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ORIGINAL PAPER

Comparison of two different running models for the shock wave lithotripsy machine in Taipei City Hospital: self-support versus outsourcing cooperation

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Abstract To compare two different running models including self-support and outsourcing cooperation for the extracorporeal shock wave lithotripsy (SWL) machine in Taipei City Hospital, we made a retrospective study. Self-support means that the hospital has to buy an SWL machine and get all the payment from SWL. In outsourcing cooperation, the cooperative company provides an SWL machine and shares the payment with the hospital. Between January 2002 and December 2006, we used self-support for the SWL machine, and from January 2007 to December 2008, we used outsourcing cooperation. We used the method of full costing to calculate the cost of SWL, and the break-even point was the lowest number of treatment sessions of SWL to make balance of payments every month. Quality parameters including stone-free rate, retreatment rate, additional procedures and complication rate were evaluated. When outsourcing cooperation was used, there were significantly more treatment sessions of SWL every month than when utilizing self-support (36.3 ± 5.1 vs. 48.1 ± 8.4, $P = 0.03$). The cost of SWL for every treatment session was significantly higher using self-support than with outsourcing cooperation (25027.5 ± 1789.8 NT$ vs. 21367.4 ± 201.0 NT$). The break-even point was 28.3 (treatment sessions) for self-support, and 28.4 for outsourcing cooperation, when the hospital got 40% of the payment, which would decrease if the percentage increased. No significant differences were noticed for stone-free rate, retreatment rate, additional procedures and complication rate of SWL between the two running models. Besides, outsourcing cooperation had lower cost (every treatment session), but a greater number of treatment sessions of SWL every month than self-support.

Keywords SWL · Outsourcing cooperation · Self-support · Cost · Investment

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Introduction

The cost of treating urolithiasis is amazing. In 2001, the expense was more than 20 billion in the USA [1]. The introduction of extracorporeal shock wave lithotripsy (SWL) had revolutionarily influence on the management of urolithiasis. SWL is the preferred modality for the treatment of renal and ureteral stones [2]. In 1997 and 2007, the American Urological Association Ureteral Stones Clinical Guidelines Panel suggested that both ureteroscopic lithotripsy (URSL) and SWL were considered acceptable treatment for distal ureteral stones <1 cm. The recommendations for treatment method were based on success, retreatment and complication rates, without considering the

cost of treatment or patient preference [3]. Lotan and Pearle suggested that for ureteral stones, observation was the least costly treatment modality and URSL was less costly than SWL [4]. In 1985, Veterans General Hospital, Taipei, obtained the first SWL machine (Dornier, HM3) in Taiwan and got good results for treating patients with urolithiasis. Therefore, many other hospitals wanted to buy this expensive machine, because they were worried about losing patients if they did not have the SWL machine. Although very expensive, most hospitals in Taiwan bought the SWL machine (self-support) initially. Later, some hospitals used outsourcing cooperation to get the machine from the cooperative firm, instead of buying, to decrease the initial cost.

In 1994, the Central Health Insurance Company (CHI) in Taiwan included SWL as case payment, and the payment for every treatment session was fixed. Because the number of treatment sessions of SWL increased rapidly, CHI enacted some rules (such as patients with ureteral stone >1 cm or renal stone >2.5 cm were not suitable for SWL) to decrease the growing expense from SWL. Cost, in addition to efficacy and morbidity, has become a very important factor in choosing the best therapeutic strategy for many diseases. Cost-effectiveness analysis is a very useful tool for comparing different treatment modalities, especially if cost and effectiveness vary significantly among the modalities [5]. To compare the two different running models, including self-support and outsourcing cooperation for the SWL machine, we made a retrospective study.

Methods

Between January 2002 and December 2006, we used self-support for the SWL machine, and from January 2007 to December 2008, we use outsourcing cooperation. Patients with ureteral stone >1.5 cm or renal stone >2.5 cm were not advised to receive SWL. Quality parameters including stone-free rate, retreatment rate, additional procedures and complication rate were evaluated. Stone-free state was confirmed by plain X-ray or ultrasonography 4 weeks after SWL. Second or third SWL (retreatment) was suggested if the stones were fragmented and residual stones noticed. Additional procedures (such as URSL or percutaneous nephrolithotripsy) were recommended if a failure of SWL was noticed. Major complications included those that required hospitalization or additional intervention (such as urosepsis or pyelonephritis), and minor complication were those that did not need hospitalization or additional intervention (such as colic, fever and mild urinary tract infection).

The break-even point was the lowest number of treatment sessions of SWL to maintain a balance of the costs every month. The SWL machine was electromagnetic (Storz Medical SL-20) for self-support, and spark gap (stonelith smart, PCK) for the outsourcing cooperation. In outsourcing cooperation, the hospital provides medical staff and a place for the SWL machine without actually buying it. The machine is provided by the cooperative company. On the other hand, in the self-support, the hospital has to buy an SWL machine initially and enact a contract of maintenance with the agent firm. All the payment from SWL belongs to the hospital when using self-support, but the hospital using outsourcing cooperation has to share the payment with the cooperative company at an initially negotiated percentage (40% in this study). The method of full costing is used to calculate the cost of SWL, including cost of the equipment, consumed materials and salary of the medical staff.

Break-even point was the lowest number of treatment sessions (N) of SWL needed every month to maintain a balance of the costs. The formula for self-support is: fixed cost + variable cost $\times N$ = payment (from CHI) $\times N$, and that for outsourcing cooperation is: fixed cost + variable cost $\times N = 40\%$ payment (from CHI) $\times N$. Fixed cost for self-support included cost of equipment (SWL machine), indirect labor and materials, while variable cost for self-support and outsourcing cooperation included cost of direct labor and materials every month. But, fixed cost for outsourcing cooperation was only the cost of indirect labor and materials, without the cost of the SWL machine. Cost of direct labor included salary of the in-charge attending physician and technician, attributed by working hour, and cost of indirect labor consisted of the salary of other medical staff multiplied by the ratio (income from SWL/total income in the hospital). Cost of direct materials included the cost of the SWL machine, maintenance fee, drugs and medical materials, while cost of indirect materials consisted of electricity, water and others multiplied by the ratio (income from SWL/total income in the hospital). The formulas in detail are illustrated in Table 1. Sensitivity analysis was based on the change of payment by CHI (increase or decrease). Evaluation of investing in new SWL machines was based on break-even analysis and supply–demand.

Results

The baseline characteristics (including stone location and size, operation time, number of shock waves and power for SWL) of all the patients are shown in Table 2. The average operation time for SWL was about 60 min, and the average number of shock waves was about 3,500 for all the patients. No significant differences in stone size, operation time, number of shock waves and power for SWL were found between the two running models. The stone-free rate, retreatment rate, rate of additional procedures and compli-

Table 1 Formula for different costs (NT$)

	Formula	Explanations
Direct labor/h	(Salary of in-charge attending urologist + salary of technicians every year)/(8 h × 250 days)	Cost of direct labor every hour in performing SWL
Direct material/ treatment session	(Cost of drug and consumed medical material for SWL every month/no. of treatment sessions every month) + (no. of shock wave × 1.25)	Every lithotripter (NT$1,250,000) could perform 1,000,000 times of shock wave (NT$1.25 for each number of shock wave)
Indirect labor/h	[Salary of other staff related to SWL in the hospital every year × (total income from SWL/ total income from hospital)]/(8 h × 250 days)	The cost of nursing, administrative staff, mechanics and others, except direct labor, every hour for performing SWL
Indirect material/ treatment session	[Cost of other materials related to SWL in the hospital every month × (total income from SWL/total income from hospital)]/no. of treatment sessions every month	The cost of water, electricity, cleaning, administration and others except direct material
Fixed equipment/ treatment session	{[Cost of SWL machine × (1 + interest rate)/12 months × 5] + (cost of place performing SWL/month) + (maintenance fee for SWL/month)}/no. of treatment sessions every month	[a]The value of SWL machine would be depreciated to reach 0 after 5 years and the interest rate was 5%; cost of place: rent/month

Average operation time for each SWL: 60 min (about 1 h); average working hour per day: 8 h; working day per year: 250 days

[a] According to the regulation of normal time limit for fixed assets in Taiwan; 1 US$ = 35 NT$

Table 2 Baseline characteristics of patients in the two models

	Self-support (n = 2,178)	Outsourcing cooperation (n = 1,155)	P value
Renal stone	n = 1,300	n = 690	
Stone size (cm)	1.53 ± 0.45	1.49 ± 0.42	0.87
Ureteral stone	n = 878	n = 465	
Stone size (total)	1.13 ± 0.17	1.12 ± 0.26	0.85
U/3 ureter	1.11 ± 0.14 (n = 293)	1.09 ± 0.18 (n = 157)	0.79
M/3 ureter	1.07 ± 0.11 (n = 272)	1.05 ± 0.14 (n = 140)	0.74
L/3 ureter	1.18 ± 0.16 (n = 313)	1.14 ± 0.15 (n = 168)	0.69
Operation time for every treatment session (min)	58.6 ± 6.2	60.2 ± 7.1	0.89
Number of shock waves	3503.5 ± 350.2	3498.6 ± 332.4	0.85
Power of SWL (kV)	17.0 ± 1.8	16.5 ± 2.0	0.71

The data were expressed as mean ± SD; statistical analysis by Mann–Whitney; $P < 0.05$ was considered as significant

U/3 upper third, *M/3* middle third, *L/3* lower third ureter

cation rates (including major and minor) are illustrated in Table 3, and no significant differences were noticed between the two running models. There were a significantly higher number of treatment sessions with SWL every month using outsourcing cooperation than using self-support (36.3 ± 5.1 vs. 48.1 ± 8.4, $P = 0.03$). The cost of the SWL machine was NT$25,000,000 for SL-20 and NT$20,000,000 for PCK, and the maintenance fee was NT$140,000/month for SL-20 and NT$130,000/month for PCK. The cost of SWL machine and maintenance was higher for SL-20 than for PCK. The cost of direct labor and material per treatment session was higher for the self-support than for the outsourcing cooperation, but no significant difference was noticed (Table 4). The cost of fixed equipment for every treatment session was significantly higher for self-support than for the outsourcing cooperation (Table 4). The cost of indirect labor and material per treatment session was significantly higher for the outsourcing cooperation than for self-support (Table 4). The total cost of SWL for every treatment session was significantly higher using self-support than with the outsourcing cooperation (NT$25027.5 ± 1789.8 vs. NT$21367.4 ± 201.0, $P < 0.01$). The total cost of SWL for the outsourcing cooperation included the cost of the hospital (NT$3950.5 ± 150.2, 18.5%) and the cooperative firm (NT$17416.9 ± 176.3, 81.5%).

The break-even point was 28.3 (treatment sessions), but if the outsourcing cooperation was chose to getting the SWL machine, the break-even point was 28.4, when the hospital got 40% of the payment, which would decrease if the percentage increased (Fig. 1). Therefore, outsourcing cooperation carried lower risk but lower profit than

Table 3 The quality parameters of SWL in the two models

Parameters/ running model	Self-support (%)	Outsourcing cooperation (%)	*P* value
Stone-free rate	63.5	63.1	0.87
Retreatment rate	25.1	25.9	0.85
Additional procedures rate	11.4	10.9	0.82
Complication rate	29.2	30.1	0.79

Statistical analysis by Chi-square test; $P < 0.05$ was considered as significant

Table 4 The cost of SWL every treatment session in the two models

Running model/ cost (NT$)	Self-support	Outsourcing cooperation	*P* value
Direct labor	2028.2 ± 20.5	1955.3 ± 19.5	0.87
Direct material	6485.7 ± 105.2	6480.7 ± 99.4	0.95
Indirect labor	775.5 ± 18.9	1023.9 ± 31.2	0.04
Indirect material	1584.7 ± 15.2	1846.4 ± 14.5	0.04
Fixed equipment	14166.5 ± 835.3	10570.5 ± 135.4	<0.01
Total cost	25027.5 ± 1789.8	21367.4 ± 201.0	<0.01

The data were expressed as mean ± SD; statistical analysis by Mann–Whitney; $P < 0.05$ was considered as significant; 1 US$ = 35 NT$

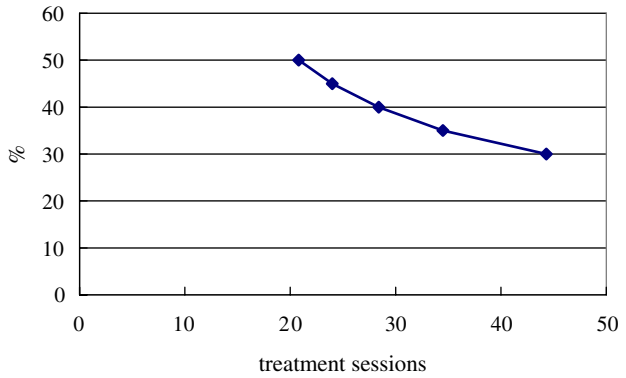

Fig. 1 The break-even point (treatment sessions every month) of SWL, according to the percentage of payment belonging to the hospital with outsourcing cooperation

self-support for investing SWL machine (Fig. 2). By sensitivity analysis, the break-even point would increase and the profit would decrease if the payment decreased (Table 5).

Discussion

Shock wave lithotripsy is the least invasive procedure for treating renal and ureteral stones and can be performed at OPD. SWL has a success rate of 85–96% for small nonobstructive upper ureteral calculi, but low success rate for large impacted ureteral stones [6–8]. We know that the

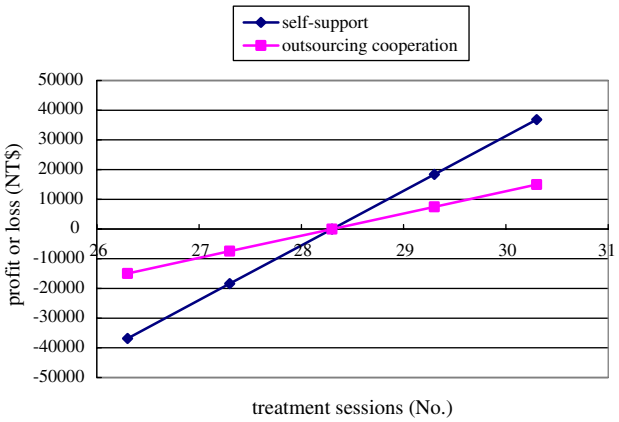

Fig. 2 The profit or loss from SWL in the hospital with self-support or outsourcing cooperation (getting 40% of payment), according to treatment sessions every month (1 US$ = 35 NT$)

clearance of stone after SWL depends on the stone size, location and composition, the SWL machine, and the number and the power of the shock wave [9]. The Dornier HM3 lithotripter is known to be more efficient than other lithotripters [10–12], but in this study we used Storz Medical SL-20 and stonelith smart (PCK) for SWL. From this study, a significantly higher number of treatment sessions were noticed for outsourcing cooperation than for self-support. The possible explanation is that patients could receive SWL according to their schedule (even in the weekend or at night), and SWL could be performed immediately after the stone was confirmed (especially in the emergency room or outpatient department at night), because the technicians were always available when needed under the model of outsourcing cooperation, which was difficult in the model of self-support. Therefore, if the efficiency could be improved for the model of self-support, the number of treatment sessions of SWL might be higher.

Cost is another important factor in choosing the technique to treat patients with urolithiasis, but the issue remains controversial [4, 13]. The hospital using self-support can get all the payment from SWL, but needs high initial capital to buy an SWL machine. If outsourcing cooperation was chosen to get an SWL machine, the hospital did not need to invest a lot of money initially, and the cooperative firm would join as a team with the hospital to make the machine work well. In this study, the total cost of SWL for every treatment session was significantly higher for the self-support than the outsourcing cooperation. Besides, the outsourcing cooperation had a significantly higher number of treatment sessions of SWL every month than the self-support. Furthermore, there was no significant difference in the quality parameters, including stone-free rate, retreatment rate, additional procedures and complication rates of SWL between the two running models.

Table 5 Sensitivity analysis of SWL according to the decrease or increase of payment by CHI in the hospital for self-support

Decrease or increase rate of payment by CHI (%)	+10%	+20%	−10%	−20%
Payment every treatment session by CHI (NT$)	29,612	32,304	24,228	21,536
Break-even point (no. of treatment sessions every month)	24.7	21.9	33.1	39.9
Profit for every treatment session over break-even point (NT$)	21,110	23,802	15,726	13,034

1 US$ = 35 NT$

With the break-even analysis, we could estimate the lowest number of treatment sessions of SWL needed to maintain a balance, and with sensitivity analysis, we could estimate the risk of investing in a new SWL machine. There were about 70,000 persons requiring SWL every year in Taiwan, estimated by the population of Taiwan × prevalence rate of urolithiasis (about 9%) × rate of seeing a doctor and needing SWL (about 10%). In Taipei city, there were about 20,000 people undergoing SWL every year, and 32 SWL machines in that area in 2003. If the capacity of an SWL machine is about 600 treatment sessions every year, then it is reasonable to invest in new SWL machine in the Taipei city. In this study, we found that self-support would get more profit than outsourcing cooperation, if the treatment sessions every month were >28.4. On the contrary, there would be more loss and greater risk with self-support than outsourcing cooperation, if the treatment sessions every month were <28.4 (Fig. 2).

There were limitations to this study, which could be improved by the following: (1) We should evaluate the cost of prevention, such as use of alternative therapies, correction of pre-existing renal or systemic disease, treatment of urinary tract infection, use of prophylactic antibiotics and improvement of SWL efficacy [14]. (2) We might put more efforts into the study of the epidemiology of urolithiasis to more exactly estimate the demand of SWL. (3) The payment for SWL for every treatment session from CHI was fixed and higher than URSL in Taiwan, which might influence the decision-making of urologists to treat patients with urolithiasis and increase the possibility of unnecessary treatment or overuse of SWL. (5) The cost of the SWL machine was high, which might influence managers of hospitals to choose cheaper machines and overlook its quality, safety and efficacy. (6) The cost of the SWL machine and its maintenance was lower for PCK than for SL-20. The cost when using outsourcing cooperation (because of using cheaper lithotripter) would be reduced and therefore result in some relevant bias. (7) The reimbursement systems for SWL are different in other countries; this study was based on the system in Taiwan and cannot be directly transferred to other countries.

In conclusion, no significant differences were noticed for stone-free rate, retreatment rate, additional procedures and complication rate of SWL between the two running models. Besides, the outsourcing cooperation had lower cost (every treatment session), but higher number of treatment sessions of SWL every month than the self-support.

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