, large bowel, pleura, and lung).	1a
Both prone and supine positions are equally safe, but neither has a proven advantage in operating time or SFR.	1a
Percutaneous nephrolithotomy performed with small instruments tends to be associated with significantly lower blood loss, but the duration of procedure tended to be significantly longer. There are no significant differences in SFR or any other complications.	1a
In uncomplicated cases, a totally tubeless PNL results in a shorter hospital stay, with no increase in complication rate.	1a

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

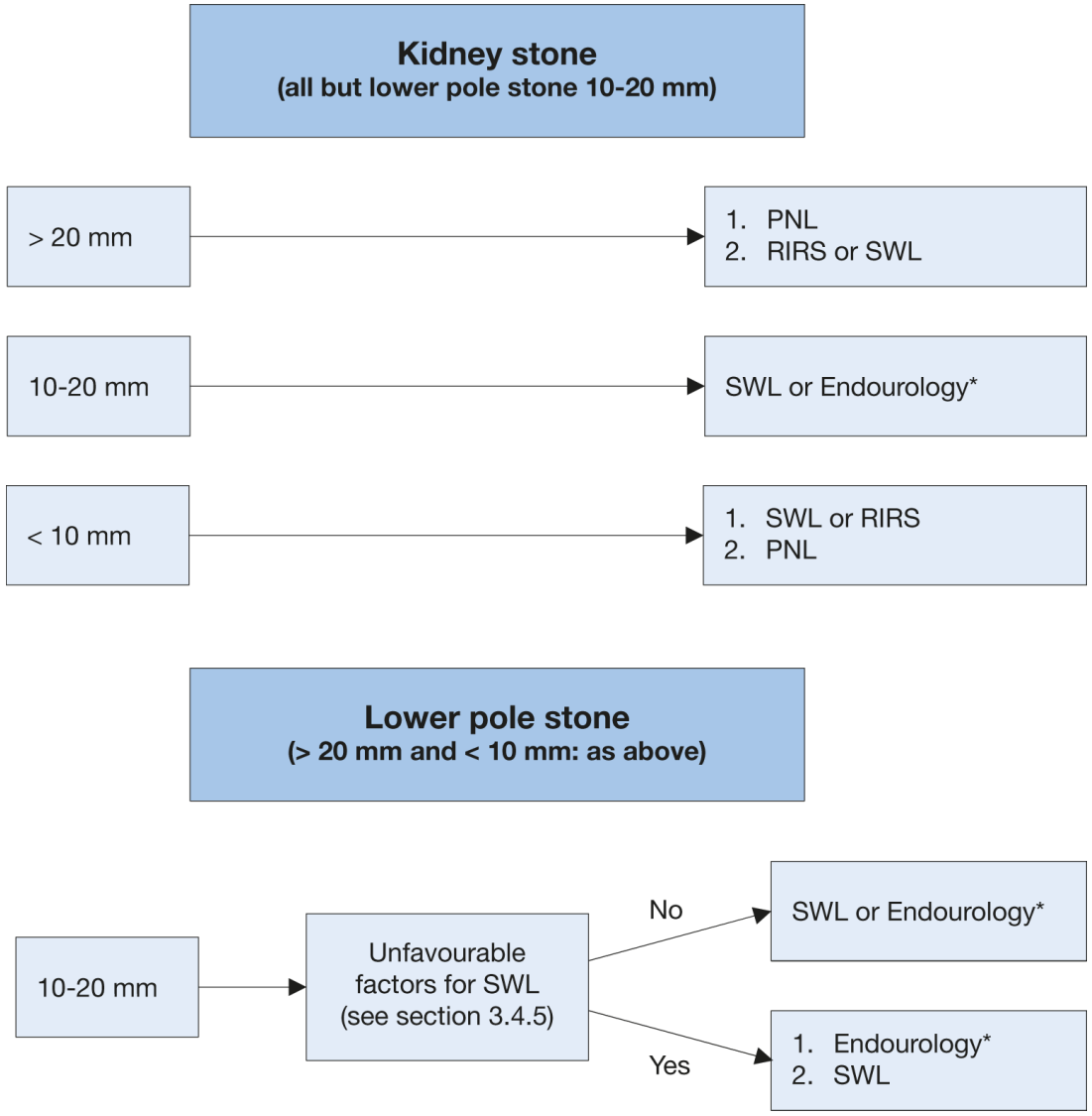
KEY POINTS: PERCUTANEOUS NEPHROLITHOTOMY

- Critical preoperative steps include correcting underlying coagulopathy and close attention to preoperative microbiologic studies and perioperative antibiotic therapy.
- Complete stone removal generally requires both rigid and flexible nephroscopy and a corresponding armamentarium of rigid and flexible lithotrites.
- There is an increasing role for smaller caliber dilation/instrumentation approaches such as mini-, micro-, and ultramini-PCNL. Their ultimate place in the spectrum of therapies is not yet well defined, but they appear to be associated with less bleeding and pain. However, the efficiency of stone clearance also may be reduced.

Treatment algorithm for ureteral stones (if active stone removal is indicated)



Treatment algorithm for renal stones (if/when active treatment is indicated)



Metabolic Evaluation and Recurrence Prevention

- After stone passage, every patient should be assigned to a low- or high-risk group for stone formation
  - reliable stone analysis by infrared spectroscopy or X-ray diffraction;
  - basic analysis
  - Only high-risk stone formers require specific metabolic evaluation.
- Timing of specific metabolic work-up
  - The first follow-up 24-hour urine measurement is suggested eight to twelve weeks after starting pharmacological
    - enables drug dosage to be adjusted if urinary risk factors have not normalised, with further 24-hour urine measurements, if necessary.
  - Once urinary parameters have been normalised, it is sufficient to perform 24-hour urine evaluation every twelve months.

General preventive measures

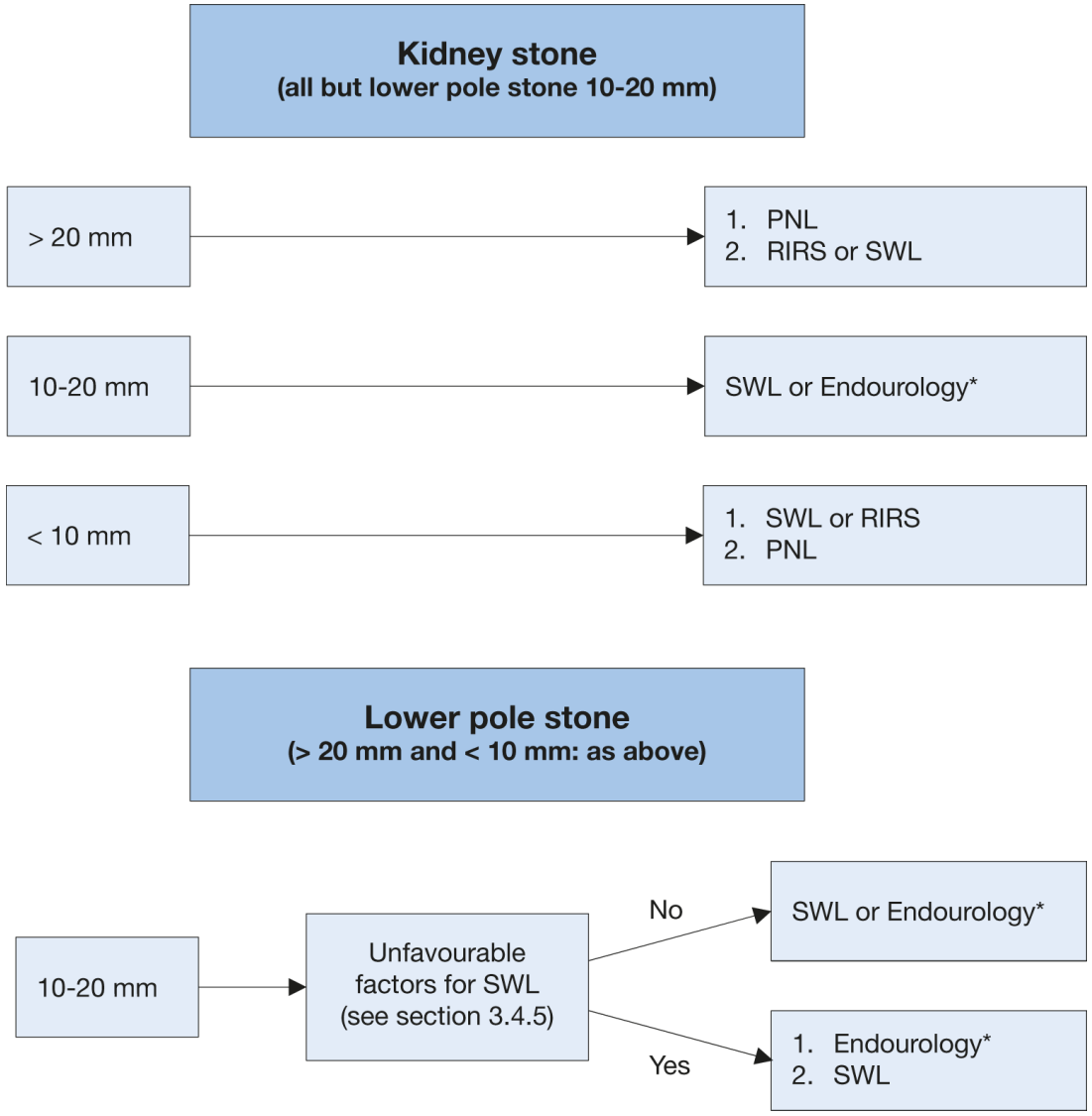
General preventive measures	
Fluid intake (drinking advice)	Fluid amount: 2.5-3.0 L/day
	Circadian drinking
	Neutral pH beverages
	Diuresis: 2.0-2.5 L/day
	Specific weight of urine: < 1,010 g/day
Nutritional advice for a balanced diet	Balanced diet*
	Rich in vegetables and fibre
	Normal calcium content: 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: Protein requirements are age dependent; therefore, protein restriction in childhood should be handled carefully.

Take home messages

- Ultrasound ad the primary diagnostic tool
- NCCT as the standard diagnosis for acute flank pain
- Pregnancy: ultrasound as primary tool followed by MRI> low dose CT
- Children:high risk recurrence, stone analysis was necessary, ultrasound as primary diagnostic too
- Stone analysis should be performed in all first-time stone formers

Treatment algorithm for renal stones (if/when active treatment is indicated)



References

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- *EAU Guidelines. Edn. presented at the EAU Annual Congress Amsterdam, 2022. ISBN 978-94-92671-16-5.*