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ARTICLE

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Epidemiological trends in urolithiasis: impact on our health care systems

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Abstract The progressive increase of the social cost for treating urolithiasis could be related to an increased incidence of the disease and/or to an increase of costs for diagnosing and treating renal stones. In the course of the last century, the incidence of renal stones has progressively increased in Europe, North America, and other industrialised countries. This has been explained in terms of changing social conditions and the consequent changes in eating habits. In contrast, renal stones were less frequent than in developing countries of the world but in the last 20 years investigators began to report high incidences of upper urinary stone disease also from some areas of the Third World concurring with the changing of economic and social conditions. Each stone episode involves the costs for emergency visits, diagnostic work up, and medical or surgical treatment. Furthermore, we have to consider the costs of follow-up visits and the costs of testing and drugs for stone prevention. In adjunct of direct costs for diagnosis and treatment, we should also take into account the indirect individual and social cost of workdays lost. Finally, we should estimate the costs of complications and outcomes of treatment with particular attention to the costs of chronic renal failure secondary to stone disease. The strategy of treatment of each stone centre involves different costs for the treatment of each single stone episode. On the other hand the choice of treatment can be driven by National Health Systems and insurance companies by their policy of reimbursement for different procedures. The trends of renal stone incidence will have different impact on health care systems in different countries. In Europe and North America, the peak of incidence has been probably reached but the increase of costs for diagnosing and treating each single stone episode will still increase the social cost for managing stone disease. For this reason the actual objective should be to optimise protocols avoiding redundant or expensive diagnostic procedures or inappropriate treatments. In developing countries, the incidence of stone disease is still increasing and it could reach peaks even higher as a consequence of hot climate in some geographical areas. In those countries the demand for treatment of symptomatic stones could dramatically increase involving a huge financial outlay.

Keywords Urinary calculi · Epidemiology · Economics · Cost benefit

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Introduction

The cost of each incident of stone disease in the United States was estimated for the year 1985 to be approximately $2,000, exclusive of recurrences [1]. Costs were estimated by considering hospital costs (number of surgeries, cost of various types of surgery, number of days hospitalized, and room rates) and costs of work force lost (workdays lost and income categories). On this basis, the annual cost for the United States due to kidney stones was calculated to be about $315,000,000.

Ten years after, in 1993, the annual cost for treating urolithiasis in the United States was estimated to be at least $1.83 billion [2].

The progressive increase of the social cost for treating urolithiasis could be related to an increased incidence of the disease and/or to an increase of costs for diagnosing and treating renal stones.

In fact the total costs for treating urinary stone disease in a given territory (village, town, region, state) are a difficult estimate. Each stone episode involves the costs for emergency visits, diagnostic work up, and medical or surgical treatment. Furthermore, we have to consider the costs of follow-up visits and the costs of testing and drugs for stone prevention. In adjunct of direct costs for diagnosis and treatment, we should also take into account the indirect individual and social cost of workdays lost. Finally, we should estimate the costs of complications and outcomes of treatment with particular attention to the costs of chronic renal failure secondary to stone disease.

On the basis of the estimated local cost for a single incident of stone disease, a projection of the costs for the entire territory can be made knowing the local annual incidence rate of symptomatic urinary stone episodes and the local health policy in relation to stone treatment.

In the absence of a precise knowledge of all these elements the estimates are necessarily approximated and the simple projection of cost to different regions on the basis of the number of inhabitants (even knowing the local incidence rate of stone disease) could be misleading, being the cost different in relation to a different health policy and to different local costs for diagnosis and treatment.

Incidence and hospitalisation rate of urinary stone disease

The current trends in urolithiasis epidemiology are described by numerous surveys conducted in various countries [3].

Europe

In the nineteenth century, primitive bladder stones unassociated with stasis and bladder neck obstruction were relatively frequent in Europe. Bladder stones affected mainly adults but 20–30% of cases occurred in the paediatric age group. Stones were 50% ammonium urate (the nucleus of the stone) while the rest was calcium oxalate. In the period between 1829 and 1839, the incidence of hospitalisation for urinary stones in Great Britain was estimated to be 0.001% [4].

In the course of the last century, there has been a gradual decrease in the incidence of bladder stones in Europe, while reno-ureteral stones typical of adult age and composed mainly of calcium oxalate and calcium phosphate have become more common.

This has been explained in terms of changing social conditions and the consequent changes in eating habits. Indeed, in the last century, poverty and infantile malnutrition have gradually disappeared in Europe, while affluence has spread to all social classes, and with it, the tendency to eat protein-rich food in large quantities.

The increased incidence of reno-ureteral stones has tended to involve firstly the more northerly European nations, where it occurred earlier and with greater intensity.

Scandinavia

In Scandinavia, the only interruptions in the upward trend in the incidence of renal calculosis coincided with periods of economic depression: the First World War, the slump of the thirties, and the Second World War. The annual incidence of renal calculosis in the Oslo population rose from 0.118% in 1940 to 0.3% in 1960 [5]. In the province of Uppsala, Hedenberg [6] noted a hospitalisation incidence of 0.00919% in 1911–1914, 0.0829% in 1935–1938, 0.0701% in 1939–1942, and 0.0745% in 1943–1946. In Finland, a 100-fold increase in the incidence of hospitalisation for urolithiasis compared with the total population was reported, from 0.0003% in 1885–1918 to 0.03% in 1953–1954, with an increase from 4.8 to 60% in cases of calcium oxalate calculi and a reduction in the proportion of calculi due to infection [7]. In the period between 1960 and 1980, the prevalence rate of upper urinary stone disease in Scandinavia was estimated to be between 10 and 20% for males and 3 and 5% for females in Scandinavia with annual incidence rates of hospitalisation for urinary calculi up to 200/100,000 inhabitants/year [8].

UK and Central Europe

Incidence and prevalence of renal stones in the UK and Central Europe confirmed the trend observed in Scandinavia, although with lower figures. The annual hospitalisation incidence was estimated at 0.068% in Scotland in 1957–1961 [9], at 0.035% in Sheffield, England, and at 0.056% in Wales in 1978 [10]. On the basis of a multicentre study involving 18 British towns, Power et al. [11] estimated the annual incidence of cases of calculosis between 0.015 and 0.056%. The prevalence rate was estimated at 3.5–3.8% [12–15].

In Western Germany, Hesse et al. [16] calculated the prevalence rate of nephrolithiasis at 5%.

Southern Europe

In the southern regions of Italy, the incidence of hospitalisation for primitive vesical calculosis in children, still relatively high in the 1920s, gradually decreased in the period before the Second World War and then rose sharply during the war corresponding to a period of serious alimentary deficiency. Only in the post-war period thanks to international food aid, the incidence of the disease gradually decreased until its disappearance in the 1960s [17]. In the 1960s, adult renal stones mostly calcium oxalate stones had become more frequent in Italy. The annual hospitalisation incidence gradually increased from 0.049% in 1954 to 0.097% in 1974 and the total annual incidence of urolithiasis in the working population increased from 0.16% in 1954 to 0.2% in 1964 and to 0.3% in 1974 [18]. The prevalence rate of nephrolithiasis has been determined at 5.9 and 6.1%, respectively, in Milan in 1986 [19] and in Parma in 1990 [20], whereas an increase of the prevalence from 5.9 to 9% was observed from 1986 to 1998 in the province of Milan [19].

A similar trend was observed in Portugal where an 8.3% prevalence rate of renal stone was reported in 1995 [21].

Eastern Europe

The prevalence of renal stone disease in Eastern Europe reflects the lower level of affluence of these regions in comparison to other European countries. In the last 10 years, as a consequence of the improved economic and social conditions, increased rate of incidence and prevalence were reported from some countries of East Europe [22, 23].

North America and Japan

The epidemiologic trend of urolithiasis in North America was similar to that observed in Scandinavia reflecting the elevated level of affluence reached in those regions since the pre-war period.

In the United States, the annual hospitalisation incidence was an estimated 0.0947% in 1948–1952 [24], but 20 years later, Sierakowski [25] observed an incidence of 0.164% and more recently Curhan reported a 0.273–0.326% total annual incidence of urolithiasis in a population of 45,000 male health care operators aged >40 years [26]. Prevalence rates of 12 and 18.5% (age-adjusted) were observed, respectively, in Rochester in 1979 (Minnesota) [27] and in Tennessee in 1991 [28].

In Newfoundland (Canada), the annual hospitalisation incidence for urolithiasis in 1972 was found to be 0.244% and the prevalence 15.5% [29].

In Japan, the prevalence of renal stones is similar to that observed in Western countries with a lifetime risk of forming a stone of 10% [30].

Third World

Endemic infantile vesical calculosis with characteristics similar to those described in Europe in the nineteenth century is still widespread in some regions of Asia and North Africa, with calculi composed of ammonium urate and calcium oxalate and 80% of paediatric cases. Vesical calculosis is frequent in many areas of Turkey, Iran, India, China, Indochina, Indonesia, Tunisia, and Sudan, although the incidence is decreasing in proportion as social conditions gradually improve.

Until the 1990s, reno-ureteral calculosis was less frequent than in Europe, North America, Australia, and Japan.

On the contrary, in the last 20 years investigators began to report a high incidence of upper urinary stone disease also from some areas of the Third World concurring with the changing of economic and social conditions.

In Saudi Arabia, where economic and social conditions and eating habits are now similar to those of the Western countries, a high prevalence of nephrolithiasis is reported. The very hot and dry climate could be a further risk factor for renal stones. Robertson estimated a 20% lifetime risk of forming a renal stone, in fact, not very different or even higher than the European or North American rates [31]. Increased prevalence rates of renal stone disease were recently reported also from Turkey (14.8%) [32], Taiwan (9.8%) [33], Brazil (5%) [34], and India (4%) [35].

Estimate of costs for diagnosing and treating stone disease

Emergency treatment

The expense of diagnosis and treatment for emergency cases presenting with renal colic attack is rarely taken into consideration, although relevant considering the number of cases in a year.

Li et al. [36] examined the charts of 159,083 emergency visits to a community emergency department for 48 months extrapolating 397 (0.25%) consecutive patients presenting with painful urolithiasis. Most patients were male (73%), in the fifth decade of life (mean age 47 years), had stones in the mid ureter (32%) or at the ureterovesicular junction (44%) and received opiates for pain control (91%). The diagnosis was made by non-contrast helical computed tomography in half of the patients, while in the remaining 50% by intravenous pyelography (IVP).

Protocols for emergency work up of patients presenting with a renal colic attack are different in any institution. Emergency visit can consist of a simple physical examination with prescription or administration of analgesic treatment or imply a complete diagnostic evaluation including lab testing, renal ultrasound, or X-ray. The reasons for a different approach could be related to organisational and economic consideration. As a consequence, the estimated cost of the emergency room visit for a stone episode could range from $30 to $400 in different countries [37].

Some protocols include IVP or non-contrast helical computed tomography, which improve the diagnostic accuracy but considerably increase the costs.

The cost of IVP and CT was, respectively, estimated to be $445 and $1,409 by Li et al. [36], while Chandoke et al. [37] reported an estimated cost for non-contrast helical computed tomography ranging from $50 to $686 in different countries.

Furthermore it has to be considered that about 50% of the patients with a renal colic attack present to the hospital between 5 p.m. and 7 a.m. when the radiology departments are generally available only for emergency imaging.

At our institution the protocol for the diagnosis and treatment (PDT) of patients presenting with renal colic attack includes medical history, physical examination, and laboratory tests. A visual analogue scale is administered to the patients to score the intensity of flank pain and treatment with diclofenac or opiates is offered to the patients in order to reduce pain. After an observation of up to 6 h the patients are evaluated to score the pain with the visual analogue scale: if the pain disappeared or reduced to at least 50% the patient is dismissed with appointments for abdominal ultrasound and follow-up visit within 48 h. In the case of resistant pain, solitary kidney, renal insufficiency, fever, or elevated white blood count the patient is hospitalised.

Treatment costs

The reported costs of surgical management of stones vary in consideration of the method applied for estimating costs: billing charges, evaluation of institutional costs, or reimbursement by National Health Care or maximal insurance reimbursement.

Chandoke et al. [37] conducted an international survey involving ten countries to compare the costs of various treatment options of kidney stone disease.

Reported costs in Europe (mainly on the basis of National Health Care reimbursement fare) for shock wave lithotripsy (SWL) and ureterorenoscopy (URS), respectively, ranged from $360 to $2,740 (mean $1,311) and from $160 to $1,900 (mean $1,154). The costs estimated in the United States on the basis of billing charges were much higher being $9,924 and $8,108, respectively, for SWL and URS, considering that the costs reported from Canada on the basis of an evaluation of institutional costs were $750 for both SWL and URS.

Institutional costs in Japan and Turkey were, respectively, $2,490 and $373 for SWL and $1,527 and $491 for URS.

Treatment options

The strategy of treatment of each stone centre involves different costs for the treatment of each single stone episode. On the other hand, the choice of treatment can be driven by National Health Systems and insurance companies by their policy of reimbursement for different procedures.

Routine indications for a specific treatment are well known and widely accepted, but alternative options can be considered in the case of distal ureteral stones or staghorn kidney stones or lower pole kidney stones [38].

Distal ureteral stones can be successfully treated by SWL or URS, but the cost-effectiveness of the two modalities should be considered. Both procedures have similar duration of treatment (<1 h) and morbidity (outpatient procedure in most countries) and similar costs, but URS is superior to SWL in terms of time to stone-free status and retreatment rate. Furthermore, the cost of ancillary procedures and the higher number of follow-up visits and imaging studies to ascertain the stone-free status of the patient increase the final cost of SWL. The efficacy of SWL is also dependent on the lithotripter used, in fact most of the second and third generation lithotripters are not able to compare the results of Dornier HM3.

The percutaneous nephrolithotomy (PCN) combined to SWL proved to be more cost effective than other treatments for staghorn stones with a surface greater than 500 mm^2, whereas SWL (first generation lithotripter) and PCN were equally effective for stones with a surface lower than 500 mm^2.

The SWL is more cost effective than PCN for lower pole stones <1 cm, but the opposite is true for stones >2 cm. Stones of 1–2 cm could be conveniently treated by Dornier HM3, but second and third generation lithotripter could have a limited effect for such stones.

Finally, limitations of treatment should be considered in order to avoid inappropriate therapy as in the case of silent calyceal or calyceal diverticula stones, medullary sponge kidney, or asymptomatic residual fragments after SWL [39].

Follow-up and prevention

Some authors evaluated the cost-effectiveness of medical prevention of renal stone disease.

Parks and Coe [40] estimated that medical stone prevention could result in an average saving of $2,158 ± 500 patient/year, which is the difference between an expenditure of $1,068 patient/year on yearly drugs and testing and a reduction of $3,226 per patient in medical costs.

Chandoke et al. [37] calculated the various stone frequencies at which medical prophylaxis becomes cost effective on the basis of the costs reported for treating urinary stone disease in different countries. It was pointed out that even considering a very high rate of urological intervention (60%) the lowest stone recurrence rate at which medical prophylaxis becomes cost effective is a stone frequency of 0.32 stone episodes/year (about once every 3 years).

We previously reported that pharmacological prevention of stone disease is cost effective only for patients with a recurrence rate >0.5 stone episodes/year/patient [41].

Tiselius suggested to individualise the strategy of prophylaxis on the basis of the severity of stone disease and the presence of residual fragments after SWL. An annual saving of 1,875 euros/year/patient was calculated for patients with an annual stone rate of 0.2 [42].

Also Strohmaier and Robertson demonstrated that medical management of recurrent stone formers could be cost effective [43, 44].

Complications and outcomes

Chronic renal insufficiency was a relatively frequent complication of infection or struvite stones, whereas metabolic stones rarely imply the development of renal failure, apart from stones associated with other renal diseases such as cystinuria, oxalosis, renal tubular acidosis, and myeloma.

It was estimated that end-term renal failure of 1.4–2.5% of patients on dialitic treatment [45–47] has been caused by infection stones.

In past years infection stones treated conservatively were associated with a mortality rate of 28–30% [48, 49].

The improvement of medical and surgical treatment of renal stones and particularly the application of newer endoscopic and extracorporeal treatments improved the prognosis of infection stone disease, reducing the risk of chronic renal insufficiency associated with infection stones. However, in less developed countries or in people who cannot afford appropriate medical treatment the risk of developing chronic renal insufficiency secondary to infection staghorn stones still persists [50]. Individual and social cost of dialitic treatment or of transplantation for such patients should be considered when computing the costs of renal stone disease.

Conclusions

The increase of incidence of renal stones will have a different impact on health care systems of different countries.

In Scandinavia and North America, the peak of incidence has been reached in the 1980s while in other European or non-European countries (Australia, Japan, Corea, Taiwan, Saudi Arabia) about 10–20 years later.

The increase of costs for diagnosing and treating each single stone episode will still increase the social cost for managing stone disease. For this reason the actual objective should be to optimise protocols avoiding redundant or expensive diagnostic procedures or inappropriate treatments.

In other developing countries (Eastern Europe, India, and China), the incidence of stone disease is still increasing and it could reach peaks even higher as a consequence of the hot climate in some geographical areas. In those countries the demand for treatment of symptomatic stones could dramatically increase involving a huge financial outlay.

Educational campaigns with the intent of modifying dietary habits in order to prevent stone formation could be a way for reducing the economic impact of the disease on our health care systems.

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