Journal Reading

Presenter: PGY Dr.黃琬翔
Supervisor: Dr. 吳柏衡
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CONTINUING MEDICAL EDUCATION

CLINICAL PRACTICE

CME

Radiological Imaging of Patients With Suspected Urinary Tract Stones: National Trends, Diagnoses, and Predictors

Antonio C. Westphalen, MD, Renee Y. Hsia, MD, MSc, Judith H. Maselli, MSPH, Ralph Wang, MD, and Ralph Gonzales, MD, MSPH

Introduction

- Many patients with stones develop renal colic and seek urgent care for pain relief.
- In the United States, the American College of Radiology has recommended computed tomography (CT) as the first line of investigation for suspected urinary tract stones in the adult population (with the notable exception of pregnant women).

Introduction

- However, in some European and South American countries, ultrasound (US) is also considered an acceptable first line option.
- This is particularly true for patients who have recurring episodes of renal colic, as repeat CT scans seldom change management.

Introduction

- Advantages of CT: Its superior accuracy for detection of stones and alternate diagnoses that could account for the clinical presentation of the patient.
- Advantage of US: Lack of radiation exposure.
- Disadvantages of CT: Radiation exposure.
  (Repeat CT scans in patients with known urolithiasis result in exposure to effective doses equivalent to that of 200 to 1,500 chest radiographs.)
- Disadvantage of US: operator dependency and decreased accuracy compared with CT.

Introduction

- It is important to note, though, that more than half of renal calculi missed by US are smaller than 5 mm, many measuring less than 3 mm, a size that many consider clinically insignificant.
- Finally, it is unknown if the improved detection of stones by CT is associated with improved outcomes for patients.

Introduction

- Considering the potential public health concerns related to cumulative patient radiation exposure, and the large and relatively young population affected by urinary tract stones, we conducted this study to determine:

1) The national trends and predictors of CT and US utilization for assessment of suspected urinary tract stones in emergency departments (EDs)

2) If trends in imaging utilization have resulted in changes in the diagnosis rates of urinary tract stones and other significant disorders.

Method—Study Design

- A retrospective cross-sectional analysis of ED visits from the National Hospital Ambulatory Medical Care Survey (NHAMCS) between 1996 and 2007.

Method—Study Setting and Population

- The NHAMCS data were aggregated into 3-year intervals to provide a sufficient sample size for analyzing trends in ED visits for suspected urolithiasis.
- The NHAMCS is a publicly available sample of ED visits in the United States.
- Data are collected in noninstitutional general and short-stay hospitals (excluding federal, military, and Veterans Administration hospitals) of the 50 states and the District of Columbia.

Method—Study Setting and Population

- For each hospital, data are collected during a random 4-week period.
- For the period of study, the NHAMCS survey includes 368,680 actual visits, which extrapolate to an estimated 1,289,500,000 ED visits.

Method—Study Setting and Population

- For this study, we restricted the study population to nonpregnant adult patients (age ≧ 18 years) with the primary reason for visit of flank pain or kidney pain
- These symptoms were chosen because they are commonly associated with urinary tract stones, and they often lead to imaging evaluation in the ED.
- We opted for excluding pregnant women because CT scans are generally discouraged during pregnancy.

Method—Study Setting and Population

- The main outcome of this study was the proportion of visits for flank or kidney pain receiving CT and / or US testing.
- We also examined specific diagnosis rates and hospital admission rates as secondary outcomes.

Method—Study Setting and Population

- An ED diagnosis of urolithiasis was based on the primary diagnosis of ICD-9 CM codes 592.x (calculus of kidney and ureter) or 594.x (calculus of lower urinary tract).
- We examined the variation of CT utilization during the most recent 3-year period.
- Predictor variables were selected based on previous literature showing that the proposed variables are likely associated with different rates of imaging utilization.

Method—Study Setting and Population

- We evaluated patient characteristics of

1) age *(18–44, 45–64, and >65 years)*

2) Sex

3) Race / ethnicity

(non-Hispanic white, non-Hispanic black, Hispanic, Asian, and other)

Method—Study Setting and Population

4) Insurance

Private insurance, Medicaid, Medicare, uninsured (self-pay and charity / no charge), and other (e.g., worker's compensation, Veteran's Administration, CHAMPUS, or Tricare).

5) Presenting level of pain

(mild, moderate, severe)

6) Triage level, defined as the immediacy with which patient should be seen determined by triage nurse

(<15 minutes, 15–60 minutes, 1–2 hours, 2–24 hours).

Method—Study Setting and Population

- We analyzed the following hospital-level variables: U.S. geographical region, as defined by the U.S. Census Bureau (Northeast, Midwest, South, and West); urban vs. rural institution; teaching vs. nonteaching hospital; and safety-net vs. non–safety-net hospital.

Method—Data Analysis

- Multivariate logistic regression analysis was performed to investigate independent predictors of imaging utilization (CT vs. other) using data obtained from the last period of our study (2005 to 2007).
- We chose to restrict this analysis to the last 3 years of the study to limit our results to current practice patterns.
- A two-tailed p value of $\leqq 0.05$ was considered statistically significant.

Results

- During the study period, there were 3,818 actual sampled ED visits for flank or kidney pain by adults present in the NHAMCS, which represents an estimated 14.3 million visits (95% CI = 12.9 to 15.8) across the United States.
- Approximately 19% of these patients received a diagnosis of urolithiasis.

Results

- Our results show a substantial and persistent increase in the utilization of CT to assess patients with suspected urolithiasis, rising from 4.0% (95% CI = 2.0% to 6.1%) to 42.5% (95% CI = 37.5% to 47.4%).

Results

- In contrast, the use of US was relatively low in 1996 and did not change until it decreased beginning in 2005 through 2007.
- Despite the large increase in CT use, the proportion of patients with a principal diagnosis of urolithiasis did not change.
- In addition, there was no change in the proportion of patients admitted to the hospital following imaging, remaining stable at about 10% to 11% for overall admissions .
- Admissions of patients with urolithiasis also appeared to remain stable over time, but were too few to allow for reliable estimates.

Table 1
NHAMCS ED 1996–2007 Adult, Nonpregnant Visits, With Primary Reason for Visit of Flank Pain/Kidney Pain

	1996–1998	1999–2001	2002–2004	2005–2007	p-values
Number of visits	1,629	868	1,176	1,145	—
Estimated visits*	2,876,566 [2,418,161–3,334,971]	3,635,441 [2,964,892–4,305,990]	3,556,561 [3,110,189–4,002,933]	4,273,515 [3,490,287–5,056,743]	0.07
Imaging utilization†					
None	2,601,160 (90.4) [2,173,276–3,029,044]	2,780,014 (76.5) [2,238,107–3,321,921]	2,253,311 (63.4) [1,942,812–2,563,810]	2,298,538 (53.8) [1,840,508–2,756,568]	<0.001
US	153,236 (5.3) [94,291–212,181]	160,052 (4.4) [86,901–233,203]	163,426 (4.6) [106,929–219,923]	103,750 (2.4) [54,089–153,412]	0.01
CT	116,177 (4.0) [52,951–179,403]	665,344 (18.3) [474,001–856,687]	1,096,462 (30.8) [900,650–1,292,274]	1,814,727 (42.5) [1,411,353–2,218,101]	<0.001
Dx of urolithiasis	513,383 (17.8) [376,393–650,373]	657,236 (18.1) [472,228–842,244]	694,740 (19.5) [556,505–832,975]	812,213 (19.0) [598,736–1,025,690]	0.55
Admissions, any Dx	336,328 (11.7) [244,088–428,568]	409,503 (11.3) [274,259–544,747]	356,796 (10.0) [271,583–442,009]	451624 (10.6) [313,787–589,461]	0.49

Numbers in parentheses are percentages; numbers in brackets are 95% CIs.
*Trend test performed on visits with weighted linear regression.
†Trend test based on percentages.
Dx = diagnosis; NHAMCS = National Ambulatory Medical Care Survey; US = ultrasound.

Table 2
Proportion of Patients With a Primary Abdominal or Thoracic Diagnosis, Stratified by Diagnoses Group: NHAMCS ED 1996–2007 Adult, Nonpregnant Visits, With Primary Reason for Visit of Flank Pain/Kidney Pain

Diagnosis Group*	1996–1998	1999–2001	2002–2004	2005–2007	p-value†
1	17.9 (14.0–21.7)	18.1 (14.6–21.5)	19.5 (16.5–22.6)	19.0 (12.8–25.2)	0.55
2	6.8 (1.2–12.4)	9.3 (0.4–18.1)	6.7 (0.4–12.9)	6.7 (0–14.8)	0.46

Data are reported as % (95% CI). Group 1 = urolithiasis; Group 2 = acute infectious/inflammatory processes (including pleural effusion); Group 3 = acute cardiovascular event; Group 4 = malignant neoplasms.
*For any given period, groups of acute cardiovascular events and malignant neoplasms had fewer than 30 visits (<0.8%) and not considered reliable by the National Center for Health Statistics.
†Trend test based on percentages.

Multivariate Analysis-Patient Characteristics

- Patients with the following characteristics are more likely to receive CT scan:
  1) **Patients with severe pain**
     (OR = 2.96, 95% CI = 1.14 to 7.65)
  2) **Patients with a triage time of 15 minutes or less**
     (OR = 2.41, 95% CI = 1.08 to 5.37)
  3) **Male patients**
     (OR = 1.83, 95% CI = 1.22 to 2.77)
  4) **Non-Hispanic whites**
     (OR = 0.48, 95% CI = 0.23 to 0.98).
- Insurance type did not appear to be associated with differences in the likelihood of receiving a CT scan

	OR	95% CI
Patient characteristics		
Age, yr		
18–44 (ref)	—	—
45–64	1.43	0.93–2.21
>65	0.88	0.32–2.38
Sex		
Female (ref)		
Male	1.83	1.22–2.77
Race/ethnicity		
Non-Hispanic white (ref)	—	—
Non-Hispanic black	0.67	0.38–1.16
Hispanic	0.84	0.45–1.58
Other	0.48	0.23–0.98
Insurance		
Private (ref)	—	—
Medicare	0.73	0.33–1.63
Medicaid	0.67	0.39–1.14
Uninsured/self	1.16	0.68–1.99
Other	0.30	0.07–1.23
Presenting level of pain		
None	—	—
Mild	2.57	0.99–6.65
Moderate	1.43	0.54–3.81
Severe (ref)	2.96	1.14–7.65
Triage		
<15 minutes (ref)	2.41	1.08–5.37
15–60 minutes	2.01	1.01–4.01
1–2 hours	1.91	0.88–4.13
2–24 hours	—	—

Multivariate Analysis—Hospital Characteristics

- Computed tomography utilization was lower in hospitals with the following characteristics:
  1) Rural hospitals (vs. urban areas; OR = 0.34, 95% CI = 0.19 to 0.61)
  2) Hospitals not managed by a nonphysician health care provider (OR = 0.19, 95% CI = 0.07 to 0.53).
  3) Hospitals in the the south (OR = 0.50, 95% CI = 0.29 to 0.85) and west (OR = 0.38, 95% CI = 0.20 to 0.74) regions.
- We did not find an association between CT utilization and visits to either safety-net EDs or teaching hospitals.

Hospital characteristics		
Region		
Northeast (ref)		
Midwest	0.71	0.42–1.19
South	0.50	0.29–0.85
West	0.38	0.20–0.74
SMSA		
Rural	0.34	0.19–0.61
Urban (ref)	—	—
Safety-net hospital		
Yes	0.68	0.43–1.07
No (ref)	—	—
Teaching hospital		
Yes	0.64	0.31–1.31
No (ref)	—	—
Provider type		
Physician (ref)	—	—
Resident	1.38	0.60–3.20
Other	0.19	0.07–0.53

Discussion

- A marked rise in the utilization of CT scans; specifically, we found a greater than 10-fold increase from 1996–1998 through 2005–2007.
- During the same period of time, the proportion of patients who did not receive imaging and the proportion receiving US each decreased by half.

Discussion

- We can only hypothesize why US utilization has decreased over time, but this is likely a multifactorial process, including
  1) the superior accuracy of the CT scan
  2) resource availability
  3) increased clinician intolerance for diagnostic uncertainty

Discussion

- It has been shown that high-risk specialist physicians, such as emergency physicians, have identified ordering diagnostic imaging as a common act of defensive medicine.
- Other factors (e.g., patient expectations, increasing radiologist preference for CT rather than US) may have also played a role in the decrease utilization of US in the United States.

Discussion

- Despite the superiority in accuracy of the CT scan (vs. US) for urinary tract stones as well as significant thoracic and abdominal alternate diagnoses, we found essentially no change in the
  1)proportion of patients diagnosed with kidney stones,
  2)proportion of patients admitted to the hospital following imaging
  3)or proportion of patients diagnosed with an alternative acute infectious or inflammatory diagnosis.
- These findings suggest that the increased utilization of CT scans in ***patients with suspected urolithiasis may not have had a significant effect on diagnosis or management of urolithiasis.***

Discussion

- Because of the evidence suggesting that CT scans have not had a major clinical effect on the evaluation or management of adults with suspected urolithiasis, we explored whether nonclinical factors might be contributing or accounting for increased CT utilization rates.

Discussion

- We found that there were a number of predictors for CT utilization in 2005 through 2007, including patient (male sex, severe acuity of pain, time in triage, other race / ethnicity) and hospital (northeast hospitals, urban hospitals, nonphysician providers) characteristics.

Discussion

- Patient
  @male sex=>women prefer US, especially reproductive women
  @ severe acuity of pain, time in triage=>
  Signal of danger!!
- Hospital
  @ Urban hospitals serve as referral centers
  @ Sufficient CT scans per ED in urban hospitals

Discussion

- In the seminal study published in 1995, Smith et al. showed the superiority of CT scan for the identification of ureteric stones (comparing it to intravenous urography).
- Since this time, CT scan has essentially replaced intravenous urography in patients with suspected kidney stones.

Discussion

- However, there is a dearth of evidence supporting the use of CT scan over US in terms of clinical efficacy or patient safety.
- Our findings contribute to the literature by showing that the conventional argument for the choice of CT over US in the evaluation of flank or kidney pain in the ED is not supported by any evidence that increased use of CT scans have changed diagnosis or treatment rates.

Limitations

- Not true population
- Repeated visits were not identified
- No anatomical records of the CT scans
- Diagnosis of urolithiasis is overestimated in patients who do not undergo imaging

Conclusions

- Based on data from the National Hospital Ambulatory Medical Care Survey over the time period of 1996 to 2007, there has been a 10-fold increase in the utilization of CT scan for patients with suspected kidney stone.
- However, we did not find any appreciable change in the diagnosis of kidney stone, diagnosis of significant alternate diagnoses, or admission to the hospital over the same time period.
- The choice to utilize CT scan should be weighed against the known risks, particularly radiation exposure.

Thanks for your attention!!