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ORIGINAL ARTICLE

Epidemiology and treatment of inpatients urolithiasis in Taiwan



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Abstract *Background/Introduction:* Urolithiasis is a common disease with high prevalence and recurrence rates in Taiwan. A national survey in Taiwan determined that 9.6% of the population suffered stones throughout their lifetime.

Purpose/Aim: This study analyzed the epidemiological characteristics and patterns of inpatient treatment for urolithiasis and thus provides a reference for the implementation of future health strategies.

Methods: A cross-sectional study was conducted using data collected from the Inpatient Expenditures by Admissions and Registry for Contracted Medical Facilities files of the National Health Insurance Research Database. A total of 40,027 patients were included in the final data analysis. SPSS 22.0 statistical software was used to analyze the epidemiological characteristics and corresponding treatments for each patient group.

Results: The average age of the inpatients with urolithiasis was 52 ± 14 years, with a male-to-female sex ratio of 2.4:1. The highest admission rate occurred between July and August (10.4–10.6%). Ureteral stones were the most common (76.4%), followed by kidney stones (15.8%), bladder stones (7.5%), and urethral stones (0.4%). Moreover, 57.4% of the patients were treated at regional hospitals and 27.5% were treated at medical centers. Of the 4531 urolithiasis examinations conducted, 63.6% involved intravenous urography, 21.8% abdominal sonography, and 5.9% retrograde pyelography. In total, 13,610 treatments were performed in the 40,027 inpatients with urolithiasis, with a surgical treatment rate of 34%. Extracorporeal shock wave lithotripsy (ESWL) is the most commonly used treatment for patients with renal or ureteral stones with an annual medical expenditure of nearly NT \$3 billion. Regional hospitals conducted the highest number of ESWL treatment for inpatients with stones, whereas medical centers conducted more percutaneous nephrostomy lithotripsy than did regional hospitals.

Conflicts of interest: All authors declare no conflicts of interest.

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Conclusion: This study reveals patterns in the epidemiology and utilization of medical resources for inpatients with urolithiasis and provides a basis for the implementation of stone treatment guidelines in Taiwan.

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1. Introduction

Urolithiasis is a common urologic disease that is increasing in prevalence in many high-incidence nations.^{1–3} A national survey by Lee et al⁴ in Taiwan determined that 9.6% of the population suffered stones throughout their lifetime (male 14.5% vs. females 4.3%). Despite the complexity of the causes of urinary tract stones and the fact that some mechanisms remain unknown, studies have indicated age, sex, geography, season, climate, race, obesity, diabetes, and water intake to be risk factors.^{5–7} In recent years, the epidemiology of urolithiasis has changed in line with an improvement in social conditions, particularly in urban areas within more affluent developing countries. However, according to the scholar Bart, "... with the geographical distribution of urinary tract stones," people in specific geographic areas globally are more prone to urinary tract stones compared with those in other areas.⁸ In this respect, Taiwan is located in a geographical belt where urolithiasis is more likely to occur throughout the lifetime of the population, with a prevalence between 4% and 20% at a male-to-female sex ratio of 2:1. The old Arabian proverb "prevention is better than treatment" is relevant to urolithiasis, and a patient's understanding of the disease helps to lower the prevalence and associated costs. Although statistical studies on urolithiasis have already been conducted, this study focused on specific epidemiological groups and their corresponding treatments.

2. Materials and methods

This is a cross-sectional study, and data were obtained from National Health Insurance Research Database files, namely, Inpatient Expenditures by Admissions and Registry for Contracted Medical Facilities, published in 2010; information related to ICD-9-CM diagnostic codes 592.X and 594.X was selected. This study disregarded 192 patients with incomplete information and 75 patients associated with coding errors. Therefore, information related to a total of 40,027 patients was used in the final data analysis. The inpatients were divided into the following groups in accordance with the site of the stone: kidney stone, ureteral stone, bladder stone, and urethral stone. SPSS 22.0 statistical software (SPSS Inc., Chicago, IL, USA) was used to analyze the epidemiological characteristics and associated medical treatment among the different groups.

The results are expressed as the mean \pm standard deviation. Statistical analysis was performed using one-way analysis of variance and a Chi-squared test; a p value < 0.05 was considered significant.

3. Results

According to statistics obtained from the Taiwan Ministry of the Interior, in mid-2010, Taiwan had a population of 23,140,940. Of this number, 40,027 people were admitted for stone treatment in the year 2010 (at a ratio of 173/100,000 people). The predominant cause for admission was ureteral stones ($n = 30,577$, 76.4%), followed by kidney stones ($n = 6307$, 15.8%), bladder stones ($n = 2987$, 7.5%), and then urethral stones ($n = 156$, 0.4%; [Table 1](#)). The average age of inpatients with urolithiasis was 52.1 ± 14.2 years, with patients with bladder stones having a higher average age of 66.2 ± 14.1 years. According to the age chart ([Figure 1](#)), the majority of patients with stones were middle aged, and the number of patients with bladder stones increased with age. The male-to-female sex ratio was 2.4:1 for all patients with urolithiasis, 1.6:1 for patients with renal stones, 2.4:1 for patients with ureteral stones, 2.1:1 for patients with urethral stones, and 11.1:1 for patients with bladder stones.

For all patients with urolithiasis, the highest admission rate occurred between July and August (10.4–10.6%; [Table 1](#)), but the rate was lower in other seasons (5.3–9.4%; [Figure 2](#)). In addition, the lowest admission rate occurred in February, which is considered to be related to the Chinese New Year holiday and patients usually want to postpone treatment.

The patients' distribution was as follows: 41.5% in northern Taiwan (Taipei City, New Taipei City, Keelung City, Taoyuan, Hsinchu, and Miaoli County), 31.7% in central Taiwan (Taichung, Changhua, Nantou, Yunlin, and Chiayi County), 19.9% in southern Taiwan (Tainan, Kaohsiung, and Pingtung County), and 6.8% in eastern Taiwan (Hualien, Taitung, and Yilan County; [Table 1](#)). The outlying islands (Penghu, Kinmen, and Matsu County) had the smallest number of admissions for urolithiasis.

Of the 4531 urolithiasis examinations performed, 2880 (63.6%) were conducted using intravenous urography, 988 with abdominal sonography (21.8%), and 270 with retrograde pyelography (5.9%; [Table 2](#)). A total of 13,610 (34%) treatment procedures were performed in the 40,027 patients, and these procedures included extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrostomy lithotripsy (PCNL), endoscopic manipulation (ureteroscopy stone fragmentation and removal and cystoscopic electrohydraulic lithotripsy), and conventional open methods (nephrolithotomy, ureterolithotomy, and vesicolithotomy). Of these, ESWL was the most commonly used treatment for patients with renal or ureteral stones ([Table 2](#)); 53.1% (2697/5076) of patients with renal stones were treated by ESWL and 34.9% (1776/5076) by PCNL each year, and 61.4%

Table 1 Epidemiological characteristics of inpatients with urolithiasis in Taiwan (2010).

Location	Renal stone	Ureteral stone	Vesical stone	Urethral stone	Total	<i>p</i>
Case No. (%)	6307 (15.8)	30,577 (76.4)	2987 (7.5)	156 (0.4)	40,027 (100)	
Admission prevalence (1/100,000)	27.3	132.1	12.9	0.7	173.0	<0.001
Mean age (y)	53.5 ± 13.7	50.4 ± 13.5	66.2 ± 14.1	50.1 ± 16.6	52.1 ± 14.2	
Sex (%)						<0.001
Male	3844 (60.9)	21,514 (70.4)	2741 (91.8)	105 (67.3)	28,204 (70.5)	
Female	2463 (39.1)	9063 (29.6)	246 (8.2)	51 (32.7)	11,823 (29.5)	
Mo (%)						<0.001
January	527 (8.4)	2161 (7.1)	181 (6.1)	6 (3.8)	2875 (7.2)	
February	317 (5.0)	1643 (5.4)	168 (5.6)	8 (5.1)	2136 (5.3)	
March	632 (10.0)	2450 (8.0)	257 (8.6)	13 (8.3)	3352 (8.4)	
April	509 (8.1)	2337 (7.6)	235 (7.9)	15 (9.6)	3096 (7.7)	
May	599 (9.5)	2781 (9.1)	266 (8.9)	11 (7.1)	3657 (9.1)	
June	522 (8.3)	2611 (8.5)	243 (8.1)	16 (10.3)	3392 (8.5)	
July	635 (10.1)	3215 (10.5)	304 (10.2)	16 (10.3)	4170 (10.4)	
August	537 (8.5)	3384 (11.1)	309 (10.3)	24 (15.4)	4254 (10.6)	
September	552 (8.8)	2953 (9.7)	259 (8.7)	13 (8.3)	3777 (9.4)	
October	532 (8.4)	2759 (9.0)	277 (9.3)	9 (5.8)	3577 (8.9)	
November	486 (7.7)	2153 (7.0)	240 (8.0)	16 (10.3)	2895 (7.2)	
December	459 (7.3)	2130 (7.0)	248 (8.3)	9 (5.8)	2846 (7.1)	
Area (%)						<0.001
Northern	2597 (41.2)	12,740 (41.7)	1190 (39.8)	90 (57.7)	16,617 (41.5)	
Middle	1999 (31.7)	9864 (32.3)	783 (26.2)	31 (19.9)	12,677 (31.7)	
Southern	1102 (17.5)	6043 (19.8)	778 (26.0)	28 (17.9)	7951 (19.9)	
Eastern	606 (9.6)	1888 (6.2)	221 (7.4)	7 (4.5)	2722 (6.8)	
Islet	3 (0.0)	42 (0.1)	15 (0.5)	0 (0.0)	60 (0.1)	
Medicare unit (%)						<0.001
Medical center	2323 (36.8)	7885 (25.8)	777 (26.0)	15 (9.6)	11,000 (27.5)	
Regional hospital	3322 (52.7)	17,946 (58.7)	1607 (53.8)	85 (54.5)	22,960 (57.4)	
Local hospital	662 (10.5)	4746 (15.5)	603 (20.2)	56 (35.9)	6067 (15.2)	

Data are presented as mean ± standard deviation (range).

(4960/8079) of patients with ureteral stones were treated by ESWL and 30.7% (2481/8079) by endoscopic removal. For patients with vesical or urethral stones, endoscopy was the primary treatment.

We determined that 55.5% (7554/13,610) of treatment procedures were undertaken in regional hospitals, 34.2% (4653/13,610) in medical centers, and 10.3% (1403/13,610) in local hospitals (Table 3). Regional hospitals had the highest ESWL treatment rate overall (4938/7657, 64.5%), whereas medical centers conducted more PCNL than did

regional and local hospitals (53.6% vs. 42.9% and 3.5%). Regional hospitals also had the highest rate of performing open surgical methods for stone removal than did medical centers and local hospitals (51.8% vs. 34.1% and 14.1%).

4. Discussion

The lifetime prevalence of kidney stones is approximately 10% in developed countries. The condition most commonly

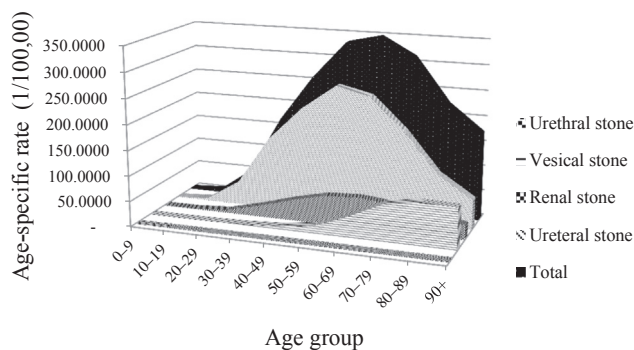


Figure 1 Distribution of inpatients with urolithiasis by age group in Taiwan (2010).

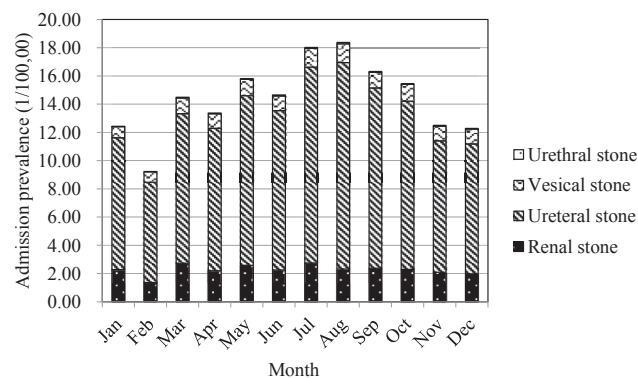


Figure 2 Distribution of inpatients with urolithiasis by type and season in Taiwan (2010).

Table 2 Urolithiasis inpatient examination and surgical treatment methods (Taiwan 2010).

	Renal stone	Ureteral stone	Vesical stone	Urethral stone	Total
Study					
Intravenous urography	343	2434	69	34	2880 (63.6)
Abdominal sonography	175	750	56	7	988 (21.8)
Retrograde pyelography	90	158	14	8	270 (5.9)
Kidneys—ureters—bladder radiograph	39	168	39	1	247 (5.5)
Computerized tomography scan	44	83	19	0	146 (3.2)
Total	691 (15.2)	3593 (79.3)	197 (4.3)	50 (1.2)	4531
Surgical treatments					
Extracorporeal shock wave lithotripsy	2697	4960	0	0	7657 (56.3)
Percutaneous nephrostomy lithotripsy	1776	200	0	0	1976 (14.5)
Endoscopic manipulation	511	2481	291	12	3295 (24.2)
Open surgery	92	438	151	1	682 (5.0)
Total	5076 (37.3)	8079 (59.4)	442 (3.2)	13 (0.1)	13,610

Data are presented as *n* or as *n* (%).

Table 3 Therapeutic procedures performed for inpatients with urolithiasis in Taiwan at different types of treatment centers.

	Medical center	Regional hospital	Local hospital	Total
Extracorporeal shock wave lithotripsy	1768	4938	951	7657 (56.3)
Percutaneous nephrostomy lithotripsy	1059	848	69	1976 (14.5)
Endoscopy	1593	1415	287	3295 (24.2)
Open methods	233	353	96	682 (5.0)
Total	4653 (34.2)	7554 (55.5)	1403 (10.3)	13,610

Data are presented as *n* or as *n* (%).

affects people in midadulthood,^{3,9,10} and incidence rates have been increasing in many countries in recent years.^{11–13} Because Taiwan is a region with high prevalence, with a total prevalence of 9600/100,000 people and an admission prevalence of 173.3/100,000,⁴ stone treatment has become a major problem for the Health Insurance Department because of both the high prevalence of urolithiasis and its recurrence rate.

Although most people with urolithiasis are treated effectively, approximately 40% experience recurrence, with some experiencing relapse up to five times.¹⁴ In Taiwan, the stone recurrence rate is 6.12% for the 1st year, but this rate increases to 34.71% within the first 5 years.¹⁵ Our data show that patients admitted for stone treatment had an average age of 52.1 years and that >70% were men. In addition, peak admission times were in spring and summer, as confirmed by a previous report,¹⁶ and this is presumably due to the rapid loss of body fluid in a hot climate when reduced urine output results in a high urine concentration and easy crystal aggregation.¹⁷ Eisner et al¹⁸

reported that high temperatures increase urinary excretion of calcium, resulting in calcium oxalate and calcium phosphate supersaturation, thereby increasing the risk of stone formation. More than 70% of the patients studied lived in midnorthern Taiwan; this number is considered to be attributed to multiple factors such as the higher population density, differing Medicare approaches, and the availability of Medicare resources within the various regions. The prevalence of pediatric urolithiasis in Taiwan was 0.047% in 2005, which was much lower than that of adults¹⁹; the peak age of pediatric stone occurrence was 15–18 years and was most commonly associated with urinary tract infection. However, similar to the occurrence rate of adult urolithiasis, that of pediatric urolithiasis correlates significantly with the urbanization level and geographic area.

In our study, >76% of the inpatients were admitted for ureteral stones, either with acute renal colic or obstructive and complicated urinary tract infection, or other comorbidities. Of the inpatients with stones, 57% were admitted to regional hospitals, whereas medical centers had the highest admission rates for inpatients with renal stones compared with regional hospitals (21% vs. 14%), which may reflect the higher rate of PCNL treatment due to the larger stone burden with comorbidities such as infection or obstruction.

Stone occurrence in the urinary bladder or urethra is relatively rare (<10%) and is mostly caused by prostatic hyperplasia or a neurogenic bladder in relation to long-term catheterization in elderly people. Most of these stones were treated endoscopically using various forms of lithotripter, and few patients underwent stone removal via operative methods.

In 2010, intravenous urography was the most commonly used method for stone evaluation, followed by computerized tomography scanning as the secondary choice. Currently, noncontrast computerized tomography scanning is gradually being implemented as a first-line screening tool for renal colic patients in the emergency department.

The National Health Insurance Bureau Statistics reveal that more than NT \$2 billion has been spent on ESWL monotherapy for patients with urolithiasis in Taiwan since

2004 every year, and that >60,000 patients receive ESWL treatment each year. In 2011, a total of 64,386 patients received ESWL treatment for urolithiasis, accounting for a total number of 87,646 ESWL treatments (average 1.36 times/person) and costing over NT \$2.8 billion. However, in 2010, only 7657 ESWL treatments were conducted on inpatients with urolithiasis, indicating that >90% of ESWL treatments occurred in outpatient clinics.

High stone recurrence rates combined with expensive treatment costs place a similarly significant burden on the health-care system in the United Kingdom, and the management of stone diseases comprises a significant and increasing proportion of urological practice, with implications for workforce planning, training, service delivery, and research in this field.^{16,20,21} Turney et al¹¹ reported that the number of hospitalizations related to upper urinary tract stone episodes increased from 63% to 83% in the 10-year period from 2000 to 2010, and that the use of ESWL for upper tract stones increased from 14,491 cases to 22,402 cases (a 55% increase), with a 69% increase in lithotripsy for renal stones in the United Kingdom. However, the use of ESWL is four times higher in Taiwan than in the United Kingdom in 2010, which may be a result of the differing treatment guidelines between these two countries.

In the United States in the year 2000, urolithiasis was the cause of nearly 2 million office visits, 600,000 emergency room visits, and >177,000 hospitalizations, totaling more than US \$2 billion in annual expenditures.²² The cost appears to be increasing despite a shift from inpatient to outpatient treatment and the emergence of minimally invasive treatment methods, and this increase is considered to be related to an increase in the prevalence of stone disease. Between 1994 and 2000, the rate of hospitalization for urolithiasis decreased by 15%, the length of stay decreased from 2.6 days to 2.2 days, and outpatient visits increased by 40%; in addition, between 1992 and 2000, physician office visits increased by 43%.²³ However, in 2010 in Taiwan, 40,027 patients were admitted for urolithiasis treatment out of a total population of 23 million, which is proportionately higher than the rate in the United States¹¹; this difference may be attributed to either the complexity of the disease or the difference in health-care systems. By 2010 in Taiwan, diagnosis-related group items had not yet included inpatient urolithiasis treatment, and therefore, this would have had no direct effect on the inpatient and outpatient ratio. Nevertheless, since its inclusion, a certain percentage of complex patients may have received inpatient treatment and this would thus have had a direct influence on the ratio of inpatients and outpatients. In 2010, the National Health Insurance coverage rate rose to 99.51%, and the case study of urolithiasis inpatients presented here may reflect the state of the Taiwanese health-care system as a whole. However, limitations still exist as only 1 year of data have been available from our database in Taiwan and a serial comparison is lacking.

4.1. Conclusion

In conclusion, from our analysis of data published in 2010, we determined that higher admission rates and usage of

ESWL were two primary characteristics of urolithiasis treatment in Taiwan. This study provides information for use in medical resource allocation for urolithiasis patient admissions, and it can be used as a guideline for strategizing and improving stone treatment in the future.

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