

# Detection of Ureteric Calculi on Computed Tomography of the Kidneys, Ureters, and Bladder (CT KUB) in an Outpatient Population

Review began 10/08/2026

Review ended 10/17/2026

Published 10/25/2026

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DOI: 10.7759/cureus.118569

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## Abstract

Renal colic is an acute urological presentation that accounts for many attendances to the emergency department and urology service in the UK. Given the severe nature of the pain, renal colic typically presents acutely to secondary care. However, the urology service in University Ayr Hospital (UHA) receives a significant number of outpatient referrals from primary care with suspected renal colic.

Standard practice in UHA currently is to vet these referrals directly to an urgent outpatient computed tomography of the urinary tract (kidney, ureter, and bladder) (CT KUB). This project aimed to assess the detection rate of CT KUB in detecting ureteric stones in patients referred as an outpatient with suspected renal colic.

A retrospective cohort study was performed using data collected from outpatient referrals to the urology service in the University Hospital Ayr from August 2023 to August 2024. Information was gathered from Clinical Portal regarding the history, examination, and investigations performed in primary care, alongside the results of CT KUB.

A total of 173 referrals with suspected renal colic were vetted straight to CT KUB. Twelve (6.9%) patients had ureteric calculi, and 35 (20.2%) had renal calculi. Six patients with ureteric calculi and four patients with renal calculi had their calculi managed with an operation. Many patients were referred without prior blood tests, ultrasound imaging, or urinalysis performed. These results highlight the need for a new pathway for the outpatient investigation of suspected renal colic, given the low detection rate of ureteric calculi on CT KUB in outpatient settings.

**Categories:** Urology, Radiology

**Keywords:** acute renal colic, ct kub, outpatient, renal calculi, ureteral calculi, ureteric colic

## Introduction

Urinary tract calculi are estimated to affect one in 10 people within their lifetime, with a prevalence of 1-2 cases per 1000 people per year [1]. Urolithiasis refers to the production of calculi anywhere in the urinary tract, with most stones forming within the kidney [2]. Renal colic describes the severe, spasmodic pain that occurs when a calculus moves into the ureter, obstructing the flow of urine from the kidney [3]. Risk factors for kidney stone formation include previous stone formation, inadequate hydration, urinary tract infections, genetic conditions, electrolyte disturbances, and diet [4]. Recurrence rates are 50% in patients who have previously formed a kidney stone [5].

Most ureteric calculi can be managed conservatively. The decision on management of ureteric calculi is made based on several factors, including the size of the stone, location of the stone, biochemical markers (including renal function, C-reactive protein, and white blood cell count), as well as patient factors such as anatomical abnormalities and the presence of a solitary functioning kidney [5]. The most valuable predictors of spontaneous stone passage with conservative management are stone size and location, with larger stones and more proximal stones having lower rates of spontaneous passage [6].

Renal colic accounts for many attendances to the emergency department and urology service in the United Kingdom (UK) [7]. Patients typically present with severe pain in their flank, which is spasmodic and can radiate from the flank to the groin or, in men, to the testicles [1]. Most patients (84%) will have non-visible haematuria on microscopic or dipstick urine testing [8]. Ultrasound imaging is recommended as the first-line investigation in the assessment of acute flank pain and in selected patient groups such as pregnant women and children. The gold-standard investigation for confirming the presence of a urinary tract calculus is low-dose non-contrast computed tomography of the kidneys, ureters, and bladder (CT KUB) [5]. A study that assessed the positive scan rate for patients undergoing CT KUB for suspected renal colic to the emergency department found that 37% of patients had an obstructing renal calculus [9].

### How to cite this article

Sneddon M, Avril S, MacDonald A, et al. (October 25, 2026) Detection of Ureteric Calculi on Computed Tomography of the Kidneys, Ureters, and Bladder (CT KUB) in an Outpatient Population. Cureus 18(10): e118569. DOI 10.7759/cureus.118569

There are several other pathologies that can cause unilateral acute flank pain. A study assessing the detection of pathology on CT KUB for acute flank pain found that 50% of patients had a cause for their pain identified, with 90% of these patients having a urological cause for their presentation. Urological causes other than ureteric stones included pelvico-ureteric junction obstruction (PUJO), hydronephrosis and ureteric stricture. The non-urological diagnoses identified included diverticulitis, abdominal aortic aneurysm, acute appendicitis, pneumonia, and pancreatitis. This study also found that 27% of patients had incidental findings and 23% of patients had a normal scan [10].

Given the severe nature of the pain, in the UK patients with acute renal colic typically present to the hospital [1]. However, the urology service at the University Hospital Ayr (UHA) receives a significant number of outpatient referrals from primary care with suspected renal colic. The urology service at UHA provides urology care to all patients in the National Health Service (NHS) Ayrshire and Arran (A&A) health board in Scotland, with a catchment population of 366,000 [11]. Current standard practice in UHA is for consultants to vet suspected renal colic referrals straight to an urgent outpatient CT KUB, without prior assessment in a urology clinic. As a result, the information provided in the GP referral guides the decision to perform a CT KUB.

It has been noted that there are a significant number of outpatient CT KUBs performed in UHA for suspected renal colic with a low positive scan rate. The department was interested in determining the detection rate from these scans and identifying possible risk factors for a positive scan, to optimise the use of resources and service delivery. This quality improvement project was designed to investigate this and guide the development of new referral guidelines for suspected renal colic.

## Materials And Methods

Outpatient referrals with suspected renal colic to the urology service at UHA from GPs during the period of 01/08/2023-30/08/24 were identified. A retrospective cohort study was carried out using data collected from the Clinical Portal, including GP referral letters, radiology reports, operation notes, clinic notes, and blood results. These data were compiled in a spreadsheet and then analysed. The data gathered included information on pain description, pain laterality, presence of haematuria, renal function, imaging before referral, history of urolithiasis, presence of a renal stone on CT KUB, presence of a ureteric stone on CT KUB, and presence of other pathology on CT KUB. If urolithiasis was present, the size of the calculi, location of the calculi, and how the patient was managed were noted.

## Results

There were 173 patients included in this study. As demonstrated in Figure 1, urolithiasis was detected in 47 (27.2%) patients; eight (4.6%) patients had ureteric and renal calculi, four (2.3%) patients had only ureteric calculi, and 35 (20.2%) patients had only renal calculi.

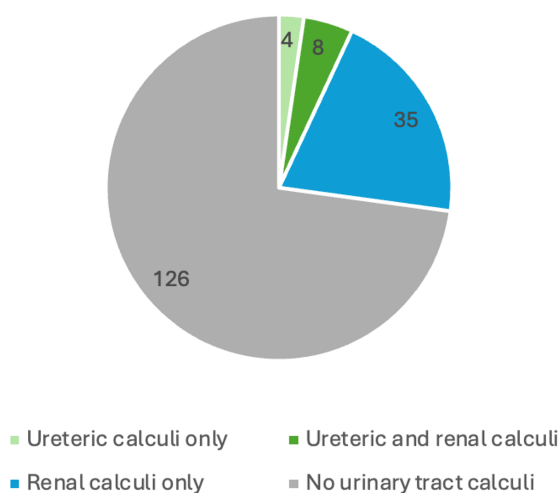


**FIGURE 1: Proportion of patients with urolithiasis on CT KUB**

CT: computed tomography; KUB: kidneys, ureters, and bladder

Ureteric calculi were detected in 12 (6.9%) of patients on CT KUB. Six (50%) patients with ureteric calculi identified went on to have a ureteroscopy and laser stone fragmentation to treat the calculi. The other six

patients were managed conservatively, with interval repeat imaging showing passage of the calculus. Eight (72.7%) patients with ureteric calculi also had renal calculi. Three patients in this cohort had a ureteric stone on the opposite side to the pain they had presented to primary care with. Most patients (9, 75%) had previous stones, and of those who had a urine dipstick analysis (8 patients), the majority (86%) had haematuria.

Renal calculi alone were detected in 35 patients (20.2%) on CT KUB. Four of these patients (11.4%) had clinically significant stones that were treated with primary ureteroscopy and laser stone fragmentation. The patients who had an operation to treat their stones had stones greater than or equal to 6 mm. The other 31 patients were managed conservatively.

There were several incidental findings on CT KUB. 65 patients (37.6%) had other pathologies detected, including renal cysts, diverticulosis, ovarian cysts, and liver cysts. Congenital urological abnormalities were also detected, including horseshoe kidney and duplex collecting systems.

Investigations performed prior to referral were recorded. Ultrasound imaging was performed in 28 (16.2%) of patients prior to referral. Urinalysis results were included in 137 (79.1%) of referrals. Renal function was checked in 118 (68.2%) of patients. Overall, 10 patients (5.8%) had an operation to treat urinary tract calculi that were detected on an outpatient CT KUB for suspected renal colic.

## Discussion

Urolithiasis is a common condition encountered in secondary care. There are key features in a patient's history, examination, and investigations that direct a clinician towards a diagnosis of a ureteric calculus. Renal colic typically causes severe pain and systemic upset, resulting in patients presenting acutely to the ED or an assessment unit. This study suggests that patients deemed well enough to be investigated as an outpatient for suspected renal colic are unlikely to have a ureteric calculus.

This study demonstrates that the detection rate of ureteric stones in the community is low (12, 6.9%). Most patients who did have ureteric stones had haematuria and/or a history of urolithiasis. Half of these patients had ureteric stones that required an operation as definitive treatment.

There was a higher detection rate of renal calculi (35, 20.2%). Most of these calculi were less than 5 mm and were managed conservatively. Only four (9.3%) patients out of 43 had an operation to manage their renal calculi. Six (17.1%) patients had renal calculi on the side opposite to their pain, indicating these calculi were purely incidental findings.

There were varying investigations carried out in the community before referral to secondary care. Urine dipstick testing is readily available in the community; however, 37 (21.3%) of referrals did not detail urinalysis results. Phlebotomy to assess renal function and the use of ultrasound of the urinary tract as an outpatient were also not fully utilised to aid diagnosis before referral. This highlights an area of potential improvement to streamline which patients are at higher risk of ureteric calculi and therefore should go straight to a CT KUB.

Upon review of the literature, there are currently no studies investigating the use of CT KUB in outpatients with suspected renal colic in the UK. This study is novel and, if replicated in other centres with a larger population size, could impact guidance on investigation for acute flank pain.

Performing CT scans exposes patients to ionising radiation. CT KUBs can be performed using a very low-dose radiation protocol; however, this still exposes a patient to roughly two years of background radiation (5.3 millisieverts) [12]. As clinicians, we have a responsibility to limit patients' radiation exposure by performing only necessary tests.

Ultrasound (US) imaging does not expose a patient to any ionising radiation and can assist in the diagnosis of ureteric calculi. US is recommended by the European Association of Urologists (EAU) as the first-line imaging modality for patients with acute flank pain. US can detect upper urinary tract obstruction and calculi in the kidney, proximal ureter, and distal ureter. The sensitivity and specificity of US in detecting urinary tract calculi are detailed in Table 1. The limited sensitivity is often attributed to overlying bowel gas obscuring the images [5]. This study has shown that the clinical workup for renal colic in the community could be more thorough prior to referral to secondary care for CT KUB, which could reduce the number of patients undergoing CT and enable urologists to target appropriate patients for CT KUB.

| Location of calculus | Sensitivity (%) | Specificity (%) |
|----------------------|-----------------|-----------------|
| Ureter               | 45              | 94              |
| Kidney               | 45              | 88              |

**TABLE 1: Sensitivity and specificity of ultrasonography for detecting ureteric and renal calculi**

EAU: European Association of Urologists

The table was created based on the information in the EAU Guidelines 2026 [5]

Performing cross-sectional imaging can lead to incidental findings. Just over a third of patients had other pathologies detected on CT, including renal cysts, diverticulosis, and ovarian cysts. There were no cancers detected incidentally in this cohort. Incidental findings often result in further investigations, which can be invasive and can lead to patient anxiety [13]. Reducing the number of CTs performed should reduce the number of incidental findings, which should also reduce the number of other investigations and procedures that have been organised as a result.

The cost of performing CT KUB in the NHS is also an important consideration. An adult CT scan of one area costs the NHS £137 in 2025/26, compared to a US scan which costs £95 [14]. Therefore, there are financial benefits to the NHS from reducing the number of CT scans performed when US would be a more appropriate initial diagnostic tool for suspected renal colic.

The presence of blood in the urine is a parameter used to determine the probability of having a urinary tract calculus. A meta-analysis found that 84% of patients with confirmed urolithiasis had microhaematuria [8]. Our data demonstrated that seven (87.5%) patients with confirmed ureteric calculi and 12 (42.8%) of patients with confirmed renal stones had microhaematuria. These figures exclude the 10 (5.8%) patients with confirmed urolithiasis who did not have urinalysis documented prior to CT KUB. This highlights that the presence of microhaematuria alone is a limited diagnostic indicator for urolithiasis and therefore needs to be integrated alongside other investigations to aid the diagnosis.

Biochemical markers have a role in the diagnosis of renal colic. A study investigating patients who presented to the emergency department with renal colic were more likely to have confirmed urolithiasis when they had abnormal renal function, white blood cell count, and CRP alongside haematuria on urinalysis. This study also found that larger stones were associated with higher CRP and lower estimated glomerular filtration rate (eGFR) [15]. Biochemical markers can also have a role in steering a clinician to alternative diagnoses as a cause of the patient's presentation [16].

Patients with a history of previous stones have a 50% chance of forming a further stone in their lifetime [5]. Typically, patients who have experienced renal colic before will be able to identify the symptoms of another attack. This study found that nine (75%) of patients with ureteric stones had a history of urolithiasis, highlighting the importance of a patient's history of stones to be considered when investigating suspected renal colic.

This study benefits from the large sample size with complete electronic data. Limitations of this study include it being in a single health board in Scotland, which may mean the data is not representative of other areas in the United Kingdom. This study also did not assess patient demographics when determining the risk of having a ureteric calculus.

### Conclusions

The detection of ureteric calculi using CT KUB in outpatients with suspected renal colic is low. Current guidance from the EAU is to investigate acute flank pain with US, which does not expose patients to ionising radiation and costs less to perform. A pathway to investigate outpatients with suspected renal colic in NHS A&A should be developed to include US, urinalysis, and biochemical markers prior to CT KUB.

### Additional Information

#### Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

**Concept and design:** Melanie Sneddon, Ross Clark

**Acquisition, analysis, or interpretation of data:** Melanie Sneddon, Alexander MacDonald, Sophie Avril, Harry Hayter, Ross Clark

**Drafting of the manuscript:** Melanie Sneddon

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**Supervision:** Ross Clark

## Disclosures

**Human subjects:** Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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