|  |  |  |  |
| --- | --- | --- | --- |
| **Type of Input Factor** | **Model Input Factor** | **Value / Levels** | **Reference** |
| ***Population statistics*** | English Population | 2016: 55,289,000  2017: 55,619,500  2018: 55,924,500  2019: 56,230,100  2020: 56,326,000 | ONS |
| Death rates in England | Proportion per population per 5 year age band | ONS |
| Incidence of Kidney stones (estimated increments) | 1-2%  **(0.25% increments – start at 0.5%\*)** | NHANES - Hill et al. J Urol 20221 |
| Age distribution of 1st stone episode | Mean: 52.61±13.98 | Meta-analysis result of combined AoU + UKB |
| Sex distribution of 1st stone episode | Male: 60.9% | Meta-analysis result of combined AoU + UKB |
| ***Numbers of Individuals undergoing Intervention*** | PCNL | 2016: 10,454  2017: 10,953  2018: 11,463  2019: 11,164  2020: 4506\* | HES |
| URS | 2016: 11,441  2017: 12,016  2018: 12,669  2019: 12,444  2020: 12,840 | HES |
| ESWL | 2016: 20,745  2017: 20,030  2018: 18,964  2019: 19,957  2020: 13,000 | HES |
| ***Estimated Global Stone Free Rates (For Renal Stones)*** | PCNL | 74% | Geraghty et al. 20242 |
| URS | 60% | Ghani and Wolf 20153 |
| ESWL | 50% | Brain et al. 20234 |
| ***Estimated Global Stone free Rates (for Ureteric stones)*** | URS | 89% (PP2) | Dasgupta et al. 20215 |
| ESWL | 70% (PP2) | Dasgupta et al. 20215 |
| Spontaneous passage | 74% | Shah et al. 20196 |
| ***Sensitivity / Specificity for Detection of de novo stones*** | US | *Sens*: 0.54; *Spec*: 0.91 | Ganesan et al. 20167 |
| XR | *Sens*: 0.58; *Spec*: 0.76 | NICE 20198 / Fulgham et al. 20129 |
| CT | *Sens*: 0.95; *Spec*: 0.98 | Coursey et al. 201210 |
| Low dose CT | *Sens*: 0.95; *Spec*: 0.97 | Coursey et al. 201210 |
| ***5 year Recurrence rates (estimated)*** | High Risk | 60-100% (estimated from KM plots) (**5% increments**) | Dhayat et al. 202311 |
| Low Risk | 10-40% (**5% increments**) | Estimated |
| ***Costs*** | Initial Urology Consultation | £145 | NHS Tariff for corresponding year (2023/24 as example) |
| Follow-up Urology clinic review | £71 |
| XR | £27 |
| US | £43 |
| CT | £69 |
| PCNL | £4548 |
| URS | £2386 |
| ESWL | £445 |
| Stent insertion | £822 |
| A&E attendance | £288 (Category 3) |
| R256 Genetic Panel | £~100 | Bristol Genetics Laboratory |
| 24 hour urine\* | £190.50 | QE Laboratory, Gateshead |
| ***Radiation dose*** | XR | 0.7mSv | Coursey et al. 201210 |
| CT | 10mSv | Coursey et al. 201210 |
| Low dose CT | 3mSv | Coursey et al. 201210 |
| PCNL | 0.9mSv | NuTH Estimation |
| URS | 1.1mSv | NuTH Estimation |
| ESWL | 0.5mSv | NuTH Estimation |
|  |  |  |  |

**Scenarios to model:**

Stone free vs not stone free

Recurrence vs no recurrence

Death vs no death

Intervention vs no intervention

Stone free following intervention or not

Elective vs emergency intervention

**Notes**:

1. Incidence of ‘clinically significant’ kidney stone disease i.e those who present with colic or need intervention is likely to be lower than the 1-2% found in the NHANES data – this was in response to the question – ‘Have you ever had a kidney stone?’.
2. No death rate data available solely for England. ONS data combines this with Welsh data. However, death rates are presumed not to differ too differently between nations and therefore used to calculate death rates in this population.
3. Incidence calculated from NHANES data presumed to be translatable to England as similar demographics and dietary habits.
4. I have presumed that the majority of patients will have a unilateral stone, and that the estimates from this model will apply to the general stone forming population, rather than those with complex anatomy / very high stone burdens which will likely require personalised follow-up.
5. Stone size / burden was not estimated as there is no data on presenting stone burden in the general population.
6. I have presumed that the goal of surgical management was to render the patient stone free.
7. Stone free is defined as no dust / residual fragments. Hence, the ureteroscopy SFR is lower than is reported elsewhere. This estimate presumes any location within the kidney.
8. The addition of stone location was considered, however the follow-up algorithm does not specify stone location. I have also included the stone free rates for a lower pole location in the global stone free rate estimate.
9. PCNL is presumed to be standard PCNL, rather than mini/micro – this is an attempt to simplify the model.
10. The SFR for URS is often defined as fragments <4mm or <2mm. However, using a more stringent SF definition (ie. No fragments) the SFR reduces to ~60%.
11. ESWL SFR was estimated from a meta-analysis published in 2023. Following meta-analysis of proportions, the SFR was ~75% (random effects model), however, the stone free definitions vary widely between studies, and therefore a more conservative estimate was used.
12. Recurrence rates in high and low risk groups estimated based on ‘no residual fragments’.
13. Presumed that some asymptomatic renal stones will be surveilled rather than undergo intervention – patient ideally should restart follow-up at appropriate pathway (< vs >4mm).
14. Preumed that those with symptomatic stones will undergo intervention in similar proportion to those undergoing intervention a priori.
15. 24 hour urine to include: volume, pH, creatinine, calcium, phosphate, urate, oxalate, citrate, cystine
16. Current practice = 1-2 years follow-up for low risk patients and up to 4 years for high risk providing they are stone free, with a 24 hour urine in first year and in one further year within follow-up.

A diagram of a medical procedure

AI-generated content may be incorrect.

Figure 1. EAU Follow-up guideline following treatment.12,13

**References**

1. Hill, A. J. *et al.* Incidence of Kidney Stones in the United States: The Continuous National Health and Nutrition Examination Survey. *J. Urol.* **207**, 851–856 (2022).

2. Geraghty, R. M. *et al.* Use of Temporally Validated Machine Learning Models To Predict Outcomes of Percutaneous Nephrolithotomy Using Data from the British Association of Urological Surgeons Percutaneous Nephrolithotomy Audit. *Eur. Urol. Focus* **10**, 290–297 (2024).

3. Ghani, K. R., Wolf, J. S. & Wolf, J. S. What is the stone-free rate following flexible ureteroscopy for kidney stones? *Nat. Rev. Urol.* **12**, 281–288 (2015).

4. Brain, E. *et al.* Outcomes of alpha‐blockers as medical expulsive therapy following shockwave lithotripsy: a systematic review and meta‐analysis. *BJU Int.* **131**, 424–433 (2023).

5. Dasgupta, R. *et al.* Shockwave Lithotripsy Versus Ureteroscopic Treatment as Therapeutic Interventions for Stones of the Ureter (TISU): A Multicentre Randomised Controlled Non-inferiority Trial☆. *Eur Urol* **80**, 46–54 (2021).

6. Shah, T. T. *et al.* Factors associated with spontaneous stone passage in a contemporary cohort of patients presenting with acute ureteric colic: results from the Multi‐centre cohort study evaluating the role of Inflammatory Markers In patients presenting with acute ureteric Colic (MIMIC) study. *BJU Int.* **124**, 504–513 (2019).

7. Ganesan, V., De, S., Greene, D., Torricelli, F. C. M. & Monga, M. Accuracy of ultrasonography for renal stone detection and size determination: is it good enough for management decisions? *BJU Int.* **119**, 464–469 (2017).

8. Renal and ureteric stones: assessment and management. <https://www.nice.org.uk/guidance/ng118/evidence/b-imaging-for-diagnosis-pdf-6653382735>.

9. Fulgham, P. F., Assimos, D. G., Pearle, M. S. & Preminger, G. M. Clinical Effectiveness Protocols for Imaging in the Management of Ureteral Calculous Disease: AUA Technology Assessment. *J. Urol.* **189**, 1203–1213 (2013).

10. Coursey, C. A. *et al.* ACR Appropriateness Criteria® Acute Onset Flank Pain–Suspicion of Stone Disease. *Ultrasound Q.* **28**, 227–233 (2012).

11. Dhayat, N. A. *et al.* Hydrochlorothiazide and Prevention of Kidney-Stone Recurrence. *N. Engl. J. Med.* **388**, 781–791 (2023).

12. Skolarikos, A. *et al.* *EAU Guidelines on Urolithiasis*. (EAU Guidelines Office, Arnhem, The Netherlands).

13. Lombardo, R. *et al.* Follow-up of urolithiasis patients after treatment: an algorithm from the EAU Urolithiasis Panel. *World J. Urol.* **42**, 202 (2024).