



Ultrasound Original Research

Risk Factors Predicting the Necessity of Renal Ultrasound in the Emergency Department

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ABSTRACT

Objectives: Renal ultrasound (US) is widely used for diagnosing renal pathologies, though few of them, such as obstructive uropathy, require emergent urological intervention. During on-call hours, when medical staff is limited, it is important to prioritize which renal US examinations will be done. The aim of this study was to evaluate patient risk factors to predict the necessity of emergent renal US in the emergency department (ED).

Material and Methods: All adult patients referred for renal US from the ED, during on-call hours from May 2015 to April 2017, were retrospectively included. The mean age was 64 years (18–98). Data were collected from the patients' medical records. Urological intervention performed within the first 24 h following the US examination was recorded. Multivariate analysis was performed.

Results: About 66% of the patients did not have a permanent urethral catheter, history of renal stones, or known abdominal or pelvic mass. None of these patients required an urgent urological intervention. The receiver operating characteristic curve was calculated at 0.883, 95% CI (0.84–0.92).

Conclusion: Using only three variables, we can greatly reduce the number of renal US examinations done at on-call hours allowing for prioritization of only the necessary examinations.

Keywords: Ultrasound, Urinary tract obstruction, Urological intervention

INTRODUCTION

Renal ultrasound (US) is widely used in the emergency department (ED) as a tool for assessing patients with suspected renal pathology. These pathologies include renal colic, renal obstruction, pyelonephritis including suspected abscess, and chronic and acute renal failure.

During on-call hours, when medical staff is limited, it is crucial to determine and prioritize which renal US examinations should be performed.

Acute renal obstruction or obstructive uropathy, resulting in acute hydronephrosis, may be considered an indication for emergent urological intervention (within 24 h), while other pathologies may be important to diagnose but are less critical to treat urgently, allowing those examinations to be postponed until the morning shift.

Several studies evaluating the use of US in the setting of acute renal insufficiency have found that it is usually unnecessary to exclude obstruction, unless there is a clinical history that strongly supports it, such as flank pain, urolithiasis, pelvic mass, or recent pelvic surgery.^[1-3] Furthermore,

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only 5% of cases are acute kidney injuries (AKIs) due to obstructive causes.^[4] However, to the best of our knowledge, there are no publications in the literature concerning identification of predictors for hydronephrosis on US leading to urgent urological intervention in patients from the ED.

The aim of this study was to evaluate patient risk factors to predict the necessity of emergent renal US in the ED.

MATERIAL AND METHODS

This retrospective study was conducted at an academic, referral, trauma center. The study received Institutional Review Board approval, with waived informed consent.

All adult patients (>18 years) referred for renal US from the ED during on-call hours (3 pm - 7 am), for a period of two years (May 2015 to April 2017), were included.

Data collected from a review of patients' medical records included age, gender, blood creatinine and white blood count (WBC) levels, renal US results, and previous medical diagnoses; specifically those predisposing patients to urinary tract obstruction. The latter included a known diagnosis of abdominal and pelvic mass (benign or malignant), benign prostatic hypertrophy (BPH), neurogenic bladder, history of nephrolithiasis, and presence of a permanent urethral catheter. All examinations were performed in the US unit by trained sonographers or residents in training. The resident on-call took the initial readings, and then the on-call physician (board-certified radiologist with 0.5–20 years of experience) performed the final readings. US findings included hydronephrosis, renal stones, renal cysts, and signs of chronic renal disease manifesting as echogenic and atrophic parenchyma and small kidneys.

The primary outcome was urological intervention within 24 h following the US examination. Indications for urgent intervention were septic patient, acute rise in creatinine, acute imbalance in electrolytes, and indurable pain. Urological intervention included nephrostomy or/and urethral stent.

Statistical analysis

Bivariate analyses of factors influencing the outcome were performed using logistic regression followed by multivariate logistic analysis of the same factors. The area under the curve for the model was two tailed, with $P \leq 0.05$ considered statistically significant. All statistical analyses were performed with SPSS for Windows, version 25.

RESULTS

Four hundred and seventy-seven patients were included in the study. The mean age was 64 ± 19 (range 18–98) years. Table 1 lists patient demographic characteristics and medical history.

Fifty-eight (12%) patients had a permanent urethral catheter, 49 (10%) had a history of renal stones, and 87 (18%) had a diagnosis of abdominal or pelvic mass.

US results are listed in Table 2. A hundred and forty patients (29%) had hydronephrosis and 41 patients (9%) had visible stones on US.

Only 17/477 (3.6%) patients required an emergent urological intervention.

A background of malignancy, recent and current chemotherapy administration, personal history of renal stones, history of previous nephrostomy, presence of a permanent catheter, and presence of abdominal or pelvic mass all predicted an emergency urological intervention with $P < 0.05$. Neurogenic bladder also predicted an emergency urological intervention with $P < 0.05$; however, there were only three such cases [Table 3].

All of the above listed factors were found to have a high correlation with three risk factors: Permanent catheter and/or history of renal stones and/or known abdominal or pelvic mass. Other factors did not predict emergency urological intervention, including congestive heart failure, acute and chronic renal failure, hypertension, sepsis, diabetes, cirrhosis, BPH, history of previous abdominal surgery, creatinine >1.3 mg/dl, and WBC $>11 \times 10^3/\mu\text{l}$.

Based on the multivariate analysis, 160/477 (33.5%) patients had a permanent urethral catheter and/or a history of renal

Table 1: Patient demographics and medical history.

Characteristics	No. of patients	Percentage
Demographics		
Gender male	250	52
Medical history		
Malignancies	133	33
Neurogenic bladder	3	1
Chronic renal failure	114	24
Sepsis	32	7
BPH	52	11
History of stones	49	10
Previous nephrostomy	37	8
Recurrent UTI	33	7
Abdominal or pelvic mass	87	18
Permanent urethral catheter	58	12

BPH: Benign prostatic hypertrophy, UTI: Urinary tract infection

Table 2: Ultrasound results.

Ultrasound diagnosis	No. of patients	Percentage
Hydronephrosis	140	29
Visible renal stones	41	9
Signs of chronic renal disease	102	21
Other incidental findings on US	87	18

Table 3: Correlation between patient characteristics and risk of an outcome of urgent urological intervention – urethral stent or nephrostomy.

Patient characteristics	All patients		Urethral stent or nephrostomy		
	Number	Number	Percentage	P-value	95% CI
Malignancies	133	10	7.5	0.016	1.27–10.07
Nephrotoxic chemotherapy	46	5	10.9	0.017	1.27–11.56
History of stones	49	6	12.2	0.002	1.86–15.01
Previous nephrostomy	37	4	10.8	0.021	1.23–12.09
Abdominal or pelvic mass	87	7	8.0	0.018	1.23–09.00
Permanent urethral catheter	58	8	13.8	0.000	2.69–19.75

CI: Confidence interval

stones and/or known abdominal or pelvic mass. Of these, only 17 (10.6%) patients received a urological intervention within 24 h of the US examination. However, 317/477 (66.5%) patients did not have a permanent catheter, history of renal stones, nor a known abdominal or pelvic mass. None of these patients received a urological intervention within 24 h following the US examination. The receiver operating characteristic curve (ROC) for the model was calculated as 0.883, 95% CI (0.84–0.92).

DISCUSSION

Prioritizing imaging examinations are crucial in any medical facility, especially referral trauma centers at night. At those hours, the medical staff in the radiology department usually consists of less experienced residents who are generally overwhelmed by the demand for imaging examinations from the ED as well as from inpatient wards.

US has high sensitivity and specificity for detecting renal stones and acute renal obstructions with known advantages, including the low cost and absence of radiation.^[5]

In our institution, we try to reduce the number of CT examinations, to reduce exposure to radiation, by performing US first, especially during on-call hours when only emergent pathologies with a need for emergent treatment should be performed.

Renal US is often recommended in the evaluation of AKI to exclude hydronephrosis even if the pre-test probability for obstructive uropathy is low.^[4,6] Therefore, the examination is ordered in high volumes, very often for no urgent indication.

Although the American College of Radiology (ACR) has published appropriateness criteria for suspected stone disease and renal failure,^[7,8] these guidelines are insufficient for prioritizing all patients referred to a renal US, especially during on-call hours.

Nevertheless, some authors do advocate a more restricted use of renal US, given that the majority of AKI cases in hospitalized patients are due to acute tubular necrosis or

pre-renal etiologies, and US results are not expected to change patient management.^[2,3,5]

In our study, a multivariate analysis showed that not one of the patients that had none of the three risk factors (permanent urethral catheter, history of renal stones, or a known abdominal or pelvic mass) needed an urgent urological intervention. However, 10.6% of the patients that had one of the risk factors needed urological intervention urgently. The ROC for the model was calculated as 0.883, 95% CI (0.84–0.92). This result states that the three risk factors; permanent urethral catheter, history of renal stones, or a known abdominal or pelvic mass, are accurate in predicting the outcome of urgent urological intervention.

Sepsis is a common indication for urgent intervention in patients with urinary obstruction, it was not found to be a predicting factor in our study for emergent intervention. This can be explained by the fact that only a small percentage of the patients presenting to the ER with sepsis have an urgent urinary obstruction, and the cause of their sepsis is of a different origin. Therefore, sepsis is not an independent risk factor that can predict urinary obstruction on US that may mandate emergent intervention.

Our study showed that more than half of the patients underwent emergent renal US during on-call hours with no immediate advantage for patient outcome with regard to renal obstruction. This large number of US examinations constitutes an unnecessary work overload. In times of increased demand and decrease in medical staff, this can have a negative impact on the ability of the on-call residents to give urgent service to those who truly need it.

Limitations

There were some limitations to our study. First and foremost, we decided that the important diagnosis that we did not want to miss during on-call hours was obstructive uropathy. We did not include another, less common but still urgent, diagnosis of renal abscess mainly due to its low prevalence and the fact that its presenting symptoms are usually very different.

Due to the retrospective nature of the study, the data collected for each patient were not always available. Furthermore, US is an operator-dependent, complex diagnostic tool and we needed to rely on documented results written and performed by residents, although subsequently reviewed by the attending radiologist.

It should be noted that prioritizing all US examinations is needed, but due to the overwhelming number of requests of renal US examinations, in our institution, the need to evaluate renal examinations specifically has risen.

CONCLUSION

Using only these three variables, permanent urethral catheter, history of renal stones, or known abdominal or pelvic mass as risk factors for an outcome of emergent urological intervention, we can greatly reduce the number of renal US examinations done at on-call hours allowing for prioritization of only the necessary examinations.

Declaration of patient consent

Institutional Review Board permission obtained for the study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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