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COMPUTED TOMOGRAPHIC SCANS ON PATIENTS WITH REPEAT RENAL CALCULI: A PILOT STUDY

A Major Paper Presented

by

Kayla Reposa BSN, RN

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COMPUTED TOMOGRAPHIC SCANS ON PATIENTS WITH REPEAT RENAL CALCULI: A PILOT STUDY

by

Kayla Reposa BSN, RN

A Major Paper Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Patients at risk for repeat renal calculi presenting to the ED with symptoms similar to their previous episodes, are likely to be over-exposed to computed tomographic (CT) scans. With recurrence at fifty percent minimizing CT use in this population is imperative (Goertz & Lotterman, 2010). Studies indicate using urinalysis and alternative imaging methods are necessary to prevent increases in radiation exposure, cost and ED visit time. The purpose of the project was to decrease CT use by providing current evidence-based research to ED providers on the overuse of CT scans for patients with a history of renal calculi who present with symptoms comparable to previous episodes. Using the logical model, the project was a retrospective chart review. The study took place in Charlton Memorial Hospital's ED. Charts were reviewed of patients who had a history of renal calculi and presented to the ED with flank pain. Patients were excluded for age less than eighteen, recent surgery, and chronic renal failure and/or dialysis due to renal impairment at baseline. The pre-presentation chart review was to assess the need to decrease CT scan ordering in the given population. An informational session on current research was provided to the providers and a post presentation chart review was completed to evaluate if there was a subsequent decrease in CT ordering. The study proved using evidence-based research to educate providers could result in a decreased amount of CT scans ordered. CT scans were ordered, eighty percent pre-presentation and decreased to sixty-five percent post.

Keywords: Renal calculi, computed tomographic scans, emergency department

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COMPUTED TOMOGRAPHIC SCANS ON PATIENTS WITH REPEAT RENAL CALCULI: A PILOT STUDY

Background/Statement of the Problem

Renal calculi or more commonly known as kidney stones is a disease process which is common in ED patients. CT use increases patient exposure to radiation, causes increased costs to the patient and health care system and extends ED visit times. The United States (U.S) spends billions of dollars annually on symptomatic and asymptomatic renal calculi disease which affects millions of patients. Saigal, Joyce, and Timilsina (2005) reported that treatment for renal calculi cost more than 5.3 billion dollars annually. Literature demonstrates an upward trend in CT use for diagnosis, which ultimately contributes to the cost of treatment for renal calculi.

The current standard of care for confirmation of renal calculi is an unenhanced, helical CT scan of the abdomen and pelvis. The previous standard of care was an intravenous pyelogram (IVP), which was performed for decades. IVP versus CT accuracy is known to be eighty-seven percent versus ninety-six percent. Positive and negative predictive values for CT are one-hundred percent and ninety-one percent, where for IVP it is ninety-seven percent and seventy-four percent (American Urological Association, 2012). In circumstances where CT scanners are not available, an abdominal radiograph is often utilized and can be seen as very accurate because seventy-five percent to ninety percent of calculi are radiopaque (American Urological Association). Despite its inferiority to a CT, ultrasound (US) is the first choice of imaging when calculi are suspected during pregnancy (American Urological Association).

The use of US is a secondary recommendation to diagnose renal calculi and exposes the patient to less radiation. Studies showed bedside ultrasound sensitivity and specificity in patients with hydronephrosis to be almost eighty-seven percent and when accompanied with hematuria was almost eighty-eight percent (Gaspari & Horst, 2005). With recurrence rates as high as fifty percent, it was reasonable to estimate life-long radiation from CT use has being exponential (Goertz & Lotterman, 2010). Total radiation exposure from medical sources had increased to fifty percent and CT scans alone account for twenty-four percent of these incidents (Robb-Nicholson, 2010). CT scans exposed patients to two hundred to one thousand and five hundred times the radiation of just one chest x-ray (Westphalen, Hsia, Maselli, Wang, & Gonzales, 2011). The risk from fatal cancer was estimated at 0.05 percent per each abdominal CT scan which is significantly high (Goldstone & Bushnell, 2010).

The obvious problem at hand is the overuse of CT scans to diagnosis renal calculi in patients who presented to the ED, symptomatic, with history of renal calculi.

Purpose

The purpose of the project was to decrease CT use by providing current evidence-based research to ED providers on the overuse of CT scans for patients with a history of renal calculi who present with symptoms comparable to previous episodes. A preliminary needs assessment was completed via chart review to determine the percentage of patients presenting with a potential repeat renal calculi diagnosis and obtaining a CT scan. The needs assessment was used to demonstrate the necessity to lower the number of CT scans ordered and also to serve as a benchmark to compare to another chart review completed post education presentation. The chart review post presentation evaluated if the information provided was adequate for practice change and to evaluate if CT usage in the population would actually decrease.

Literature Review

A literature search was performed using PubMed, Elton B. Stephens Company (EBSCO), and Cumulative Index to Nursing and Allied Health Literature (CINAHL). Key terms used when searching for literature included a combination of the following: renal calculi, nephrolithiasis, kidney stone, urolithiasis, ureterolithiasis, ureteral stone, computed tomographic, imaging, repeat, recurrent, cost, radiation, and emergency department. Articles were reviewed for validity and relevance. Additionally, references from qualified articles were used to expand the literature review. There were no time or setting restrictions.

Renal Calculi

Calculus of the urinary tract is common diagnosis, only exceeded by urinary tract infections and prostate disorders (Grossman & Porth, 2014). Calculi are polycrystalline aggregates of material that the kidney typically excretes. Clinical manifestations include renal colic, acute, intermittent, and excruciating pain in the flank and upper outer quadrant of the abdomen on the affected side. Pain can radiate to the lower abdominal quadrant, bladder area, perineum or scrotum in men. Other symptoms include cool, clammy skin, nausea, and vomiting (Grossman & Porth). Hematuria was another classic sign when evaluating for kidney stones. Gross or microscopic hematuria was present in approximately ninety percent of patients (American Urological Association, 2012). Clinical manifestations are important when diagnosing renal calculi.

Renal calculi, were two times more likely to form in men than women with the highest risk being between the ages of twenty and fifty (Havard Medical School, 2012). Other risk factors included: family history, cauasian race, middle-aged, low fluid intake, high sodium intake, high amounts of animal protein, high amounts of dietary sugar, use

of calcium supplements or low intake of dietary calcium. Medical risk factors included: diabetes, cornary artery disease, obesity, weight loss surgery, gout, overactive parathyroid gland, inflammatory bowel disease, and certain uriary infections or structural abnormalities of the urinary tract. The highest risk factor was a past medical history of a renal calculi (Havard Medical School, 2012).

Evaluation and Treatment Methods

The evaluation of a renal calculus has evolved over time. The conventional methods for diagnosing renal calculi were the abdominal plain film x-ray and intravenous urogram (IVU) (Vrtiska, et al., 2010). A non-enhanced CT is currently used for diagnosis. Early studies showed a single-energy CT scan was ninety-seven percent accurate in diagnosing renal calculi (Vrtiska, et al.). A dual-energy CT (DECT) can be used to better identify the composition of a renal calculus. Radiation was a concern with any CT, especially when recurrence was an issue in disease processes such as renal calculi. Although more modern DECT were low-dose and contained a comparable amount of radiation as former single-energy CT scanning, it was still important to consider the amount of radiation exposure to patients (Vrtiska, et al.). The American College of Radiology recommended the CT scan has the primary diagnostic test for renal colic with the exception of pregnant patients. In contrast, some European and South American countries primarily used US especially in patients with recurrent visits, as CT scans rarely caused a change in management (Westphalen at al., 2011).

Studies indicated the diagnostic significance of CT scans may not necessarily change treatment protocols. Treatment was based on the size of the calculus and the likelihood of it passing through the ureter. Most calculus measuring four millimeters

(mm) or less pass spontaneously (Preminger, 2014). Larger calculi, up to ten mm, had a decreased likelihood of passing. Newly diagnosed calculi that are less than ten mm are trialed with an observation period for passage. Initial treatment from an ED perspective would include an observation period to assess for passage, pharmacological aid for passage and pain management, hydration, and urology consult (Wolf, 2014).

Emergency Department and National Trends

The use of imaging and pharmaceuticals for renal calculi during ED visits had increased in the U.S. (Fwu, Eggers, Kimmel, Kusek, & Kirkali, 2013). The goals of a retrospective study conducted by Fwu and colleagues, assessed trends in ED renal calculi visits, including imaging use in the U.S. and estimated the recurrence of renal calculi in the ED. Data was generated from the National Health and Nutrition Examination Survey (NHANES) and the National Hospital Ambulatory Medical Care Survey (NHAMCS). The NHANES was used for patients who self-reported to the ED with a renal calculus and identified avoidable radiation exposure in patients with suspected renal calculi (Fwu et al.). The study included a total sample of 551,577 visits between 1992 and 2009. The rate of ED visits with a diagnostic code for urolithiasis steadily increased from 178 per 100,000 individuals between 1992 and 1994 to 340 per 100,000 individuals between 2007 and 2009 (Fwu et al.). The proportion of ED cases which used any imaging increased from fifty-six percent to seventy-nine percent in a fourteen year period (Fwu, et al.). X-ray use decreased from forty-eight percent to seventeen percent and CT use increased significantly from twenty-one percent to seventy-one percent (Fwu, et al.). US use was only between five percent and six percent as late as 2006 (Fwu, et al.). The researchers discussed the overuse of the CT scan and stated that even though CT use had

an important role in accurate diagnostic information, the repeat use of CT scans for patients who presented with repeat renal calculi largely contributed to increased cost and radiation exposure (Fwu, et al., 2013). Recommendations of the study included: first, the diagnosis of renal calculi by clinical judgment is straight forward in patients with history of a calculus. Second, once evaluation for flank pain is complete and other sources for true abdominal pain have been excluded, physical exam and urinalysis can be used to evaluate hydration status and possible infection. Third, if a calculus is not passed during an observation period, an US can be performed. The researchers supported a decrease in CT scans to benefit the patient by diminishing significant radiation exposure, cost and time constraints for ED visits.

Findings were similar in a study by Westphalen et al., (2011) where the NHAMCS data between 1996 and 2007 were used and emphasized the over-utilization of CT scans. The data were collected in non-institutionalized general and short-stay hospitals in fifty states but excluded: federal, military, and veteran's hospitals. Data were reviewed in random four week periods, over three years for three ICD-9CM codes (592.x calculus of kidney, 594.x calculus of lower urinary tract, and 788.8 renal colic) (Westphalen et al.). The objective of the study was to determine the national trends of CT and US use in the ED for patients presenting with suspected urolithiasis (Westphalen et al.). The method of evaluation included a retrospective cross-sectional analysis of ED visits from the NHAMCS data and determined the proportion of patients presenting with flank or kidney pain who received CT or US testing (Westphalen et al.). The researchers included diagnosis and hospitalization rates and accounted for alternative diagnoses. The researchers found patients received an increased incidence of CT scans with being male,

presenting with more severe pain, a triage assessment lasting fifteen minutes or less, and when evaluated by a non-physician health care provider (nurse practitioner (NP) or physician assistant (PA) (Westphalen et al., 2011). In patients with a possible renal calculus, a ten-fold increase in CT use was observed. Despite the increase, there was no direct correlation to change in diagnosis or admissions to inpatient. (Westphalen et al.). Resistance continued among clinicians due to the belief that CT use was essential in suspected renal calculus patients. The findings of the study however, do not support the increased use of CT changes diagnosis or treatment. Health care providers believed that the use of CT is geared toward ruling out an alternative critical diagnosis as opposed to ruling in renal calculi (Westphalen et al.). Also, the study did not support the idea of alternative diagnoses being prevalent in the population of patients with repeat renal calculi, including acute cardiovascular incidents or malignancy.

There was concern among clinicians who are urged to decrease CT use due to the potential to miss alternative diagnoses. Physical exam and urinalysis were strongly encouraged to differentiate between many potential diagnoses. For example, renal carcinoma may produce clots which could be confused with calculi on imaging, despite, patients rarely present with renal colic like renal calculi (Sarma, Deiparine, & TG, 1990). Pyelonephritis presents with flank pain, fever and pyuria as opposed to hematuria. With the presence of an uncomplicated calculus, fever is uncommon (Curhan, Aronson, & Preminger, 2015). Ectopic pregnancy can cause flank pain, but is easily differentiated by renal and pelvic ultrasounds. Rupture or torsion of ovarian cysts can also be diagnosed with US (Curhan et al.). Rarely is a patient with aortic aneurysm diagnosed or misdiagnosed with a kidney stone (Curhan et al.). Abdominal obstruction, diverticulitis,

appendicitis, biliary colic, cholecystitis, acute mesenteric ischemia, and herpes zoster have the potential to present with symptoms of flank pain but are not typically associated with hematuria (Curhan et al., 2015).

Current Research in Decreasing CT use

In addition to increasing US use, recent research had been aimed at the overall decrease of CT use despite options of alternative imaging. A number of large studies have investigated whether imaging changes the diagnosis or treatment in the evaluation of flank pain and a potential renal calculus.

Aubrey-Bassler et al. (2013) determined despite CT scans being confirmative for diagnosis and helping with the rare alternative diagnoses, they were expensive, time consuming and potentially unnecessary. The researchers performed a retrospective study of 2,315 patients with a suspected urinary tract stone (UTS). The researchers' goals were to measure if the use of CT scans impacted resources and to derive a score that predicts critical emergencies in patients that are suspected to have a UTS (Aubrey-Bassler et al.). Data were collected from 2005 to 2008. Patients were excluded if they were less than eighteen years of age, transferred from a peripheral hospital, or had a single kidney or kidney transplant (Aubrey-Bassler et al.). A serum white cell count, abdominal pain, temperature, and urine red blood cell count (WATUR) score was used to predict emergent situations. The higher the score of the combined characteristics, the more likely an emergency or urgent situation existed. About two percent of patients had an emergent outcome on CT and less than one percent had an urgent outcome (Aubrey-Bassler et al.). About eleven percent had a procedure within eight weeks of the CT. The researchers suggested a CT scan in the ED may be unnecessary for diagnosis or treatment.

Furthermore, clinicians concerned with missing an emergent event may use the WATUR score to determine if a CT scan is necessary. The scores were validated on all 2,315 patients included in the study.

Goldstone and Bushnell (2010) performed a retrospective chart review on ED patients to determine if CT scans changed diagnosis on patients with a history of renal calculi. Inclusion criteria were all ED patients who received a CT for renal colic after previously receiving the diagnosis of an obstructive renal calculus by CT during a previous ED admission and were eighteen years old or older. Data were collected between 1997 and 2007 on patients who were billed for a non-contrast abdomen and pelvis CT for renal colic, received the diagnosis of renal colic, ureterolithiasis, or urolithiasis and had a history of CT proven renal calculi. The frequency of the same diagnosis on repeat CT was compared to the frequency of alternative diagnosis to ultimately determine necessity of CT scan on return to ED (Goldstone & Bushnell). Eighty-one percent of patients did not have a change in diagnosis as a result of repeat scan, approximately twelve percent of patients received a diagnosis that did not require urgent intervention, and only about seven percent received a new diagnosis that required intervention. The study indicated EDs could reduce the amount of CT scans performed if patient history was considered prior to ordering the CT. When obtaining urine for hematuria, the number of patients with an alternative diagnosis and requiring a change in actual treatment could have been decreased to less than four percent (Goldstone & Bushnell). The researchers insisted prospective evaluation can be done to form protocols regarding when repeat CT scans should be used. The practice of prospective evaluation

can reduce the amount of CT scans ordered and decrease radiation exposure in patients that are already likely to have repeat visits (Goldstone & Bushnell, 2010).

Zwank et al. (2014) argued that CT usage in suspected renal colic patients may be unnecessary in diagnosis and management. The researchers conducted a prospective observational study at an academic hospital. Participants were patients eighteen or older with suspected renal colic. Ninety-three patients were included in the study with exclusion criteria of history of: kidney stone, history of chronic kidney disease, urinary tract infection (UTI), CT within the last six months, history of nephrectomy, or renal transplant. A pre and post-CT survey was completed by the ordering provider. The survey allowed the physicians to predict diagnosis and express if they felt the CT scan would change treatment management. The pre CT-survey included: the three most likely diagnoses, treatment plan, if they thought a CT scan would change management, and if any consultation would be needed. The post CT- survey included: final diagnosis, changes in management, any consults, and final disposition (Zwank, et al.). Sixty-two patients were diagnosed with renal colic and eighty four percent of these patients had hematuria. There were five cases of alternative diagnoses noted on CT scan and seven had changes in diagnosis. In conclusion, the researchers stated when providers didn't expect a change in management despite CT results, there was no change as they expected when receiving the actual results. The researchers suggested providers who are confident in using clinical manifestations to diagnosis renal colic should consider forgoing a CT scan (Zwank et al.).

Ultrasonography

Goertz and Lotterman (2010) supported the use of US to determine the degree of hydronephrosis to predict renal calculi size. A retrospective review was performed on patients that had both an emergency renal US and non-contrast CT to determine if the degree of hydronephrosis was a positive predictor for renal calculi size. The participants were divided into two groups. One group included renal calculi size of greater than five mm and the second group had calculi less than five mm. One-hundred and seventy-seven charts were reviewed and all patients were adults older than eighteen (Goertz & Lotterman, 2010). The charts reviewed were from 2004 to 2008 and included patients who had a non-contrast CT indicated for renal colic as well as a bedside US performed by an ED physician. Hydronephrosis was classified as none, mild, moderate, and severe. Of the one hundred and seventy five patients, one hundred and forty-four patents had renal calculi less than five mm and thirty-three had calculi larger than five mm (18.6%) (Goertz & Lotterman). Less severe hydronephrosis indicated renal calculi five mm or smaller in one hundred thirteen patients (87.6%) (Goertz & Lotterman). Of the sixteen patients who had a calculus greater than five mm yet had less severe hydronephrosis, none of them had a calculus greater than ten mm. Of the patients who had severe hydronephrosis, their calculi were larger than five mm and six patients had a calculus greater than ten mm. Most patients in the study had neither large calculi nor severe hydronephrosis, indicating that a bedside US in the ED may be a way to decrease CT use (Goertz & Lotterman). Therefore, if an US were completed and no or mild hydronephrosis is observed, it is extremely likely the calculus was less than five mm and the likelihood of spontaneous passage was greatest. CT evaluation could then be used if

the calculus were expected to be larger. The collective dose of radiation over a lifetime is imperative to consider in patients with recurrent renal calculi. If a CT scan were used for multiple evaluations, recurrence rates can be as high as fifty percent (Goertz & Lotterman, 2010).

Another study equated the use of emergency US and urinalysis to evaluate flank pain. Patients were prospectively enrolled in the study if the physician thought the patient presenting with flank pain actually had renal colic. The study used exclusion criteria of: fever, trauma, known current kidney stone, unstable vital signs and inability to provide consent (Gaspari & Horst, 2005). The participants also had a urinalysis and CT scan the physicians were blinded to. The physicians only knew the results of the US performed by them in the ED. Six physicians performed their own US with the criteria of: long and short axis views of each kidney and a long and transverse view of the bladder, hydronephrosis was documented if there was dilatation of the kidney's central collecting system (Gaspari & Horst). The phyisicans did not attempt to locate a calculus but a finding of unilateral hydronephrosis was considered positive for renal colic (Gaspari & Horst). One hundred and four patients were diagnosed with renal colic and overall sensitivity and specificity of the US from the detection of hydronephrosis was just greater then eighty-six percent. In patients with confirmed hematuria, the US for hydronephrosis demonstrated a sensitivity and specificity of about eighty-eight percent and about eighty-five percent respectively (Gaspari & Horst). The researchers suggested the sensitivity and specificity of emergent US to diagnose preliminary renal colic in patients with flank pain and hematuria was high.

A third retrospective chart review on the use of US to evaluate renal colic indicated US as highly accurate in identifying hydronephrosis, perinephric fluid and abnormal urinary jets. This often indicated calculi are present with a sensitivity nearing one hundred percent (Edmonds, Yan, Sedran, McLeod, & Theakston, 2010). The study took place at a multi-campus academic teirtary care center in Ontario, Canada. All patients were eighteen years or older and were included if they had an emergency department US ordered for renal colic, excluding US for reasons besides renal colic despite findings (Edmonds et al.). A total of eight hundred and seventeen renal US ordered over a one year period for suspected renal calculi were retrospectively reviewed. The US were classified as normal, suggestive of ureterolithiasis, ureteric stone seen, or disease unrelated to urolithiasis (Edmonds et al.). The ultrasounds reviewed showed three hundred and fifty-two (43.2%) were normal, two hundred and forty-one (29.5%) had a renal calculus, and one hundred and seventy-seven (21.7%) were suggestive of a calculus. In the population who had a calculus only six point two percent required actual urological intervention and in the population suggestive of having a calculus, only six point eight percent required further intervention. The researchers suggested if the US were normal, there was an extremely low likelihood for urological intervention within ninety days of ED visit. This finding lead the ED clinican to order a renal US as a first and often final stop in evaluating flank pain to decrease the use of CT (Edmonds et al.).

Theoretical Framework

The logic model guided project development, specifically the Centers for Disease Control (CDC) and Prevention's "left-to-right" logic model (CDC and Prevention, 2010). Existing inputs, existing activities, desired short-term outcomes, desired intermediate outcomes, and desired long-term outcomes were explored. The logic model helped achieve the following: 1) clarified the programs strategic plan, 2) exploited the benefits and reasoning behind the need for such benefits, 3) built a congruent relationship with the participants and stakeholders in the program, 4) provided continuous evaluation of effectiveness of the plan, 5) explored feasible goals and targets, 6) prioritized resources and resource allocation, 7) incorporated evidence-based research and new research into the program, 8) made improvements and changes as necessary, 9) identified differences in practice, 10) provided a framework for evaluation, 11) organized program-specific results, and 12) continued to better the program when applied (CDC and Prevention).

There were many existing inputs that were considered in attempts at re-shaping clinical practice including: current practice guidelines, current recommendations from stakeholders and experts, and organizational input. Current practice includes the consistent use of CT scans to evaluate and diagnose renal calculi. It was imperative that the current process be explored prior to the start of the program. Reviewing CT scan use in the ED coincided with the need to review the existing process of ordering. Not only did the use of CT scans need evaluation but the providers' reasoning behind CT use was also revealed. Many factors of resistance to change practice prior to the project's start existed and was also identified in literature. These included: fear of malpractice, patient demands, increased reliance on technology, time constraints, use of radiologic techniques as default measures for consultation gateways, and admission decisions (Fwu et al., 2013)

Existing inputs and existing activities were explored via a pre-presentation chart review to assess the need for protocol development. Results demonstrated a high percentage of patients presenting to the ED for repeat renal calculi that endured a CT for evaluation and diagnosis.

In attempting to change practice potential short-term, intermediate and long-term outcomes were reviewed and preceded implementation as it does in the logic model. Desired short-term outcomes in the project included: 1) providing ED providers with the most current evidence-based information regarding renal calculi and CT scan use, and 2) Assessed whether CT scan ordering had decreased in the population. Although the project was a pilot, the intermediate and long-term desired outcomes include: 1) a further profound decrease in CT ordering among patients who present with symptoms comparable to a previous renal calculi episode, 2) healthcare cost reduction, 3) ED visit time reduction, and 4) decreased radiation exposure for patients.

Methodology

Question

Did providing evidence-based research decrease the incidence of unnecessary CT scans for patients presenting with repeat symptoms of renal calculi?

Purpose

The purpose of the project was to decrease CT use by providing current evidence-based research to ED providers on the overuse of CT scans for patients with a history of renal calculi presenting with symptoms of renal calculi that are comparable to previous episodes. A pre-presentation assessment was completed via chart review to determine the percentage of patients presenting with potential repeat renal calculi and obtaining a CT. The pre-presentation assessment demonstrated it was necessary to lower number of CT scans ordered. The assessment also served as a benchmark for comparison to the chart review which was completed post presentation. The chart review post presentation evaluated if the information provided was adequate for practice change and to evaluate if CT usage in this population would decrease.

Design

The design was a pre-presentation retrospective chart review, educational presentation and post presentation chart review. A retrospective chart review was completed on patients with history of kidney stone presenting to the ED with flank pain as a chief complaint prior to the educational presentation. Analysis of the information was used to complete a needs assessment. Evidence-based information was then disseminated to the providers at the Charlton Memorial Hospital ED as a means of education on current evidence-based research. A post-presentation chart review was then completed on patients to evaluate if the information warranted any practice change.

Practice change would be identified as the decrease in percentage of CT scans ordered on patients presenting to the ED with flank pain and a history of renal calculi.

Sample and Participants

The sample was randomly selected adult patients presenting to the ED with flank pain and a history of renal calculi. The pre-presentation chart review included forty patients who were admitted to the ED prior to the educational program. The post-presentation chart review included forty patients admitted to the ED after the providers participated in an educational program. Inclusion criteria for both groups were patients presenting to the ED with flank pain and a history of renal calculi. Exclusion criteria included recent surgery and patients with chronic renal failure and/or dialysis due to renal impairment at baseline. Inclusion criteria were not based on race or gender, but patients had to be eighteen years or older.

Participants in the education portion of the project included providers in the First Physicians Group practicing in the ED at Charlton Memorial Hospital in Fall River, Massachusetts. The group included twelve emergency department physicians and eleven mid-level providers, consisting of nurse practitioners and physician assistants.

Site

Charlton Memorial Hospital in Fall River, Massachusetts was the site for the project. It is a non-profit community hospital with three hundred sixty-two licensed beds. The ED has twenty-eight bed with an additional eight beds reserved for behavioral patients. The ED visits range from one hundred and eighty to two hundred and seventy patients per day.

Procedure

Permission was obtained from the director of the group Dr. Brian Tsang. Also, Chief Quality Officer and Nurse Practitioner Lissa Singer was recruited for IT support and assistance with chart generation. Southcoast Health System's Federal Wide Assurance (FWA) Committee provided a letter of endorsement for the project. After IRB approval, the Chief Quality Officer was contacted to generate a list of patients who presented to the ED with flank pain and a history of renal calculi. A maximum of two hundred charts were requested and the goal was to obtain forty charts that met the inclusion criteria for the pre-presentation chart review. Charts reviewed were from October 1, 2014 to October 1, 2015. In the case where forty charts were not generated, an additional fifty charts would be requested for further review. However, forty charts met the inclusion criteria during the first round of chart review. All charts were generated with the assistance of Lissa Singer and were reviewed in the locked physician's call room via electronic health record. The researcher was able to generate a percentage of CT scans ordered on the population with renal calculi who met criteria. The first retrospective chart review was used to demonstrate the need to decrease CT scans ordered for the population. The initial chart review was also used to compare a post-presentation retrospective chart review to evaluate whether education/information dissemination was adequate for change. The initial chart review took place in November 2015.

An informational handout (Appendix A) on evidenced-based research was presented to the providers outlining the prevalence of renal calculi, emphasizing the strain on ED resources, alternative testing, specificity and sensitivity of diagnostic

methods other than CT scans and general cost ramifications as cited in research. Medical imaging radiation risk was reviewed as well as alternative imaging strategies for renal calculi diagnosis in the ED. Key points summarized information about limiting CT scans as a means of diagnosis for renal calculi. A fifteen minute informational session about the most recent evidenced-based research was presented at the groups' quarterly meeting on December 3rd, 2015 using the informational handout. The informational handout was reviewed and an open discussion was provided for questions. An e-mail address was then provided to answer any questions during a week span post-information session to discuss concerns confidentially.

After the presentation and one week allotment for reflection and questions, a second retrospective chart review was completed to evaluate the program effectiveness. Two hundred charts were again requested with the goal of forty which met inclusion criteria, between December 10, 2015 and March 2016. The pre and post chart review yielded four hundred charts in total and eighty were used for data analysis.

Data analysis was completed by computing a simple percentage of pre and post CT scans ordered after the educational program intervention. The results were presented to Dr. Brian Tsang and the physician group via e-mail. The project will be presented at the Rhode Island College Masters' research symposium and submitted to Rhode Island College's digital commons database in May 2016. Submission for future publication in the American Journal of Emergency Medicine is anticipated. Once the project is completed raw data on patients will be destroyed.

Measurement

Data collected during each chart review included whether a CT was obtained, the result of the CT, if alternative imaging was used (US or radiograph), if hematuria was present, and diagnosis on discharge or admission (Appendix B). No direct patient identifiers were recorded.

The percentage of CT scans ordered on patients who presented with flank pain and a history of renal calculi pre and post educational intervention to the group was compared. A decrease in the percentage of CT scans ordered post educational program would indicate success of the interventional program.

Organizational and System Factors

Enabling factors were the support of administration including the director of the physician's group, Dr. Brian Tsang and the group's chief quality officer Lissa Singer. The researcher was familiar with the organization and was another enabling factor. Time allocation at the quarterly meeting by Dr. Tsang was an enabling factor to disseminate information to the group. Barriers included the implementation of a new Epic computer system. The ability to generate necessary charts was difficult but completed. Nursing documentation needed to be accurate and consistent. This could have posed as a barrier since the patient needed to have a documented history of renal calculi as well as being appropriately triaged under the chief complaint of "flank pain" in the repeat visit. The small sample size poses a limitation as well as provider resistance to change in personal practice. A quick turnaround time needed to evaluate the charts post intervention may not have allowed enough time for providers to explore factors influencing their change in practice.

Desired Outcome

The desired project outcome was for successful program implementation and information dissemination. A decrease in provider CT ordering in the specified sample post program implementation was achieved. Although the project was a small pilot study and change in practice can take years to occur, adding to the limited research and identifying a gap in practice on this topic was imperative.

Ethical Concerns

The project was submitted to Southcoast Health System's Federal Wide Assurance (FWA) Committee for a letter of endorsement. The project was then submitted for institutional review board (IRB) approval from Rhode Island College to protect the rights and privacy of all involved, ensure Health Insurance Portability and Accountability Act (HIPPA) compliance and to evaluate risk versus benefit and appropriately gain consent of all participants as needed. There were no discrimination of age, race, or gender.

Results

Two hundred charts were obtained for the first chart review and a random forty charts which met the participant criteria were included. The remaining one hundred and forty were excluded due to chronic renal failure and if the patient did not have both flank pain and a history of renal calculi or once forty charts made inclusion criteria. Sex of the patient was not considered. All patients had flank pain and a past medical history of renal calculi (*n*=40) as required by the inclusion criteria. The priority result revealed 80% (*n*=32) had a CT performed, 17.5% (*n*=7) had no imaging, and 2.5% (*n*=1) had an x-ray KUB. No patient had an US. Of the thirty-two patients who had a CT performed, eight had a diagnosis other than renal calculi that included: either no stone/normal imaging, Crohn's disease, pancreatitis, constipation, diverticulitis, or colitis. Of the eight patients with alternative diagnosis, 75% of them (*n*=6) had no hematuria present. The remaining twenty-four patients who had a CT were diagnosed with renal calculi and 91.7% (*n*=22) had hematuria present or no urine collected. Only two patients of the twenty- four whom

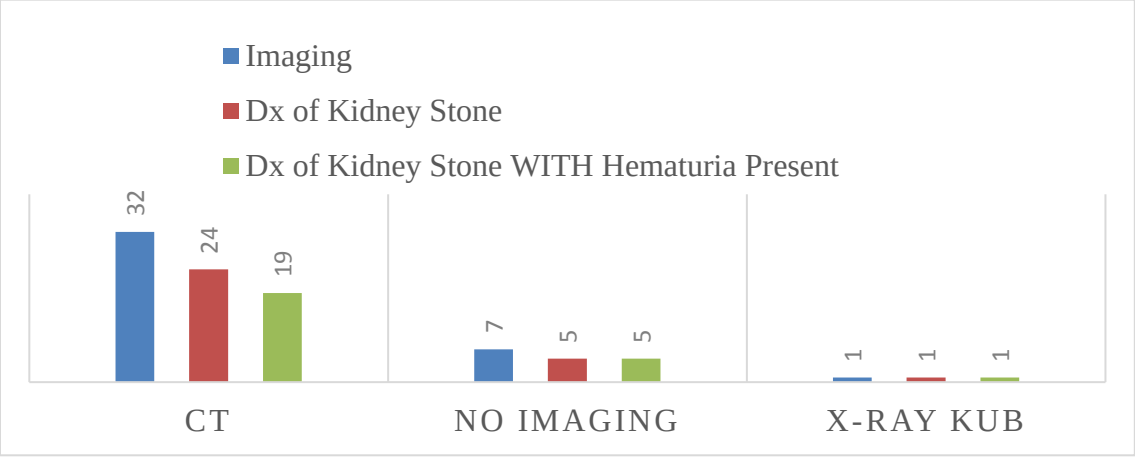

Figure 1. Relationship between type of imaging, diagnosis of kidney stone and the diagnosis of kidney with hematuria present.

had a CT scan and renal calculi diagnosis had no hematuria present (Figure 1). Five patients in the CT group had multiple CTs all less than two weeks apart. None of these patients had a change in diagnosis or admission requiring intervention.

There were seven patients with no imaging completed and five were diagnosed with renal calculi. Two had alternative diagnoses of bacterial enteritis and duodenal ulcer. One hundred percent of the patients who received the diagnosis of renal calculi (*n*=5) with no imaging had hematuria. One hundred percent of the patients who had alternative diagnoses (*n*=2) had no hematuria present. Three of these patients had a CT performed in the last four days or less. Thirty percent of all forty patients were admitted (*n*=12). Only one of these patients had an intervention for renal calculi, seven were admitted for pain control with no subsequent intervention and four were admitted for alternative diagnoses. Of the three patients who had no imaging and no recent CT, two had hematuria and were discharged home successfully with the diagnosis of renal calculi.

A total of one hundred and thirty-nine charts were obtained for the second chart review which was completed after information dissemination to the providers' group. Charts were reviewed until forty met the participant inclusion criteria and neither gender nor age were considered. All patients had flank pain and a past medical history of renal calculi (*n*=40) as required by the inclusion criteria. CT scans obtained decreased from 80% (*n*=32) prior to the program to 65% (*n*=26) post-intervention. Alternative diagnostics results showed 15% (*n*=6) had no imaging, 12.5% (*n*=5) had US, and 7.5% (*n*=3) had an x-ray. Of the twenty-six patients who had a CT, none had an alternative diagnosis. Alternative diagnoses were found with other diagnostics and clinical assessments leading to a more efficient use of the CT for this population. Of the forty

patients, four had an alternative diagnosis and 75% (*n*=3) of these patients had no hematuria. The twenty-six patients who had a CT and were diagnosed with renal calculi had hematuria or had no urine obtained making up 89% (*n*=23) (Figure 2). Only three patients had a renal calculus, CT and no hematuria, and of these patients all had a calculus less than four mm. Two patients had no imaging on ED visit but had a CT outpatient or on previous visit but had a CT outpatient or on previous visit. Unlike the first chart review these patients were not re-imaged as five patients were previous to the presentation. Five patients were admitted with only three having an intervention for renal calculi.

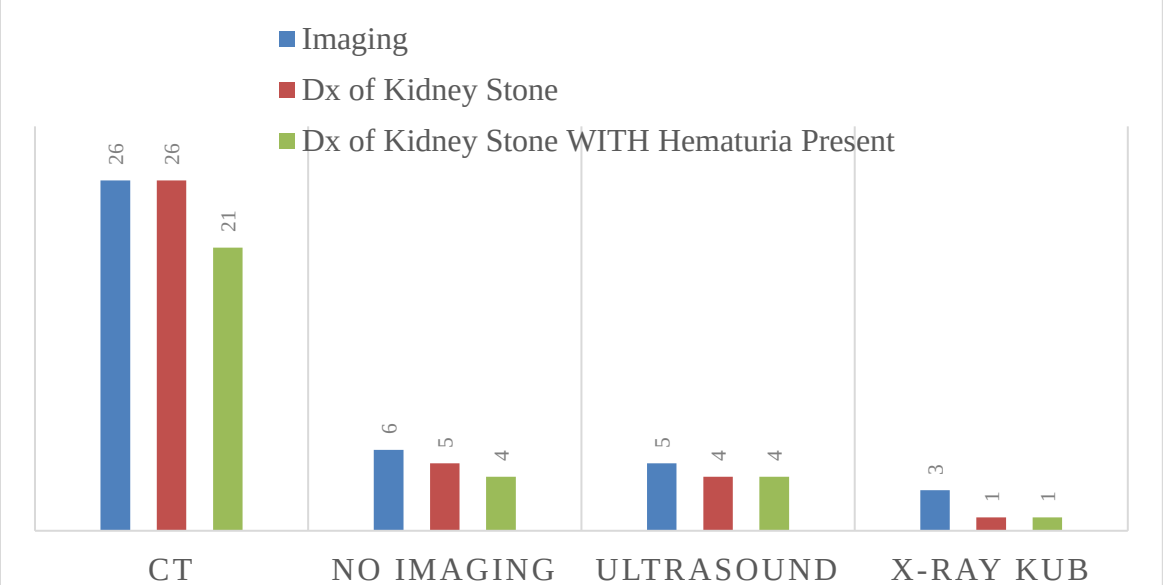

Figure 2. Relationship between type of imaging, diagnosis of kidney stone and the diagnosis of kidney stone with hematuria present post information dissemination.

Summary and Conclusions

Renal calculi ED visits are on the rise in the U.S. and treatment cost more than 5.3 billion dollars annually (Saigal et al., 2005). CT rates must be decreased since recurrence rates are as high as fifty percent. Characteristic symptoms such as renal colic, flank pain and hematuria can help with this needed decrease. CT rates are important to examine because many patients are overexposed to radiation unnecessarily, it causes a rise in healthcare cost, and there is an increase in ED visit time. When evaluating patients, their insight to past experiences with renal calculi, the presence of hematuria and the use of alternative diagnostics can prevent the unnecessary use of CT scans in the ED process.

In an initial chart review of two hundred charts with forty meeting inclusion criteria, it was noted the use of CT scans in the Charlton Memorial Hospital ED was significantly high in this population at eighty percent (n=32). Strategies to improve quality of care, assessment and treatment in this population was necessary. Guided by the logic model the study sought to do so. In providing recent evidence-based research to the healthcare providers in the ED, the providers were able to lower the percentage of CT scans ordered from eighty percent (n=32) to sixty-five percent (n=26) on repeat chart review. Although there is room for improvement, lowering the CT percentage by fifteen percent is a substantial finding. The use of urinalysis when evaluating these patients is imperative to guide diagnostics, although this was not specifically studied. Hematuria was found in more than eighty nine percent of patients diagnosed with renal calculi between the two reviews and notably more than ninety-one percent on the first chart review. To the contrary, the majority of patients with alternative diagnoses had no hematuria further helping guide diagnostics. In the pre-dissemination chart review, there were three patients who had multiple CT scans within days of each other. On repeat chart

review this portion of the population was eliminated. US use was not used by providers on pre-information dissemination chart review. However, post-intervention US was used more frequently and was a good alternative to reduce radiation exposure, time in the ED, and cost. The results of the project were consistent with current evidence-based studies reviewed.

Limitations in the study were observed. A small sample size was a barrier to a broader outlook on the issue. A retrospective review can be misconstrued and poses its own barriers. Nursing documentation can be inconsistent, in that nursing has the option to interchange abdominal pain, back pain, and flank pain on chief complaint. The study evaluated patients with flank pain only. The hospital was in the process of instituting a new electronic health record and extracting data differed from chart review to chart review. Information was collected at only one of the three hospitals within the organization. Diversity, social or ethical considerations did not pose an issue within the project. Data collection complied with HIPPA regulations. Quality, safety and cost concerns were addressed. Lowering CT use in this population provided patients with greater quality and safety within their visit as well as lowered cost as CT poses to be the more expensive of the diagnostic techniques observed. From an interdisciplinary stand point, nursing compliance with timely urine sample collection was imperative to collecting data on hematuria.

Recommendations and Implications for Advanced Nursing Practice

Broad recommendations arose from the project for advanced nursing practice in role, practice, research and policy. As an advanced practice nurse, there is a duty to the patient. Within this duty, advanced practice nurses must advocate, educate and provide quality, safe care for the patient. By preventing recurrent renal calculi patients in the ED from visiting the CT scanner repeatedly, the advanced practice nurse does just that. Education is key in allowing the patient to understand the reasoning behind diagnostics and potentially the lack there of. Advocating with providers and physicians that the patient may not need a CT and alternatively proper assessment and urinalysis is necessary before hastily ordering diagnostics is necessary to provide quality and safe care to these patients. Advocating for change in current practice reduces the risk for over-radiation, as cited throughout literature as well as lower their time in the ED and further more lowering cost to them. Patients in the ED often expect that a full arrangement of testing must be done to be safely be cared for and diagnosed properly. However in this patient population the contrary is proven true. Educating patients on why a CT may be unnecessary, the role of the urinalysis results in diagnosis and their risks by having the CT scan done when recurrence is likely is imperative.

With the advanced practice nurse's duty to the patient also comes duty to their organization and healthcare system. While lowering the percentage of CT scans benefits the patient, it also benefits individual organizations as well as the healthcare system as a whole. Preventing unnecessary CT scans lowers spending and not just for the patient, but for the healthcare system. Whether patients have private insurance, state/federal insurance or no insurance, lowering cost is beneficial at all levels. Decreasing ED visit time is another benefit to the patient and the department, organization and healthcare

system. While wait times flourish in EDs across the nation any means of decreasing patient time within the department should be taken. Advanced practice nurses through diagnostic ordering stewardship and education to patients and other healthcare providers alike can take part in the movement to decrease ED time.

There is a potential lapse of time from research to translation into practice. Any change in practice observed in the project was substantial. The ED studied was an evolving, busy department and the providers involved challenged themselves to look into the new literature provided to better care for their renal calculi patients. The study will be shared with the group including the advanced practice nurses, in hopes that role modeling behavior can potentiate long term change in the ED and further improve the great quality care already provided. As of today, no evidence-based protocol is available to dictate how providers should determine when to order CT scans when renal calculi recurrence is probable. Advanced practice nurses should continue to add to the research to make policies and protocols to guide practice.

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Appendix A

Information Handout

CT Scans for Patient's with History of Kidney Stones Presenting With Flank Pain to the ED

Introduction/Impact:

- Patients at risk for repeat renal calculi presenting to the ED with symptoms similar to their previous episodes, specifically renal colic pain are likely to be over-exposed to computed tomographic (CT) scans.
- CT use increases patient exposure to radiation, causes increased costs to the patient and health care system and extends emergency department visit times.
- The United States spends billions of dollars annually on symptomatic and asymptomatic renal stone disease. Saigal, Joyce, & Timilsina (2005), reported that treatment for renal stone disease cost more than $5.3 billion dollars annually.
- Current standard for confirming renal calculi is an unenhanced, helical CT scan of the abdomen and pelvis. The previous gold standard was an intravenous pyelogram (IVP) . In areas where CT scans may not be available, an abdominal radiograph is often utilized and can be accurate as 75-90% of stones are radiopaque (American Urological Association, 2012). Ultrasound despite its inferiority to a CT is the first choice of imaging when stones are suspected during pregnancy (American Urological Association).
- With recurrence as high as fifty percent it is reasonable to acknowledge that life-long radiation from CT use is exponential (Goertz & Lotterman, 2010).
- CT scans are known to expose patients to 200-1,500 times the radiation of just one chest x-ray (Westphalen, Hsia, Maselli, Wang, & Gonzales, 2011).
- The risk from fatal cancer is estimated at 0.05% per abdominal CT scan (Goldstone & Bushnell, 2010).
- **Gross or microscopic hematuria is present in approximately 90% of patients (American Urological Association, 2012).**
- Kidney stones are more prevalent in males with the highest risk between the ages of 20 and 50 years. (Havard Medical School, 2012).
- **The highest risk factor being past medical history of a stone (Havard Medical School, 2012).**

Current Research:

- **Imaging for recurrent kidney stone patient's has raised greatly (**Large retrospective study in 2013 used NHANES and NHAMCS- 551,577 ED visits between 92'-09')
- X-ray use has decreased from 48% to 17%, **CT use has increased from 21% to 71% and US use was only 5-6% of the time**
- The study recommends that: **The diagnosis of kidney stone be done by clinical diagnosis and is straightforward in patients with a history of kidney stone Evaluation for true flank pain should be completed and exclude that it may be abdominal pain Physical assessment with a urinalysis can evaluate for infection and hydration status Lastly if a stone is not passed during an observation period or imaging at the initial visit is necessary start with a renal ultrasound**
- Another large study also used NHAMCS data between 96'-07'
- 10-fold increase in CT use with no direct correlation in diagnosis changes or admission rates
- **CT scans are essential to ruling-out other critical diagnosis.**

- **However, when looking at diagnosis and imaging rates there is no parallel to the increase of imaging and actual critical diagnosis in patients with a history of kidney stone who tell you they are having a similar episode including cardiovascular and malignant events.**
- Ruling out differential diagnosis with physical exam and urinalysis:
    - Pyelonephritis may have a similar presentation with flank pain except will present with fever and pyuria as opposed to hematuria (in the case of uncomplicated stone a fever is not only uncommon but rare)
    - Ectopic pregnancy can have a similar presentation in women however can be ruled out by US
    - Rupture or torsion of ovarian cysts also can be identified by US
    - Aortic aneurysm- missing this diagnosis on a patient presenting with flank pain with a history of kidney stone according to the study is extremely rare
    - Abdominal obstruction, diverticulitis, **appendicitis**, **biliary colic**, **cholecystitis**, acute mesenteric ischemia and herpes zoster may present with flank pain but not with hematuria.
- Aubrey-Brassler et al. (2013) (Retrospective chart review on 2,315 patients from 05'-08')
- WATUR (WBCs, Abdominal pain, Temperature, Urine RBC) score to predict need for CT/emergent situation

Higher the score the higher the risk for emergent situation

- Only 2.1% had an emergent outcome on CT and the score was validated on **ALL** patients
- Goldstone and Bushnell (2010) (Large academic hospital emergency department with an annual census of 55,000) Data from 97'-07' on all ED patient's billed for CT for renal colic and had a confirmative CT in the past for a kidney stone
- 81% had no change in diagnosis, 11.6% required no urgent intervention, 6.5% required further intervention and when using a urinalysis that number is decreased to 3.5%
- The study recommends decreasing CT use on these patients to decrease radiation since they will be likely to repeat their visits
- Goertz and Lotterman (2010), 177 charts reviewed between 04'-08'
- Supports the use of US to determine the degree of hydronephrosis to predict stone size
- Patients had a renal US and non-contrast CT for stones to determine if hydronephrosis was a positive predictor for stone size
- Group 1: stones > 5mm and Group 2: stones < 5mm and Hydro was classified as none, mild or severe
- Results: 144 patients had a stone < 5mm, 33 patients had a stone > 5mm
- Less severe hydro = stone < 5mm 87.6% of the time
- 16 patients did have less severe hydro but a stone > 5mm BUT none of these patients had a stone >10mm
- Of patients with severe hydro all were >6mm and only 6 patients in the study had a stone greater than 10mm
- **So… if an US is completed and you have no to mild hydro spontaneous passage is GREAT**
- Gaspari and Horst (2005) evaluated ED ultrasound and urinalysis to assess flank pain (took place in a Massachusetts teaching hospital with an annual census of 75,000)
- Prospectively enrolled if the physician after physical assessment felt the flank pain was renal colic
- Patient's evaluation included a urinalysis, CT that the physicians were blinded to and then the physician did an US (not looking for a stone but looking for unilateral hydronephrosis)
- Results: 104 diagnosed with renal colic and sensitivity/specificity was approximately 88%/85% when using a urine with evaluation
- Research suggest if US were normal it was an extremely low likelihood of urologic intervention needed w/ in 90 days of the ED visit
- From an ED stand point an US should be the first and often only stop in evaluating flank pain to decrease CT use

Appendix B

Data Collection Tool

Identifier (1-40)	Type of Imaging	Result of Imaging	Hematuria?	Discharge or Admission and Diagnosis	History of Kidney Stone (Required)