

# Are renal stone protocol computed tomography reports giving us enough information?

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## ABSTRACT

**INTRODUCTION:** Non-contrast computed tomography (CT) is the gold-standard diagnostic test for urolithiasis. Little is published regarding which information needs to be included in the report for it to be most useful to the healthcare team for efficient triage and high-quality patient care. This study aimed to assess the quality and variability of CT scan reporting at a single Canadian tertiary academic medical center.

**METHODS:** We completed a retrospective review of 100 consecutive renal colic CT scans. Descriptive statistics were used to report the frequency with which specific elements commonly used by urologists to triage and treat patients were included in radiology reports.

**RESULTS:** Our sample had a mean age of  $51.4 \pm 13.1$  years. Stone size was universally reported for obstructing stones but was less frequently reported for non-obstructing stones (100% vs. 86.8%). A similar trend was observed for the exact stone number (100% vs. 93.4%). Non-obstructing stones were more likely than obstructing stones to be reported in one dimension (77.5% vs. 47%). Obstructing stones were reported in three dimensions 27% of the time. CT reports commonly include the presence or absence of hydronephrosis status (98%) but are less likely to include renal size (32%) and periureteral stranding (16%). Hounsfield units (HU) were reported in 3% of the reports, but skin-to-stone distance (SSD) and radiation dose were never reported.

**CONCLUSIONS:** Reports routinely included assessments of stone size, location, and number (although not uniformly). HU, SSD, and radiation dose were rarely reported. This provides insight into opportunities for standardized reporting to optimize knowledge transfer that may result in clinical efficiency and improved quality of patient care.

## INTRODUCTION

Urolithiasis is common, affecting 10.6% of men and 7.1% of women, and presents a substantial and growing healthcare burden.<sup>1</sup> Part of this demand on the healthcare system comes purely from an economic perspective, as the cost of diagnosis, treatment, and prevention of urolithiasis has been increasing in parallel with the increased prevalence. Management of kidney stones cost the healthcare system over \$10 billion in 2006,<sup>2</sup> and they represent a common and growing source of emergency department (ED) visits.<sup>3</sup>

Non-contrast computed tomography (CT) remains the gold standard for the diagnosis of urolithiasis.<sup>4</sup> Patients with urolithiasis are commonly exposed to repeat doses of ionizing radiation with multiple diagnostic studies exposing patients to risks of secondary complications.<sup>5,6</sup> More recently, low radiation dose CT renal stone protocols have proven to be effective, with a sensitivity of 90.2% (95% confidence interval [CI] 82.3–95.0%) and a specificity of 98.9% (95% CI 85.0–100.0%) for ureteral stones in ED patients with a wide range of body mass indexes (BMIs).<sup>7</sup>

Characterization of stones and associated findings based on CT has not only a significant impact on optimal stone management but also consistently predicts outcomes.<sup>8,9</sup> Current guidelines from the American Urological Association (AUA) recommend that radiological reports on CTs done for renal colic include hydronephrosis status, stone size, stone location, skin-to-stone distance, and stone attenuation, as

## KEY MESSAGES

- Radiology reports routinely included assessments of stone size, location, and number (although not uniformly).
- HU, SSD, and radiation dose were rarely reported.
- Our study provides insight into opportunities for standardized reporting to optimize knowledge transfer that may result in clinical efficiency and improved quality of patient care.

these have been shown to facilitate subsequent management decisions or inform urologists of the likelihood of treatment success.<sup>10</sup> Although they both provide evidence for the use of CT imaging for renal colic, the current Canadian Urological Association (CUA) guidelines and the Canadian Association of Radiologists (CAR) do not comment on which imaging findings are valuable for clinical practice, nor do they recommend which variables should be included in radiology reports.<sup>11</sup> Similarly, the American College of Radiology (ACR) gives no such guidance.

Standardized CT scan reports have the potential to greatly increase efficiency and utility of information delivery<sup>12</sup> and may aid in facilitating treatment decisions by urologists. Very few studies have assessed the quality of CT scan reporting for urolithiasis and there is currently no accepted standardized template for interpreting renal stone protocol CT scans that incorporates all clinically relevant findings.

To our knowledge, there is no agreement among radiologists, urologists, emergency physicians, and primary care physicians about what is important to include in a CT report to aid in informing patients, triaging referrals, and ultimately improving patient care. In addition, patients are increasingly gaining access to their health data, and it is important for healthcare professionals to understand their perspective about what a report contains.

This study aims to perform an environmental scan characterizing the elements currently being included in renal stone protocol CT scans at our tertiary care academic center. Quantifying the baseline variability that may exist will provide a framework for developing future standardized reporting templates.

## METHODS

Ethics approval was obtained from the University of Alberta Research Ethics Office Health Research Ethics Board – Health Panel, with study ID Pro00069187.

We completed a retrospective review of 100 consecutive non-contrast CT scans performed on 99 adult patients in an academic tertiary care center in Edmonton, Alberta, Canada. Using the Andrew Fisher's Formula, we calculated a necessary sample size of 88 based on our population size, incidence of urolithiasis, and a 90% confidence level, standard deviation of 0.5, and a CI of  $\pm 5\%$ . All scans were ordered by either "non-urologists," which included family and emergency physicians or urologists. All reports were generated by local radiologists.

Patients were included if they were older than 18 years old and the CT was requisitioned as a "renal colic" protocol study. Reports were excluded if there were no stones present, if they were done for indications other than renal colic, or if they were done for other stone-related indications such as perioperative planning or postoperative followup. These criteria were designed to include all renal stone protocol CT scans of adults with accessible dictated reports and images while excluding those in which kidney stones are not present or not the primary clinical concern.

Four endourologists used a structured review process to generate a consensus on clinically relevant elements that should be included in CT reports confirming urolithiasis. These included: number of stones, stone size,<sup>14-17</sup> location,<sup>16</sup> HU,<sup>18-22</sup> SSD,<sup>23,24</sup> presence of hydronephrosis,<sup>25</sup> hydroureter, perinephric stranding, periureteral edema, urinary extravasation, free abdominal fluid, and anatomic abnormalities specific to the urinary tract. Descriptive statistics were used to report the frequency of each element included in radiological reports.

## RESULTS

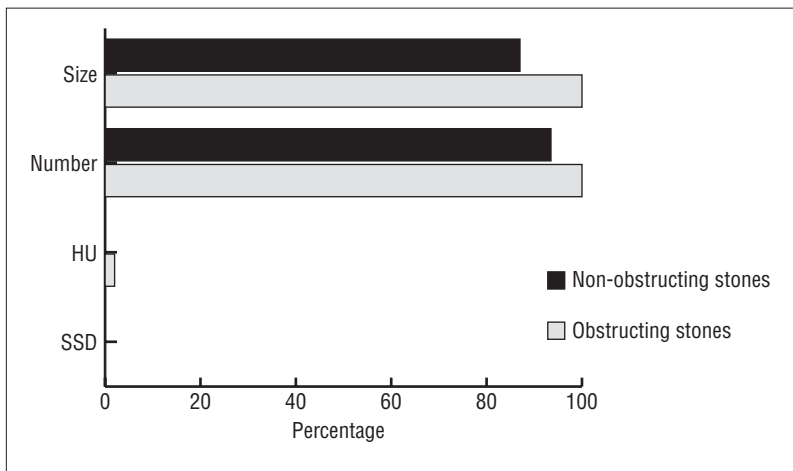
One hundred consecutive CT renal colic reports were reviewed from 99 patients. The mean age was  $51.4 \pm 13.1$  years and there was a 60:40 male-to-female distribution (Table 1). Non-urologists ordered 66% of the CT scans in this sample while urologists ordered 34%. When compared to urologists, non-urologists ordered more CT scans for symptomatic indications (92.4% vs. 20.5%) as opposed to followup scans (6.1% vs. 79.5%). Only one (1.4%) CT scan referral, ordered by a non-urologist, lacked any clinical information.

Figure 1 depicts the frequency of critical stone variables reported for both obstructing and non-obstructing stones. Obstructing stones were present

**Table 1. Baseline characteristics of CT scan reports**

Variable	Category	Value (n=100 scans)
Number of patients		99
Sex	Male	60
	Female	39 (one had two scans)
Age (mean ± SD)		51.4±13.1
PCP requested	Total	66
	Symptomatic indications	61 (92.4%)
	Followup scans	4 (6.1%)
	Indication not specified	1 (1.5%)
Urologist requested	Total	34
	Symptomatic indications	7 (20.5%)
	Followup scans	27 (79.5%)
Stone characteristic	Obstructing	70
	Non-obstructing	76

CT: computed tomography; PCP: primary care practitioner; SD: standard deviation.



**Figure 1.** Comparison of critical reported variables between obstructing and non-obstructing stones. HU: Hounsfield units; SSD: skin-to-stone distance.

in 70% of reports and non-obstructing stones were present in 76%. Laterality was universally reported. Stone size was universally reported for obstructing stones but was less frequently routinely reported for non-obstructing stones (100% vs. 86.8%). A similar trend was observed for stone number (100% vs. 93.4%). When comparing stone size reporting, variability in the number of reported dimensions was observed (Figure 2). Obstructing stones were more likely to be

reported in three dimensions (27% vs. 0%) but less likely to be reported in one dimension (47% vs. 77.5%) when compared to non-obstructing stones. The HU were mentioned in only 3% of reports. The dose of radiation and SSD were never reported.

Figure 3 depicts the frequency of commonly reported urinary tract variables. CT reports commonly included an assessment of hydronephrosis and hydroureter (98%) and are less likely to routinely comment on renal size (32%) and periureteral stranding (16%).

### DISCUSSION

The ideal contents of a report on renal colic protocol CT scans are not known. The AUA recommends that reports include hydronephrosis status, stone size, stone location, skin-to-stone distance, and stone attenuation, as these have been shown to facilitate subsequent management decisions or inform urologists of the likelihood of treatment success.<sup>10</sup> Reporting of ureteral edema, periureteral and renal stranding, and peri-renal fluid, amongst other variables, lacked sufficient evidence to be recommended by the AUA. The CUA, CAR, and ACR do not provide guidance on which imaging findings are valuable for clinical practice, nor do they recommend which variables should be included in radiology reports.<sup>11</sup>

This issue is certainly not unique to renal colic protocol CT scans and will extend to other imaging modalities and indications. In this study, we quantified the frequency of critical stone variables, determined by a group of endourologists, as they were reported on a sample of renal colic CT scan reports. Stone location and size are consistently reported and are well known to correlate with outcomes and treatment decision-making by providers;<sup>13,17</sup> however, in our study, Hounsfield units (HU) and skin-to-stone distance (SSD) were rarely reported, even though both parameters are associated with treatment outcomes of shockwave lithotripsy and ureteroscopy and are useful in shared decision-making with patients.<sup>11,26</sup>

Previous work has demonstrated a discrepancy in stone burden estimates between radiologists and urologists and cites a need for a standardized approach to measuring and reporting various stone parameters that are agreed upon by these two specialties.<sup>27</sup> To assess the feasibility of this venture, we reviewed the literature discussing the development or implementation of standardized CT scan reporting in other diseases to optimize communication between specialists. Several studies conducted across a variety of diseases implemented a standardized approach to CT reporting and

found high reporter adherence,<sup>27</sup> increased diagnostic accuracy,<sup>28-32</sup> reproducibility,<sup>29,33</sup> clarity,<sup>28</sup> efficiency,<sup>34</sup> quality of patient management,<sup>32,34,35</sup> and physician satisfaction.<sup>28,32,34,36</sup> Taken together, these studies illustrate the potential benefits of standardized radiologic reporting in a variety of disease processes including but not limited to renal colic.

Similarly, Burns et al investigated the consistency of basic characteristic reporting in CT scans for lung nodules, and in accordance with our findings identified inconsistent reporting of variables deemed important for specialist management.<sup>37</sup> The authors urged radiologists to develop and implement standardized reporting criteria for lung nodule evaluation via CT scans. This suggestion is not unique and can be made in the context of urology.

It remains unclear why certain elements of interest to urologists are not routinely included in reports. It could be the importance of stone density and SSD as it relates to the prediction of treatment outcome and patient counselling is not well understood by radiologists. The primary concern of the radiologist may be identifying the presence or absence of obstruction and other pathology that may be the source of the patient's symptoms. Alternatively, it may be that many of the variables we examined are time-consuming to measure and report, and only apply to more advanced stone management. This may include the size and number of concomitant non-obstructing stones, for example, which were reported less frequently compared to obstructing stones possibly due to lack of clinical relevance, although more work is needed as this is impossible to conclude from the current study.

These factors omitted by the radiologist may only be valuable to the urologist and not be considered or be relevant to the emergency room (ER) or primary care physician (PCP). In addition, indications for imaging could also play a role in the report. A CT ordered in followup to a clinic visit by a urologist may be looking for something different than one ordered in family practice or the emergency department for an explanation of symptoms.

Our study found that urologists ordered more CT scans for followup purposes compared to PCPs. This may be attributed to the fact that the urologist is managing patients that may have been referred with findings suggestive of a stone on ultrasound and have not yet had a definitive diagnosis from a CT scan, or that they feel CT parameters for stone staging will influence management and patient counselling. An alternative explanation would be that PCPs prefer to follow up

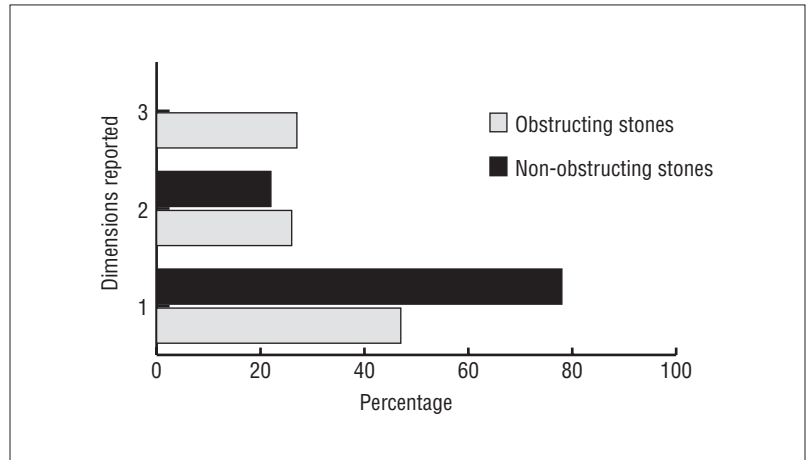


Figure 2. Variability in reporting of stone size among obstructing and non-obstructing stones.

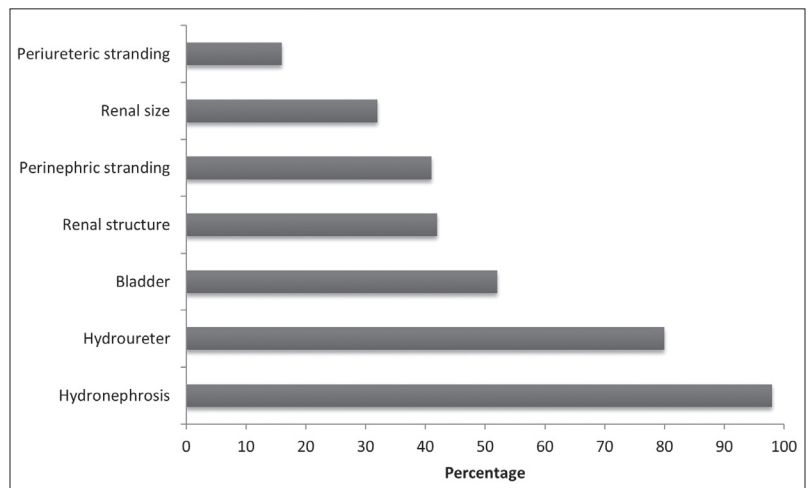


Figure 3. Reported frequency of common urinary tract variables.

with alternative imaging modalities such as ultrasound or X-ray, which inherently provide less information necessary for the urologists' clinical decision-making. It may also be easier for PCPs to access ultrasound (US) and kidney, ureter, and bladder (KUB) X-ray compared to CT scanning or be due to concerns regarding radiation exposure.

A potential solution to improve components of CT reporting would be to have reports be tailored to the indication and requesting physician; however, this could ultimately lead to the use of unnecessary repeat imaging requests if a physician's required information is not included in a report tailored to another specialty. Perhaps if patients have had other CT scans recently, some parameters would not be commented on or measured a second time. When reports do not have the necessary characteristics used to prognosticate

a patient's stone burden, and original images are not readily available to the treating physician, many will simply order another study. Even if original images are available, these are often difficult to retrieve and may delay decisions on management issues.

As our province has a centralized network for medical tests, this is not a problem at our center; however, this may not uniformly be the case. Finally, it is possible that the rates of certain variables were in part dictated by the specific contents of the CT scan referral; perhaps a radiologist would be more likely to include HU and SSD if the requisition postulated the potential utility of shock wave lithotripsy (SWL). This data was not extracted in the present study, and future work would be required to elucidate this.

There is no doubt that including information such as stone size (ideally measured in more than one dimension), HU, and SSD is important for urologic management decisions; however, our results showed low inclusion of HU and SSD overall, and lower frequency of size data for non-obstructing stones. Perhaps some radiologists do not believe it necessary to report these details for non-obstructing stones, which our data could support, as non-obstructing stones were less frequently characterized in terms of size and number and were never attributed HU or SSD values. More work would be necessary to determine if a convention for describing multiple non-obstructing stones efficiently could be adopted that could leave time and resources available allowing for increasing inclusion of HU and SSD.

### Limitations

Our study needs to be interpreted within its limitations. This is a retrospective, single-center, pilot study using a sample of 100 consecutive CT scans. All radiologist practice patterns are not accounted for, and these findings may not be generalizable to all centers. In addition, images were not retrospectively reviewed by urologists to ensure accuracy of the reports for the purposes of this study but were reviewed by urological trainees involved in the study.

This study further illustrates the importance of collaboration between radiologists, urologists, ER physicians, PCPs, and patients to ensure all parties' needs are met. Patients are gaining access to imaging reports via patient portals to electronic medical records (EMRs) and it will be important to consider patient interests and needs in reporting moving forward. We appreciate that certain variables, although important to urologists, may not have broad enough applicability for inclusion in standardized templates.

Consideration should be given to developing at least three protocols and reports; one for initial diagnosis of stones, another for post-intervention followup, and one for surveillance. The dosing and reporting should be agreed upon by all stakeholders listed above a priori. At this time our results confirm the wide variability of CT scan reporting for urinary tract stones at a single center and lay the groundwork for future efforts into generating standardized template reporting for urinary stone disease. Standardization of reporting has the potential to improve stone referral triage, reduce repeat or unnecessary imaging, and enhance efficiency of patient care.

### CONCLUSIONS

Variability exists in the reported variables for CT renal colic protocols. While stone location and size are typically mentioned in reports, stone density, SSD, and radiation dose are often omitted. Further prospective study and standardization concerning the needs of the ordering physicians, patients, and limitations concerning radiologist reporting time is required.

COMPETING INTERESTS: The authors do not report any competing personal or financial interests related to this work.

This paper has been peer reviewed.

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