EM Advances

Adverse events are rare among adults 50 years of age and younger with flank pain when abdominal computed tomography is not clinically indicated according to the emergency physician

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ABSTRACT

Objective: Many emergency physicians (EPs) order ''confirmatory'' abdominal computed tomography (CT) in young flank pain patients, despite a high clinical suspicion of renal colic and the risk of radiation exposure. We measured the adverse outcome rate among flank pain patients identified as not requiring abdominal CT by the EP on a data form, regardless of whether CT was eventually ordered. Our secondary objective was to describe diagnoses other than renal colic identified by CT in this population.

Methods: We conducted a prospective observational study at two community EDs. We asked staff EPs to complete a data sheet on patients ages 18 to 50 years with a first episode of flank pain, recording 1) if the flank pain was consistent with renal colic and 2) if the EP felt abdominal CT was indicated. Adverse outcomes (defined a priori as urgent surgical procedures, disability, or death) were assessed by research assistants at 4 weeks using telephone follow-up and a hospital records search.

Results: We enrolled 389 patients; 353 completed follow-up (91%). The average age was 38.8 years, and 72.0% were male. Of 212 patients identified in the ''CT not indicated'' group, 2 had another diagnosis identified (unruptured diverticulitis and a ruptured ovarian cyst), but none had adverse outcomes (95% CI 0–1.4).

Conclusions: Adverse events were rare ($<$ 1.5%) among patients $<$ 50 years old with flank pain when CT was not required according to the clinical assessment of the EP. Future research should assess the adverse outcomes of withholding CT in low-risk patients using a larger patient sample.

RÉSUMÉ

Objectifs: De nombreux médecins d'urgence (MU) demandent une tomodensitométrie (TDM) abdominale de « confirmation » chez les jeunes patients qui ressentent une douleur du flanc, malgré une forte présomption de colique néphrétique et le risque d'exposition au rayonnement. Nous avons mesuré le taux de résultats défavorables parmi les patients qui ressentaient une douleur du flanc et chez qui une TDM abdominale n'était pas nécessaire selon le MU sur le formulaire de données, peu importe qu'une TDM ait été demandée plus tard ou non. L'objectif secondaire était de décrire les autres diagnostics que celui de la colique néphrétique, révélés par la TDM chez les patients concernés.

Méthode: Nous avons mené une étude d'observation prospective, dans deux services d'urgence (SU) communautaires. Nous avons demandé aux MU de remplir une fiche de données sur les patients âgés de 18 à 50 ans, chez qui il s'agissait de la première crise de douleur du flanc, en notant 1) si la douleur du flanc était compatible avec la colique néphrétique et 2) si, à leur avis, la TDM abdominale était indiquée. Les événements indésirables (définis a priori comme une intervention chirurgicale d'urgence, l'incapacité ou la mort) ont été évalués, au bout de 4 semaines, par des adjoints à la recherche, au moyen d'un entretien téléphonique de suivi et d'un examen des dossiers médicaux hospitaliers.

Résultats: Au total, 389 patients ont été sélectionnés et 353 ont participé au suivi (91 %). La moyenne d'âge était de 38.8 ans, et 72.0 % des sujets étaient des hommes. Sur 212 patients chez qui la TDM n'était pas indiquée, 2 ont été traités pour un autre diagnostic (diverticulite non perforante et rupture d'un kyste de l'ovaire), mais aucun n'a connu une évolution défavorable (IC à 95 % 0–1.4).

Conclusions: Les événements indésirables se sont montrés rares ($<$ 1.5 %) chez les patients âgés de moins de 50 ans, qui ressentaient une douleur du flanc et chez qui la TDM n'était pas nécessaire d'après l'évaluation clinique faite par le MU. Il faudrait évaluer, dans le cadre d'une autre recherche, les résultats défavorables de l'absence de demande d'examens par TDM chez les patients connaissant un faible risque, à partir d'un échantillon plus grand que celui décrit ici.

Keywords: computed tomography, flank pain, renal colic

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Renal colic is a frequent presentation in the emergency department (ED). The estimated annual occurrence rate is 1 in 1,000 people,[1] and the lifetime occurrence rate is 12% of the population.[2] Renal colic results in intense pain coming in paroxysms that are related to ureteric spasm and the movement of a stone in the ureter. With upper ureteral or renal pelvic obstruction, the pain is in the flank, whereas lower ureteral obstruction causes pain that may radiate to the groin. There is often hematuria (70 to 90% of patients) and urinary frequency or urgency, as well as flank tenderness but no significant abdominal tenderness.[3,4] Emergency physicians (EPs) recognize renal colic with confidence and are also able to judge when there is uncertainty in the diagnosis, making causes of pain other than renal calculi likely.[5] Unenhanced spiral multidetector computed tomography (CT) has become the preferred method for investigating this clinical presentation and over the past 10 years has become almost universally used in the investigation of suspected renal colic, replacing selective use of intravenous pyelograms or sonograms.[6] In a previous study of 796 patients ages 18 to 50 years presenting with suspected renal colic at our hospital, 93% had a CT scan[7]; however, renal colic is usually a self-limiting condition, frequently requiring only analgesics and, rarely, further interventions.[4] Only 1 in 8 patients required a urologic intervention at our centre.[8]

Alternative diagnoses have been found in up to 10% of cases of renal colic,[9] most commonly adnexal masses, pyelonephritis, appendicitis, and diverticulitis.[9,10] Concern over missed diagnoses, combined with the ease and availability of CT and the sensitivity of detecting ureteric calculi, has led to its widespread use.[11] Detection by CT of aortic pathology masquerading as renal colic, although feared, appears to be rare: 1 case of an aortic dissection was found in a series of 1,000 consecutive patients with renal colic, although this study included patients over 50 years of age.[9] Recently, concerns have been expressed about the cost of the procedure and the resource implications of imaging all renal colic patients, as well as patient safety concerns due to potential carcinogenesis from radiation exposure.[12,13] Unfortunately, alternate imaging options such as plain-film excretory pyelography, ultrasonography, and magnetic resonance imaging are less sensitive than CT for renal calculi and the availability is less reliable.[6] Finally, the additional time associated with obtaining an abdominal CT scan may contribute to ED overcrowding.[14] Therefore, we sought to determine if there was a group of patients in the 18 to 50 years age group with clinical findings consistent with renal colic who could forego CT scanning on their first presentation to the ED. Our primary objective was to measure the rate of adverse outcomes and missed significant diagnoses among ED patients ages 18 to 50 years presenting with suspected renal colic who did not require a CT scan according to the treating EP.

METHODS

Setting

We conducted the study between August 2007 and December 2009 in two community hospital EDs in the Toronto region with annual censuses of 85,000 and 65,000. The incidence of renal colic at these institutes was 4.1 in 1,000 ED visits.

Study design and data collection

We conducted a prospective observational study in which participating staff EPs completed a data collection sheet containing demographic information and five questions (Figure 1). Questions relevant to our primary objective included 1) if the EPs felt the patient had flank pain consistent with renal colic prior to obtaining imaging and 2) if the EP felt abdominal CT was necessary for treatment and the disposition of the patient. The responses did not restrict EPs from ordering a CT scan if this was their prestudy practice. We enrolled a convenience sample of patients who presented when participating physicians were working and had enough time to enrol the patient. The study was approved by the Research Ethics Boards of both hospitals. Patients provided informed consent and agreed to telephone follow-up. The physicians were asked to complete the data collection form after seeing the patient but before obtaining the results of any CT scan ordered.

Inclusion and exclusion criteria

Patients with flank pain consistent with renal colic between 18 and 50 years of age were eligible. Patients with a known history of renal colic, solitary kidney, pregnancy, repeat renal colic presentations, or suspected urosepsis (fever, pyuria) were excluded.

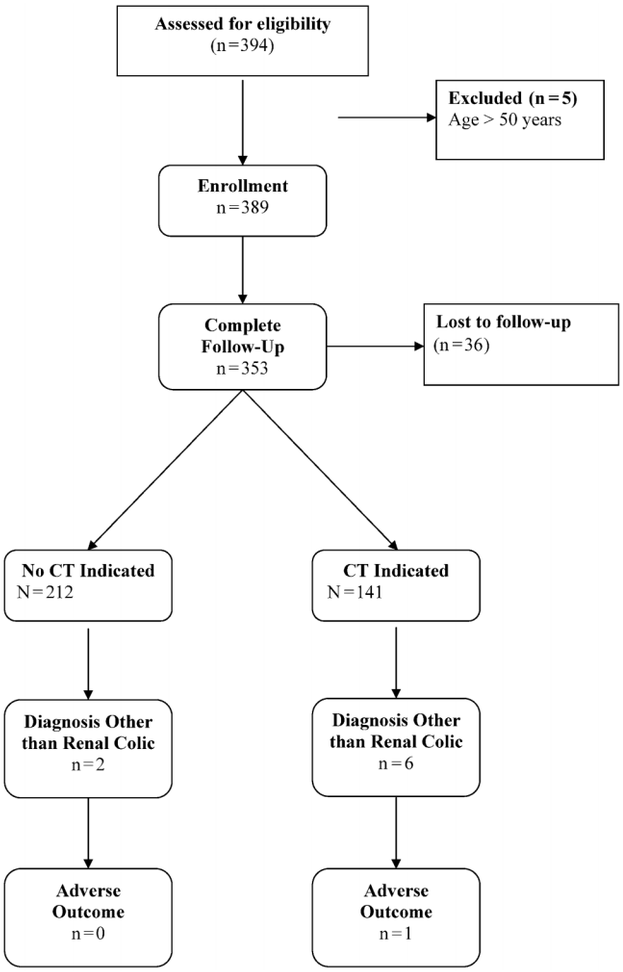

Figure 1. Patient flow chart. CT = computed tomography.

Patient management

Physicians at the participating centres were informed through rounds, discussions, and correspondence that our study would test whether patients 50 years of age or younger who responded to nonsteroidal antiinflammatory drugs (NSAIDs) or small doses of morphine could be managed without immediate CT as long as they had no comorbidities and no history of requiring urologic interventions for renal colic.[1] EPs were instructed to manage patients according to their standard practice, including their decision to acquire abdominal CT scans. Thus, other than completion of the study data sheet in this observational study, patient management was not altered in any way. Patients were verbally instructed to return to the ED if they experienced fever, vomiting, ongoing pain not relieved by their oral analgesics, or any new symptoms.

Primary outcome measure

Our primary outcome was adverse outcomes among patients with flank pain who did not require abdominal CT according to the treating EP's clinical assessment, as indicated on a postassessment questionnaire. Patients were classified as not requiring abdominal CT regardless of whether a CT scan was eventually ordered. Adverse outcomes were defined a priori as any complication due to a missed or alternative diagnosis that resulted in an urgent surgical procedure (e.g., bowel obstruction, perforated abdominal organ, hemorrhage, peritonitis, or abdominal cause of sepsis), disability, or death.[15] Our secondary objective was to describe the rate of additional and alternative diagnoses as defined by Katz and colleagues[9] among patients who had CT performed.

Patient follow-up

Telephone follow-up with patients occurred 1 month after the emergency visit. If a patient could not be contacted between 4 and 8 weeks, we continued to attempt to contact patients every 2 to 4 weeks for as long as their telephone line was in service. We continued this for up to 1 year after study enrolment to minimize the number of patients lost to follow-up. The telephone interview focused on events that had occurred 1 month after the initial ED visit, regardless of the contact delay. The research assistant performing telephone follow-up was blinded to the study hypothesis. Patients were asked if the episode of pain was ultimately diagnosed as renal colic, if any alternative diagnosis was found or any subsequent testing took place, or if any urologic interventions had happened or were scheduled. Computerized hospital records were searched for any adverse or unreported events; using regional electronic health records allowed us to determine if patients returned to any of the six hospitals in the Peel County region, which has a population of over 1 million residents and covers 900 km^2.

Analysis and sample size calculation

The data were analyzed using *SAS* 9.12 (SAS Institute, Cary, NC) software. Descriptive statistics and 95% confidence intervals (CIs) are reported, where appropriate. Our sample size calculation was based on the precision of our primary outcome: the

proportion of patients who were judged not to need CT by the EPs and experienced an adverse outcome. We estimated that given an alpha of 0.05 and a beta of 0.20, if no adverse events occurred in a sample size of 350 subjects, our 95% CI would range between 0 and 1.3% using the Fleiss continuity corrected method.[16,17] To estimate an upper CI for our observed adverse event rate of 0, we used the more conservative method of Hanley, substituting 3 for the 0 numerator.[18]

RESULTS

EPs screened 394 patients at the two hospitals. No physicians or patients refused to participate. Thirty-six patients could not be reached by telephone and were lost to follow-up (9.1%). Five patients over 50 years of age were excluded, leaving 353 subjects available for analysis (see Figure 1). The average age was 38.8 years, and 72.0% of participants were male (Table 1). The EP felt a CT scan was indicated in 141 of 353 subjects ("CT indicated" group, 39.9%), and 140 of these patients had imaging in the ED (see Table 1). For the 212 subjects for whom the EP felt no imaging was required ("CT not indicated" group), 58% had some imaging in the ED nonetheless (see Table 1).

A total of 273 of 353 (77.3%) patients had urolithiasis confirmed by CT, ultrasonography, or subsequent stone collection, and another 69 (19.5%) had probable renal colic based on clinical findings of characteristic pain and hematuria but without imaging or stone collection to confirm the diagnosis. Eight patients (2.3%) had a diagnosis other than renal colic, and three had incidental findings on imaging that did not change management (Table 2). Of the patients with confirmed urolithiasis, 92% had flank pain, 53% had costovertebral angle tenderness, and 77% had hematuria. The average stone size was 3.4 mm (see Table 1).

Primary outcome

Of the 212 subjects (60.1%; 95% CI 54.7–65.2) in the CT not indicated group, none experienced an adverse outcome (95% CI 0–1.4).

Secondary outcomes

Alternative diagnoses were confirmed in 10 subjects: 8 in the CT indicated group and 2 in the CT not indicated group (see Table 2). None of these 2 patients with alternative diagnoses had an adverse event (i.e., required a change in management or needed a surgical intervention).

Table 1. Demographic characteristics, imaging received, and urologic consultation of participating patients according to whether the EP felt CT was indicated

	All patients (N = 353)	Abdominal CT scan not indicated (n = 212)	Abdominal CT scan indicated (n = 141)
Mean age (yr ± SD)	38.8 ± 8.0	38.1 ± 8.0	39.8 ± 7.9
Male sex, *n* (%)	254 (72.0)	152 (71.7)	102 (72.3)
Symptoms, *n* (%)			
Hematuria	273 (77.3)	175 (82.6)	98 (69.5)
Flank pain	325 (92.1)	195 (92.0)	130 (92.2)
CVA tenderness	185 (52.4)	118 (55.6)	67 (47.5)
Calculi			
Collected, *n* (%)	187 (53.0)	83 (39.1)	104 (73.8)
Mean size (mm ± SD)	3.4 ± 2.2	3.3 ± 2.1	3.5 ± 2.3
Imaging, *n* (%)			
No imaging	89 (25.5)	88 (41.5)	1 (0.7)
CT abdomen	208 (58.9)	100 (47.2)	109 (77.3)
US abdomen	41 (11.6)	21 (9.9)	20 (14.2)
Other	14 (4.0)	3 (1.4)	11 (7.8)
Urology consultations, *n* (%)			
Consultation only	118 (33.4)	54 (25.5)	64 (45.4)
Consultation and Intervention	38 (10.8)	14 (6.6)	24 (17.0)

CT = computed tomography; CVA = costovertebral angle; EP = emergency physician; US = ultrasonography.

Table 2. Clinical outcomes of patients identified as needing or not needing abdominal CT scan

	All patients	CT scan not indicated	CT scan indicated
	(*N* = 353) *N* (%) (95% CI)	(*n* = 212) *n* (%) (95% CI)	(*n* = 141) *n* (%) (95% CI)
Confirmed renal colic	273 (77.3) (95% CI 72.6–81.6)	165 (77.8) (95% CI 71.6–83.2)	108 (76.6) (95% CI 68.7–83.3)
Probable renal colic	69 (19.6) (95% CI 15.5–24.1)	43 (20.3) (95% CI 15.1–26.3)	26 (18.4) (95% CI 12.4–25.8)
Alternative diagnoses	10 (2.8) (95% CI 1.4–5.2)	2 (0.9) (95% CI 0.1–3.4) Diverticulitis, unruptured (1) Ovarian cyst, ruptured (1)	8 (5.7) (95% CI 2.5–10.9) Nonperforated appendicitis (1) Cholelithiasis (2) Epiploic appendicitis (1) Herniated lumbar disk (1) Lymphocytic colitis (1) Pyelonephritis (1) Shingles (1)
Incidental diagnosis	2 (0.6) (95% CI 0.07–2.0)	2 (0.9) (95% CI 0.1–3.4) Ovarian cyst, not ruptured (2)	0 (95% CI 0–2.1)*
Adverse events	1 (0.3) (95% CI 0.01–1.6)	0 (95% CI 0–1.4)*	1 (0.7) (95% CI 0.02–3.9) Nonperforated appendicitis at surgery

CT = computed tomographic.
*Using the Hanely Substituting Three for Zero Method.

One adverse event occurred in a patient in the CT indicated group. That patient had a normal CT scan; however, the decision to operate was made clinically by the surgeon after referral by the EP. Pathology revealed "mild inflammation of the appendix," so this case was classified as an adverse outcome (see Table 2).

Urologic consultation was obtained in 115 (32.7%) cases: 63 among patients in the CT indicated group and 52 among patients in the CT not indicated group (see Table 1).

Urologic intervention occurred in 38 subjects: 14 cystoscopies (including 7 basket extractions of stones), 4 extracorporal lithotripsies, and 2 laser lithotripsies; in 13 cases, the patient could not describe or recall the exact nature of the procedure during the telephone interview. Urologic interventions were almost three times more likely among patients in the CT indicated group (OR 2.91; 95% CI 1.38–6.19).

Of note, 14 urologic interventions did occur among the 212 cases in the CT not indicated group (6.6%). In 12 of 14 patients, elective stone removal was delayed 3 to 6 weeks after the initial ED visit. Two of these 14 cases returned with severe pain unrelieved by oral analgesic and received cystoscopic extraction of stones and ureteric stent placement within a week of discharge from the ED. None of these patients experienced any renal compromise or other complications.

DISCUSSION

The use of abdominal CT for renal colic is increasing and has virtually replaced selective use of intravenous pyelograms over the past 10 years.[12,19,20] Ultrasonography is rarely used except in pregnancy and for children.[21] This study found that adverse events were rare when participating EPs felt a CT scan was not clinically indicated among adults ages 18 to 50 years with a first episode of suspected renal colic.

Unenhanced spiral CT for renal colic revealed an alternative or additional diagnosis in up to 10% of cases,[9,10] and case reports of serious alternative diagnoses such as abdominal aortic aneurysm have been a justification for widely applying CT in suspected renal colic. Such concerns, plus a perception that ordering a

CT scan is now the "standard of care," may explain why EPs obtained a CT scan in 46.2% of the 212 subjects for whom they felt CT was not clinically indicated. Among younger patients, however, most of these investigations did not affect clinical outcomes, and the CT scan is neither innocuous nor inexpensive. Unlike the use of CT scans for head injuries,[22] there are no guidelines for clinicians in the appropriate use of imaging for renal colic.

In our study of younger adults, we did not find significant alternative diagnoses in the CT not indicated group, based on clinical assessment. We did find alternative diagnoses that might have changed management (e.g., appendicitis and cholecystitis), but these all occurred in the CT indicated group.

We found that urologic intervention was significantly less common in the CT not indicated group. In a previous randomized trial, immediate imaging was shown to double the rate of urologic intervention without reducing morbidity or mortality.[1] Therefore, increased use of diagnostic imaging for flank pain may have the unintended consequence of increasing health care spending without benefitting patients.

Another potential problem with the relative speed and easy access of low-dose CT protocols without contrast that were designed for renal colic is the phenomenon of "indication creep," that is, the use of renal colic CT protocols for the investigation of other diagnoses, such as appendicitis or diverticulitis.[9] This is ill-advised as the accuracy of renal colic CT protocols in other diagnostic possibilities is unknown.[19,21,23] We attempted to measure this in our study by asking participating EPs at the start of our study if they were ordering the CT scan for other indications, and none said they did.

"Incidentalomas" or unanticipated structural findings that are not related to the presenting complaint of the patient are not uncommon. For example, adrenal masses were found on 2.3% of scans in one series.[24] The expense of subsequent investigations and potential complications from invasive investigations that occur as a result of incidentalomas are further examples of the unintended consequences associated with increased use of CT for flank pain in younger patients. We did find additional diagnoses (1.1%) in our study, but none required further treatment or investigation in this young population.

CT is an expensive investigation. In Ontario, the technical costs are absorbed in hospital budgets; however, out-of-country patients are charged about $700 for a CT scan, and the radiologist fees alone to interpret a renal colic CT are about $200.[25] The increased time spent in the ED or the return visit (generated by next-day imaging) also has resource implications to the hospital system.

Perhaps the most significant concern from the patient's perspective is the potential for adverse events due to cumulative radiation exposure. Abdominal CT scans deliver about 400 times the radiation dose of a plain chest x-ray. It is estimated that an abdominal CT scan has a 1 in 3,000 chance of inducing a fatal cancer,[12] and many patients are subjected to repeat examinations,[26] with cumulative doses exceeding 50 mSv annually in 20% of renal colic patients.[11] This dose exceeds the average exposure in a large cohort of survivors of the atomic bombs dropped in 1945 on Japan, which saw an increase in radiation-induced cancers. To justify this significant albeit delayed risk, there should be significant benefit in CT. This may not be the case for many young patients with a high clinical suspicion for renal colic. It has been suggested that we reduce the number of CT scans and repeat scans and eliminate all CT scans when not medically warranted.[13,27]

As the study progressed, participating EPs may have started to question the need for CT scans and may have ordered fewer of them. This "Hawthorne-like" effect increased the number of patients sent home without CT during the course of the study and increased the number of patients potentially at risk for an adverse outcome.[28] The fact that no patients experienced an adverse outcome supports our overall study conclusion that a CT scan is not necessary in many instances. One proposed strategy to minimize CT use would be to defer the scan until the follow-up appointment 2 to 3 weeks after the initial presentation. When employed, this strategy decreased repeat examinations by 31% with no increased morbidity; thus, the authors suggested that early imaging could be reserved for patients with fever, a solitary kidney, or intractable pain or when the stone diagnosis is in doubt.[1]

A previous study showed that EPs are able to diagnose renal colic clinically and are able to quantify their diagnostic uncertainty.[29] In our study, EPs correctly diagnosed renal colic in 341 of 353 patients (96.6%). Of the 10 patients with alternative diagnoses, 8 were in the CT indicated group.

There are limitations to our study. Our convenience sample may not be representative. Because we relied on participating EPs with time to enrol patients, we do not know if other factors influenced selection. The EPs

were not given guidelines as to which patients could safely forego imaging, so we do not know how they made this decision. Thus, the percentage of young patients in our study for whom CT was safely deferred (60%) may not be representative of our own or any community hospital ED.

There were many patients with presumed renal colic (70 of 358 patients) who had no evidence of urolithiasis by imaging or stone passage, and no alternative diagnosis was apparent. We did not document stone passage and a subsequent stone-free status of our patients, only that they became asymptomatic. We do not know if any of these asymptomatic patients, or patients with proven urolithiasis, will suffer deteriorating renal function because of prolonged ureteric obstruction. We did not test renal function in follow-up. However, renal failure is rare in young patients with renal colic unless the patient had a known metabolic disorder such as cystinuria or hyperoxaluria or had multiple recurrent episodes of symptomatic urolithiasis.[30,31] Patients with known or recurrent renal colic were excluded from this study. Finally, our study did not examine the impact of imaging to identify patients who may need urologic intervention. Future research on this topic, however, should bear in mind previous research suggesting that universal imaging may increase the rate of urologic intervention.

CONCLUSION

Given the potential societal costs and risk of radiation, our study suggests that adverse events among otherwise healthy patients 50 years and under presenting to the ED with flank pain are infrequent (< 1.5%) when the EP does not think a CT scan for renal colic is indicated. Patients should be instructed to return if they have ongoing or severe pain or fever. Future research should assess the adverse outcomes of withholding CT in low-risk patients using a larger patient sample.

Competing interests: None declared.

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