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REVIEW

Economics of stone disease/treatment

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Urolithiasis;
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Urinary stone disease;
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Metaphylaxis

ABBREVIATIONS

PCNL, percutaneous nephrolithotomy;
URS, ureterorenoscopy; DRG, diagnosis-related group

Abstract ***Objectives:*** Urolithiasis is a considerable economic burden for health systems, especially in industrialised countries where the incidence of stone disease has increased during the last few decades, and probably will further increase for several reasons.

Methods: The survey was based on investigations in collaboration with a German health insurance company and on a literature search (PubMed, and the author's collection of proceedings of urolithiasis conferences: The keywords included economics, cost, urolithiasis, nephrolithiasis, renal stone disease, metaphylaxis, recurrence) during 1999–2011. In all, 1221 articles were found but only those cited here were sufficient for the purpose of the study. Due to the nature of the subject it is not possible to give levels of evidence, as economic data on stone treatment cannot be obtained with randomised studies.

Results: The costs for the treatment and diagnosis of stones vary tremendously among different healthcare systems. Several calculation models showed that metaphylaxis is medically and economically effective when used rationally. Rational metaphylaxis is restricted to patients with a high risk of recurrence (brushite, uric acid, cystine and infected stones, patients with residual fragments after stone treatment and recurrent calcium oxalate stone formers).

Conclusions: For the groups identified, metaphylaxis is cost-effective in almost all healthcare systems, but the cost saved differs. The savings increase even more when

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adding the economic loss avoided from days off work due to treatment of recurrent stones. In most countries, stone frequency must exceed one stone per patient per year before medical therapy is more cost-effective than dietary measures.

Introduction

In industrial countries the incidence of urolithiasis has increased significantly during the last few decades [1]. In 1995 the total cost for urolithiasis in the USA was estimated to be $1.83 billion [2]. The expenses for the treatment of stone disease increased between 1994 and 2000 by 50% [3]. Saigal et al. [4] estimated the expenditures for urolithiasis at $6500 per year. This is an enormous burden for healthcare systems, and there are several reasons for this development.

ESWL has revolutionised the therapy of urolithiasis; it is a noninvasive treatment with only few side-effects [5]. During the last decades, endoscopic stone therapy had developed into a very effective and minimally invasive treatment with a low complication rate. As to the ease of these therapies, many urologists have challenged the role of metabolic evaluation and metaphylaxis in renal stone disease [6]. Why should patients tolerate cumbersome dietary restrictions and medical treatment, when physicians could treat the recurrent stone when it occurs?

There are several good medical reasons for metaphylaxis against stones. The recurrence rate is probably higher after ESWL [7], and ESWL is not without side-effects [5]. Of all recurrent calcium stone formers, 20% eventually develop renal insufficiency [8]. Urolithiasis increases the risk of arterial hypertension [9,10]. Apart from medical arguments for metaphylaxis, the economic perspective plays an ever increasing role in developing therapeutic strategies.

Costs for stone removal (surgical management)

A comparison of different healthcare systems

So far, there are only a few reports of the actual cost of stone removal, most of which are estimates. In 1995 (in the USA), the costs for the treatment of a ureteric and a renal stone were estimated at €2500 and €3000, respectively [11]. Between 1994 and 2000, the total annual expenditure for stone treatment in the USA increased by 50%. In 2000, the total costs were estimated at $2.1 billion annually [3]. By far most of this was spent on surgical treatment (stone removal). The costs for a stone therapy episode in 2002 were about $10,000 for ESWL and $8000 for ureteroscopy/laser lithotripsy, which is the highest in the world when compared with other healthcare systems. Other estimates were reported by Saigal et al. [4], at $2300 for ESWL, $1450 for ureteroscopy and $3625 for percutaneous nephrolithotomy (PCNL).

With climate change, an increase in the prevalence of urolithiasis is predicted with increasing global temperature (about 4% per °C). Annual stone-related healthcare costs will increase by 25% in 2050 over the present costs [12].

For Sweden (1991) the average cost for renal/ureteric stone therapy was €2900 per episode [13]. For Great Britain, another publication [11] assessed the average cost at €3520. Chandhoke [14] estimated the cost for ESWL and ureteroscopy at $2740 and $926, respectively.

For the first time in Germany, some years ago values were obtained for the cost of stone treatment. In a district of a German social healthcare insurance company with 150,000 insured people, in 1997 the actual cost for inpatient renal and ureteric stone therapy was €5907 per case. In 1997, there were 426 patients off work in this district due to urolithiasis (ICD-10 code 20), i.e. ≈300 urolithiasis cases per 100,000 people. Of the 426 patients, 293 (68.9%) with renal stone disease were hospitalised, the others being treated as outpatients. This is in accordance with a previous estimate of 75% of patients requiring hospitalisation [15,16].

In the USA, the number of stone patients per year is estimated at 485/100,000 people, a rate in accordance with that found in Germany. However, in the USA only 140 admissions to hospital (of 100,000 people) were estimated (29%) [11]. The number of admissions decreased by 15% between 1994 and 2000, but hospital outpatient and physician office visits increased by 40% and 43%, respectively [3]. In Sweden during the early 1980s, 140 stone formers (per 100,000 people) were seen, with 38% requiring hospitalisation [17].

In Germany, a new reimbursement system with the introduction of diagnosis-related groups (DRGs) changed the situation when compared to the calculation model mentioned above. The costs are now related to stone location and treatment method. For the author's hospital (Klinikum Coburg), the reimbursement for ESWL is €1873, for PCNL is €3173, for ureterorenoscopy (URS) in the kidney is €2514, and for ureteric stones is €1918. The values for PCNL and URS can go up to €6138 and €3695, respectively, in complicated cases. Repeated treatments for the same stone will be reimbursed again when done 2 weeks after the end of the first treatment.

These different data show clearly that values from one healthcare system cannot be taken for calculation models in another. Structures and expenses in the different healthcare systems vary considerably. This also applies to the same healthcare system when the rules for reimbursement are changed.

Cost-effectiveness of different stone treatments

How difficult it is to forecast the costs of a new treatment option is illustrated by the following example. Although its role is declining due to increasingly sophisticated endoscopic treatments, ESWL is still the treatment used most often. Originally it was assumed that ESWL could save 40–140 million DM (i.e. €20–70 million) in Germany. However, in 1986 it had already caused an increase in cost of 42 million DM (€21 million) [18].

The cost-effectiveness of the different treatments has been compared, but only rarely. For large staghorn stones, PCNL has been shown to be more cost-effective than ESWL, but for smaller stones (< 1 cm) ESWL was better [19]. When assessing cost-effectiveness a consideration is that the third-generation lithotripters most commonly used at present are less powerful than the first-generation machines. The performance of ESWL also influences the outcome. Using a slower shockwave delivery rate significantly increases the stone-free rate and decreases the re-treatment rate, resulting in a reduction in costs by about half [20].

In the USA, managing renal stones (2–3 cm) by flexible ureteroscopy is significantly less expensive, but this approach results in a lower stone-free rate [21]. The progress in endoscopic stone therapy by using flexible ureteroscopes undoubtedly has increased success rates and lowered morbidity. However, the expenses for flexible ureteroscopes and even more for disposable instrumentation are considerable. Collins et al. [22] calculated £52,000 as the cost for 100 procedures (£520 = €780), and that was only for the endoscope and the ancillary instruments. Raman et al. [23] showed that managing residual fragments after PCNL by flexible scopes is only cost-effective for fragments of > 4 mm.

Costs for metabolic evaluation and metaphylaxis (medical management)

Parks and Coe [24] calculated the cost-effectiveness of metaphylaxis for patients attending their stone clinic; they found a reduction of about €2800 in costs for stone removal per patient. Chandhoke [14] estimated the cost for a metabolic evaluation and drug therapy at $8200, which is again the highest cost in the world when compared with other healthcare systems. Saigal et al. [4] reported expenditures for drugs at $1150 per year. Robertson [25] reported a cost of £180 for a full metabolic evaluation in the UK. The cost for drug treatment was estimated at $29 per year [14].

The Bonn group [26] showed that an effective metabolic evaluation and metaphylaxis lowered the recurrence rate by 46%. This was achieved by an extensive metabolic evaluation programme in every stone former. The costs for such a screening are €250–350 [24], and the costs for drug treatment were estimated at €130, €350 and €13 per patient per year [24–27].

However, the benefit of such extensive programmes is questionable. First, the overall recurrence rate in stone disease is 50%. More than half of recurrent stone formers have only one recurrence during their life. Only < 10% of recurrent stone patients have more than three recurrences [28,29]. The figure of six or more recurrences over 30 years for one stone-former [24,25] was derived from patients attending special referring centres and were not representative of the average stone patient.

Second, a metabolic evaluation is not a good predictor of the risk of recurrence [30–33]. Third, from the therapeutic standpoint, such extensive programmes are abundant. Many variables and values do not result in consequences for therapy. In patients with a low risk of recurrence the motivation to maintain a strict metaphylaxis regimen is low.

Therefore, a more rational approach for metabolic evaluation and metaphylaxis [15,16,34] is reasonable. This approach should be orientated to the stone composition, recurrence rate, therapeutic consequences and expenses. It is the base for the following calculation model.

Calculation models: a comparison of costs for stone removal vs. metabolic evaluation/metaphylaxis

The epidemiology of urolithiasis and costs for stone removal, metabolic evaluation and metaphylaxis vary among countries. Therefore, as shown by Chandhoke [14], the cost-effectiveness of metaphylaxis depends not only on stone frequency but also on the costs for the different treatments, which can vary considerably among national healthcare systems.

Some years ago, I developed a calculation model which was based not only on estimates but on actual values from a German social healthcare insurance company [15]. However, the principles of the following calculation model are applicable to every healthcare system, and therefore it is reported here in more detail.

Comparison of costs for stone removal vs. metabolic evaluation/metaphylaxis in Germany

Costs for stone removal

The calculation model of the cost-effectiveness of metabolic evaluation and metaphylaxis (i.e. the annual cost for stone removal vs. metabolic evaluation and metaphylaxis) is presented with values from Germany. The model uses representative values for epidemiology and recurrence rates which are not derived from selected patients attending specialised referring centres.

In Germany the rate of stone recurrence is ≈□200,000 per year [35,36]. According to the values from the above-mentioned district of the German social healthcare insurance company (hospitalisation rate 68.9%), the annual costs were €0.815 billion. To avoid any bias towards supporting metaphylaxis, a hospitalisation rate of only 50% was assumed for this calculation model. Thus, the annual costs for inpatient stone removal in recurrent stone formers are €0.59 billion in Germany.

The actual costs for outpatient stone removal cannot be calculated because of the structure of the Kassenärztliche Vereinigungen (i.e. associations of office physicians). However, according to the 'EBM' (a list of medical fees in the German social healthcare insurance system) it can be estimated that the diagnosis of a stone episode and conservative treatment aiming at spontaneous stone passage costs about €85 and €8, respectively. Thus, outpatient treatment of recurrent stone formers (i.e. 100,000 cases annually) costs about €9 million. Expenses for active outpatient stone removal (e.g. ESWL, URS) are not considered, but the number of such procedures is lower than for active stone removal on an inpatient basis.

Costs for metabolic evaluation/metaphylaxis

The rational and cost-effective metabolic evaluation and metaphylaxis programme, as outlined above, is orientated to stone analysis, recurrence rates and risk factors with therapeutic implications. Special metaphylaxis seems to be justified in patients with cystine, uric acid, calcium phosphate or infected stones. In calcium oxalate stone disease, a special metaphylaxis programme should be used only in recurrent cases, as the recurrence rate is quite low. It is assumed that this programme reduces recurrence by 40%, a value somewhat less than that reported by Nolde et al. [26].

In Germany, 335,000 stone episodes occur per year [35]; assuming 70% are calcium oxalate stones [28], there are 234,000 calcium oxalate stone episodes annually. Assuming a high recurrence rate of 50% (to avoid bias for metaphylaxis, the calculation model uses this high value for the recurrence rate), there are 117,000 recurrent calcium oxalate stone formers per year. According to epidemiological data [28], the estimates made for the other types of calculi are; calcium phosphate stones 30,000; infected stones 20,000; uric acid stones 20,000; and cystine stones 1000 annually.

The rational evaluation programme examines only the risk factors relevant for the respective type of stone disease. The costs for this evaluation are also given. The expenses are calculated according to the 'EBM'. The value of one point can vary, and an average value of €0.04 per point is used. As two 24-h urine specimens should be analysed because of the considerable day-to-day variation [37], the costs for these programmes are calculated twice per patient. Therefore, the annual costs for 188,000 patients undergoing a metabolic evaluation are €16.1 million.

To calculate the annual expenses for drug treatment, the rate of patients treated with drugs was estimated at a high level, i.e. all recurrent calcium oxalate stone formers (50% alkali citrate, 30% orthophosphate, 20% thiazides), 30% of patients with calcium phosphate stones (10% citrate, 20% thiazides), all infected stone formers (100% antibiotics and l-methionine for 100 days), all patients with uric acid stones (100% alkali citrate, 50% allopurinol), and all cystinurics (100% alkali citrate and tiopronine). Under these premises, special metaphylaxis for 188,000 patients costs €52.7 million per year.

Comparison of annual costs for stone removal vs. metabolic evaluation and metaphylaxis

As outlined above, the annual saving for stone removal due to effective metaphylaxis is €240 million. The annual expenses for metabolic evaluation and metaphylaxis are €16.1 and €52.7 million, respectively. Thus, the net annual saving due to rational metabolic evaluation and metaphylaxis is €171.2 million. For the new German reimbursement system (DRG) no calculations are yet available.

Calculation models: comparison of costs for stone removal vs. metabolic evaluation/metaphylaxis in other countries

Robertson [25] and Tiselius [6] calculated for their countries (UK and Sweden, respectively) that medical prophylaxis is also cost-effective. Depending on the estimated reduction of the recurrence rate (50%, 33%, 20%, 10%) the annual savings over a 30-year period were £64,000 to £225,904 for the UK [25]. For Sweden, for a 5-year period, a cost reduction of €1.875 per patient was calculated [6]. However, as already mentioned above, cost-effectiveness depends on the costs for stone removal vs. metaphylaxis, which can differ considerably among countries.

Lotan et al. [38] compared the cost-effectiveness of medical management strategies for urolithiasis in several countries. Their model was based on the international cost survey published by Chandhoke [14]. However, the calculations in these studies for stone removal in Germany are underestimates. The values used are for ESWL/URS as outpatient procedures, but most of these procedures are performed when patients are hospitalised. The following measures were included: dietary measures, potassium citrate, thiazides and allopurinol. They showed that conservative therapy (i.e. diet) is the most cost-effective treatment strategy in all countries except the UK; drug therapy was more costly. In most countries, stone frequency must exceed one stone/patient/year before medical therapy is more cost-effective than dietary measures. However, although drug therapy produces good control, compliance is an important factor. First-stone formers and patients with a low stone frequency/low risk of recurrence are less likely to maintain drug therapy for a longer period. Therefore, specific metaphylaxis should be restricted to patients with a substantial risk of recurrence (rational metaphylaxis [15,34]).

In another model, Lotan and Pearle [39] calculated that primary prevention in every stone former is only cost-effective if the incidence is $>4.3\%$ and costs for prevention are $<\$23$. This model again supports the concept of rationale metaphylaxis, which is restricted to patients being at substantial risk of recurrence.

Off work due to stone disease

In the above-mentioned district of a German social healthcare insurance company, there were 426 of 150,000 insured people off work due to urolithiasis. The mean duration off work was 96.6 days! Most of the patients were off work for a remarkably shorter period (up to 14 days, 307 patients, up to 42 days, 94 patients). The high mean duration was caused by patients off work for up to 180 days (19 cases) or >180 days (six cases).

Compared to other countries, e.g. the USA, these values are very high. In the USA the estimated time off work was 5 days in hospitalised and 2 days in outpatients [11]. Saigal et al. [4] reported a 48-h work absence for inpatients and 5 h for outpatient treatment per patient per year. They concluded that secondary prevention (i.e. metaphylaxis) strategies might be cost-effective in a working-age population. For the UK, only 30% of employed persons with a diagnosis of urolithiasis were off work (mean 19 h annually) [3].

Although these values are only estimates they clearly show the striking differences between the national healthcare systems. One of the most important reasons for a long time off work in Germany is that socially insured people receive full wages for up to 42 days if not fit for work. The long duration off work due to urinary stone disease is not surprising when 40.9% of all days off work in Germany result from diseases with a duration of >6 weeks (statistics from the Scientific Institute of Regional Social Health Care Insurance Companies Bonn, 1997). For all of Germany, a rational metaphylaxis (lowering the recurrence rate by 40%) could avoid 60,000 cases and 5.8 million days off work due to stone disease per year. These values show clearly the enormous economic implications of an effective stone metaphylaxis programme.

Conclusions

As shown with the calculation model for Germany, metabolic evaluation and metaphylaxis in stone formers can lower healthcare costs significantly. However, importantly, not every stone former requires specific metaphylaxis. Only the high-risk patients (as outlined above) should be given specific treatment.

Although healthcare conditions can vary among countries the principles of this calculation model are applicable to every healthcare system. Only the amount of saving might differ. In most countries the stone frequency must exceed one stone/patient/year before medical therapy is more cost-effective than dietary measures.

Currently ESWL is the most frequently used treatment for urolithiasis. Given the potentially increased recurrence rate after ESWL [6,25], due to 'clinically insignificant' residual fragments as foci for re-growth and new stone formation, a rational metabolic evaluation and metaphylaxis is not only a medical, but (being increasingly important) an economic imperative. First results on such metaphylaxis programmes after ESWL are promising [40].

Rational metaphylaxis does not mean that every stone former needs a thorough metabolic evaluation and a special metaphylaxis programme. Rational metaphylaxis is orientated to the recurrence rate [15,34]. Patients with a first episode of a calcium oxalate stone and with no risk factors are not candidates for special metaphylaxis. Only in stone formers with a substantial risk of recurrence are such programmes justified and, as shown by Chandhoke [41], cost-effective.

However, apart from all the economic considerations, there are many medical reasons strongly arguing for rational metaphylaxis; the sequelae of urolithiasis, e.g. chronic kidney disease (renal insufficiency) [8] and hypertension [9], with all the negative consequences, might be avoided.

Conflict of interest statement

No conflict to declare.

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