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ORIGINAL PAPER

Hospital cost analysis of management of patients with renal colic in the emergency department

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Abstract Acute severe colicky pain in the flank region is termed as renal colic (RC), which is commonly diagnosed and treated in the emergency department (ED). The present study is designed to investigate the hospital costs of patients with RC admitted to the ED and factors affecting the figures. Retrospective analysis includes all patients diagnosed with RC following physical examination and X-ray, ultrasound, computed tomography together with laboratory investigations in the university-based ED between February 2007 and February 2009. The study included 574 patients eligible for the predefined criteria. Mean total hospital cost in patients admitted to the ED due to RC was calculated to be 55.77 Euro. The greatest contribution to the total cost was made by radiological investigations in the ED (40.5%) followed by treatment costs (19.7%). Size and location of the stone and stay times in the ED were the independent variables affecting the costs. The costs were higher as the stones were bigger and as they were more distal in the ureter. Renal stones were associated with the lowest hospital costs. Radiological investigations are the greatest contributors in the ED costs in patients with RC. Effective measures need to be undertaken to reduce resultant costs. Preventive measures as well as diagnostic and therapeutic procedures should be standardized in the ED in accordance with technological advances and also cost-effectiveness when appropriate.

Keywords Renal colic · Urolithiasis · Emergency department · Cost analysis · Hospital cost

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Introduction

Acute severe colicky pain in the flank region is termed as renal colic (RC), which is commonly diagnosed and treated in the emergency department (ED). Increased renal blood flow resulting in a surge of intraluminal pressure, and contraction of ureteral smooth muscles are accused in the pathophysiology. Increased sensitivity of nociceptive receptors, histamine and bradykinin, was also pointed out [1]. Although side pain or flank pain are the most common symptoms in RC or nephrolithiasis, abdominal pain, back pain, and groin pain are other presenting symptoms encountered in these patients [2].

The incidence of urinary stone disease in Turkey is approximately 15% which reflects the fact that it is among the endemic countries regarding the entity, and thus these patients are commonly encountered in the EDs [3, 4]. The evaluation and treatment of patients with nephrolithiasis is rapidly changing. New imaging modalities have emerged that have changed the way we evaluate patients with flank pain. Diagnostic modalities include ultrasonography (USG), computed tomography (CT), kidney, ureter, and bladder radiograph (KUB) in patients suspected to have RC whose management is frequently guided by clinical presumptive diagnosis. This can result in differences in treatment protocols and discharge of patients without a definitive diagnosis. Lack of a consensus on a commonly recognized,

feasible management protocol can lead to deficiencies in treatment, malpractice litigations, repeated admissions and finally, a boost in management costs. The latter is also aggravated by indirect work losses due to RC which significantly increases the burden on the national economy.

The present study is designed to investigate the hospital costs of patients with RC admitted to the ED and factors affecting the figures.

Materials and methods

The present study was conducted in an industrialized middle-sized city of western Turkey, Denizli, in a university-based hospital. The hospital is one of the three biggest hospitals in the city with an annual census of 36,000 patients. Retrospective analysis includes all patients diagnosed with RC following physical examination and KUB, USG, CT together with laboratory investigations in the university-based ED between February 2007 and February 2009. The patients were evaluated in the ED with detailed history, examination, urinalysis, electrolytes, complete blood count, and KUB. Abdominal USG and spiral abdominopelvic CT were performed when necessary. Patients younger than 15-year-old and those diagnosed with RC and received a recent treatment thereof were excluded from the study.

Hospital information system served as the data source for the cost analysis. The subcomponents of the costs are drugs (D), equipment charges (E), treatment (T), physicians' examinations and consultations (P), laboratory (L), and radiology (R). The costs charged in the ED were taken into account for those treated and discharged from the ED per se, and the hospital costs for the hospitalized patients were excluded from the analysis.

Annually averaged Euro currency was used to calculate costs recorded in new Turkish Liras (YTL) (1 Euro = 1.94 TL).

Statistical analysis

All data obtained in the study were recorded in and analyzed using the Statistical Package for Social Sciences for Windows, Version 11. Descriptive statistics included frequency, percentage, mean (±SD), median (min − max value), and range. The relationship between the total treatment cost and sex, the location (right and left) of the stone and hospitalization were analyzed using Mann–Whitney *U* test, while the link between the total treatment cost and size of the stone, age groups, and region of the stone were investigated with Kruskal–Wallis test. Multiple linear regression analysis was performed to determine independent risk factors for increased cost. Age, sex, the direction and location of the stone, stay times in the ED, and the total cost were included in the model. *P* values below 0.05 were considered statistically significant.

Results

The study included 574 patients eligible for the predefined criteria. Male patients constituted 64.1% ($n = 368$) of the sample. Male patients had a mean age of 40.9 (±14.3), while females averaged 38.9 (±15.1) (Table 1). Mean stone size was found to be 5.7 (±2.1) mm. A majority of the stones were located in the kidney and distal end of the ureter (Table 1).

Ultrasonography was the most commonly ordered radiological test in the sample (79.4%; $n = 456$), followed by KUB (47.6%; $n = 273$) and CT (26.5%; $n = 152$). As far as the diagnostic modalities, 51.2% of the patients ($n = 294$) were evaluated with a single method, 43.4%

Table 1 The distribution of the patients with respect to sex, age, characteristics of the stone, and outcomes

	N	Percentage
Sex		
Male	368	64.1
Female	206	35.9
Age		
18–29	144	25.1
30–39	167	29.1
40–49	108	18.8
>50	155	27.0
Stone size (mm)		
<5	175	30.5
5–6.99	260	45.3
≥7	139	24.2
Stone direction		
Right	310	54.0
Left	264	46.0
Stone location		
Renal	250	43.6
Ureter proximal	58	10.1
Ureter middle	58	10.1
Ureter distal	208	36.2
Stay time in the ED		
0–89 min	184	32.0
90–180 min	288	50.2
180 min and longer	102	17.8
Outcome		
Discharge from ED	546	95.1
Hospitalized	28	4.9
Total	574	100

Table 2 Total hospital costs and descriptive statistical data regarding patients with RC (based on average 2008 Euro currency) ($N = 574$)

Cost items	Total cost (Euro)				
	Mean	SD	Median	Min	Max
Medications	3.92	8.25	1.96	0	80.87
Medical equipments	0.81	2.38	0.19	0	23.59
Treatment costs	11.03	8.22	9.00	0	40.76
Physicians' fees for examinations and consultations	8.35	1.70	7.38	6.90	15.95
Laboratory investigations	9.04	8.97	4.57	0.71	67.41
Radiological investigations	22.62	22.19	12.06	5.34	152.11
Total	55.77	36.58	45.59	15.58	302.80

($n = 249$) underwent two, and 5.4% ($n = 31$) underwent three methods. Nearly four-fifth of the patients (79.4%; $n = 456$) were started intravenous lines in the ED, and 79.8% ($n = 458$) received fluid infusion. Non-steroidal anti-inflammatory drugs (NSAIDs) were administered in 86.8% ($n = 498$), while 4% ($n = 268$) received opiates for analgesia. Diclofenac sodium was the most commonly used NSAID, whereas meperidine ranked first among opiates. Urological consultation was ordered in 16.7% ($n = 96$), and 4.9% ($n = 28$) were admitted to the ward.

Mean total hospital cost in patients admitted to the ED due to RC was calculated to be 55.77 Euro (±36.58). The greatest contribution to the total cost was made by radiological investigations in the ED (40.5%) followed by treatment costs (19.7%) (Table 2).

As far as the variables affecting ED costs, the size and location of the stone and outcome (admission or discharge) were found to have the greatest impact on the figures. The lowest costs was associated with stones smaller than 5 mm and located in the kidney (Table 3).

Size and location of the stone and stay times in the ED were found to be independent risk factors for increased costs. It was shown that the more distal the stone, the higher the costs.

There was no patient admitted to the hospital in patients with stones smaller than 5 mm while the admission rates in groups of patients with stones between 5 and 6.99 mm and greater than 7 mm were 6.5 and 7.9%, respectively ($P < 0.001$). Patients with renal stones were more likely to be evaluated with CT compared to those with ureteral stones (frequency of CT orders in renal stones is 20.8%, proximal ureter 25.9%, mid ureter 48.2%, and distal ureter 27.9%). CT orders were also found to be significantly more frequent in the mid-portion of the ureter ($P = 0.0001$).

Table 3 Comparison of costs of RC cases with regard to some demographic and clinical variables

	Total cost					*P* value
	Mean	SD	Median	Min	Max	
Sex						
Male	56.52	36.89	46.14	15.58	297.65	0.45
Female	54.43	36.07	45.00	16.43	302.80	
Age						
18–29	54.94	41.55	43.73	16.42	302.80	0.148
30–39	53.98	27.63	47.95	19.82	214.42	
40–49	54.20	37.79	44.00	15.58	297.65	
>50	59.58	39.24	50.82	18.74	250.17	
Stone size (mm)						
<5	47.55	25.51	41.76	17.79	156.89	<0.001*
5–6.99	60.73	42.32	48.78	15.58	302.80	
≥7	56.87	35.22	47.17	18.25	195.54	
Stone direction						
Right	55.22	39.67	45.23	16.43	302.80	0.09
Left	56.43	32.64	47.01	15.58	231.12	
Stone location						
Renal	50.87	24.27	45.26	18.03	142.57	0.04**
Ureter proximal	57.22	38.13	50.23	15.58	174.35	
Ureter middle	68.19	42.71	54.44	19.82	195.54	
Ureter distal	57.80	44.90	43.81	16.43	302.80	
Outcome						
Discharge from ED	52.49	31.71	44.80	15.58	302.78	<0.001
Hospitalized	119.81	60.28	116.93	31.78	231.12	

* Binary comparisons revealed significant difference between stones <5 mm and the other two groups ($P < 0.001$, $P = 0.015$)

** Binary comparisons disclosed significant difference between renal stones and mid-ureter stones, as well as between stones situated in the mid-ureter and distal ureter ($P = 0.007$, $P = 0.008$)

Discussion

This study investigated ED costs of adult patients with RC and demonstrated that the mean cost was 55.77 (±36.58) Euros, while stone size and location and stay times in the ED were the independent variables affecting the costs. The costs were higher as the stones were bigger, and as they were more distal in the ureter. Renal stones were associated

with the lowest hospital costs. The lowest costs were associated with stones smaller than 5 mm and those situated in the kidney, while the highest costs were charged in patients in the middle ureter.

This is the first study conducted in our country on ED costs of patients with RC. In a previous study by Lotan et al. [5] on ED costs of treatment modalities in ten countries in Europe and America, our country ranked the lowest only after Germany. The costs ranged from 80 and 750 USD while the figure found in our country was 152 USD. The cost in the present study is 55.77 Euro (approximately 80 USD) which is much lower than the previous amount. The reason for this difference can be inclusion of recurrent admissions in the ED in the study by Lotan et al. and possible regional variations of the nature of the disease.

Urolithiasis usually develops when a person is between the ages of 20 and 40 years, and these patients will have a 50% chance of recurrence over 5 years. Men are inflicted 2–3 times more frequently than women. The percentage of male patients was twice that of women in the present study and nearly half the patients were those older than 40 years of age.

The costs can be expected to be higher with smaller stones, as additional imaging studies would be needed to figure out the culprit. However, the findings in the present study do not support this hypothesis. The present study showed that treatment costs of patients with stones smaller than 5 mm were lower than with bigger stones. This likely reflects the recalcitrant nature of the pain and the longer time to achieve pain control and need for more medications in these patients. Likewise, bigger stones have a tendency to cause more severe obstruction or hydronephrosis.

Another important result of this study is that renal stones caused lower costs compared to other locations. It can be explained with easier imaging of renal stones with cheaper modalities such as USG, and also rare utilization of additional medications to relieve pain, as these calculi seldom cause urinary obstruction. Ureteral stones, on the other hand, tend to be smaller and are difficult to visualize since the ureter is a non-parenchymatous organ, which leads to more frequent utilization of additional imaging studies. These factors all contribute in higher costs associated with ureteral stones.

Papa et al. [6] pointed out that significantly more investigations and more complex urological procedures and treatment modalities together with a more severe pain were associated with stones equal to and bigger than 6 mm and stones situated in middle ureter which are in accordance with the present study. Prina et al. [7] demonstrated that the stone size was a better prognostic marker than the severity of pain in RC and that advanced urological procedures and diagnostic modalities were employed more commonly in patients with stones equal to or greater than 6 mm. Patients with persistent or recurrent pain who are waiting for procedures are repeatedly seen in the ED; this contributes to an increased risk of complications for the patients, and increased health care costs and ED patient volumes.

American Urological Association (AUA) and European Association of Urology (EAU) guidelines (2007) determined that ureteral stones with a diameter of less than 5 mm will pass in up to 68% of cases. For stones >5 mm and ≤10 mm, 47% would pass spontaneously. For stones with diameters greater than 7 mm, the overall chance of spontaneous passage is low [8, 9]. Patients in the present study had stones smaller than 5 mm in 30.5% and smaller than 7 mm in 75.8% of the cases. This could have served as a contributory factor in low costs in the ED.

The findings of this study points out that imaging studies compose a major portion of the total hospital costs. Cupisti et al. [10] reported that ultrasound is the first line diagnostic study in patients suspected to have stone disease and RC and have not recommended tomography as the first choice as for financial reasons. On the other hand, Pfister et al. [11] advocated that tomography had a better economic outcome in patients with RC since it has high diagnostic accuracy, effectiveness, speed, lower risk, and slightly more costs when compared to intravenous urography. Another study recommended unenhanced spiral computed tomography in the initial radiological evaluation of stone disease and RC for its high diagnostic accuracy [12].

Ultrasound was the modality most frequently used in the present study (79.4%) followed by tomography. Nevertheless, radiological investigations are the greatest contributors in the ED costs in this study. The tendency to employ tomography in the first choice radiological investigation among the diagnostic procedures would augment costs in the ED. On the other hand, USG will help to yield significant cut-off in the expenditure. USG is postulated to alleviate total costs compared to CT; however, this characteristic was not analyzed in detail in the present study. For an acute renal colic due to stone, intravenous pyelography has been the gold standard. However, in recent years, unenhanced helical CT has been introduced as a quick and contrast-free alternative [13]. Although CT is more costly than ultrasound or IVU, the diagnosis, and a disposition, can be made quicker and obviates the need for additional imaging studies.

In the present study, admissions to the hospital have been found to be associated with greater costs. This likely reflects the recalcitrant nature of the pain and the longer time to achieve pain control and need for more medications in these patients. The findings also indicate that stay times in the ED is an independent factor affecting total costs.

This can be attributed to the number of investigations and additional treatment regimens to relieve pain. Previous studies put forth that nearly half of the patients with RC were admitted to the hospitals out of usual work hours. This fact can have increased the costs in the ED as there is no choice to receive healthcare other than the EDs, and almost all diagnostic and treatment modalities are performed in the EDs [14].

As far as the costs analysis, healthcare expenses related to RC or stone disease would be far more than it is thought to be, the relative or 'indirect' workforce losses are added to 'direct costs' examination, treatment, medications, etc. These findings warrant effective measures to be undertaken to reduce costs resulting from RC. Preventive measures as well as diagnostic and therapeutic procedures should be standardized in the ED in accordance with technological advances and also cost-effectiveness when appropriate.

References

1. Perlmutter A, Miller L, Trimble LA et al (1993) Toradol, an NSAID used for renal colic, decreases renal perfusion and ureteral pressure in a canine model of unilateral ureteral obstruction. J Urol 149:926–930
2. Brown J (2006) Diagnostic and treatment patterns for renal colic in US emergency departments. Int Urol Nephrol 38:87–92
3. Akinci M, Esen T, Tellaloglu S (1991) Urinary stone disease in Turkey: an updated epidemiological study. Eur Urol 20:200–203
4. Serinken M, Karcioglu O, Turkcuer I et al (2008) Analysis of clinical and demographic characteristics of patients presenting with renal colic in the emergency department. BMC Res Notes 16:79
5. Lotan Y, Cadeddu JA, Pearle MS (2005) International comparison of cost effectiveness of medical management strategies for nephrolithiasis. Urol Res 33:223–230
6. Papa L, Stiell IG, Wells GA et al (2005) Predicting intervention in renal colic patients after emergency department evaluation. CJEM 72:78–86
7. Prina LD, Rancatore E, Secic M et al (2002) Comparison of stone size and response to analgesic treatment in predicting outcome of patients with renal colic. Eur J Emerg Med 9:135–139
8. Segura JW, Preminger GM, Assimos DG et al (1997) Ureteral Stones Clinical Guidelines Panel summary report on the management of ureteral calculi. The American Urological Association. J Urol 158:1915–1921
9. Preminger GM, Tiselius HG, Assimos DG et al (2007) 2007 Guideline for the management of ureteral calculi. American Urological Association Education and Research, Inc; European Association of Urology. Eur Urol 52:1610–1631
10. Cupisti A, Pasquali E, Lusso S et al (2008) Renal colic in Pisa emergency department: epidemiology, diagnostics and treatment patterns. Intern Emerg Med 3:241–244
11. Pfister SA, Deckart A, Laschke S et al (2003) Unenhanced helical computed tomography vs intravenous urography in patients with acute flank pain: accuracy and economic impact in a randomized prospective trial. Eur Radiol 13:2513–2520
12. Greenwell TJ, Woodhams S, Denton ERM et al (2000) One year's clinical experience with unenhanced spiral computed tomography for the assessment of acute loin pain suggestive of renal colic. BJU Int 85:632–636
13. Kobayashi T, Nishizawa K, Watanabe J et al (2003) Clinical characteristics of ureteral calculi detected by non-enhanced computerized tomography after unclear results of plain radiography and ultrasonography. J Urol 170:799–802
14. Trinchieri A (2006) Epidemiological trends in urolithiasis: impact on our health care systems. Urol Res 34:151–156