Cost Feasibility of A Pre-checking Medical Tourism System for U.S. Patients Undertaking Joint Replacement Surgery in Taiwan

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Background: Medical tourism is a relatively recent global economic and political phenomenon that has assumed increasing importance for developing countries, particularly in Asia. In fact, Taiwan possesses a niche for developing medical tourism because many hospitals provide state-of-the-art medicine in all disciplines and many doctors are trained in the United States (US). Among the most common medical procedures outsourced, joint replacements such as total knee replacement (TKR) and total hip replacement (THR) are two surgeries offered to US patients at a lower cost and shorter waiting time than in the US.

Methods: This paper proposed a pre-checking medical tourism system (PCMTS) and evaluated the cost feasibility of recruiting American clients traveling to Taiwan for joint replacement surgery. Cost analysis was used to estimate the prime costs for each stage in the proposed PCMTS. Sensitivity analysis was implemented to examine how different pricings for medical checking and a surgical operation (MC&SO) and recovery, can influence the surplus per patient considering the PCMTS. Finally, the break-even method was adopted to test the tradeoff between the sunk costs of investment in the PCMTS and the annual surplus for participating hospitals.

Results: A novel business plan was built showing that pre-checking stations in medical tourism can provide post-operative care and recovery follow-up. Adjustable pricing for hospital administrators engaged in the PCMTS consisted of two main costs: US$3,700 for MC&SO and US$120 for the hospital stay. Guidelines for pricing were provided to maximize the annual surplus from this plan with different number of patients participating in PCMTS. The maximal profit margin from each American patient undertaking joint surgery is about US$24,315.

Conclusions: Using cost analysis, this article might be the first to evaluate the feasibility of PCMTS for joint replacement surgeries. The research framework in this article is applicable when hospital administrators evaluate the feasibility of outsourced medical procedures other than TKR and THR.

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Key words: medical tourism, joint replacement surgery, cost analysis, pricing

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The Bureau of National Health Insurance (NHI) in Taiwan was founded in 1995 on the idea of marshaling the resources of the majority to resolve the difficulties certain people have in paying for health care.[1] Through its fourteen years of operation, the NHI system has successfully provided universal coverage and convenient access to high quality health care at low premiums. NHI has become a model for other countries and has received widespread praise in the international media. To ensure that health care in Taiwan does not suffer from resource constraints, the Bureau of NHI introduced a global budget system (GBS) in phases starting in July, 2002. Since the GBS sets a fixed annual budget for medical expenditures on broad health care sectors, NHI does not reimburse hospitals with annual revenues exceeding the spending caps for providing medical services to the insured. As a result, global budgeting control greatly changed the ways that health care providers operate. Most hospitals reduced administrative costs and medical expenses and turned to alternatives that better utilized the existing facilities and resources. One of the emerging health care services many hospitals in Taiwan are seeking to enhance profits is medical tourism.

Medical tourism, combining medical treatment with exotic vacations, outsources medical services to low-cost countries. Medical tourism provides the potential benefits of greatly reduced costs and reduced waiting time for expensive surgeries.[2] Developing countries in Asia, such as India and Thailand,[3] are the main destinations for medical tourism. In fact, medical tourism has occurred in many ways for centuries. Medical travel can be traced back to around 4000 B.C.[4] At that time the Sumerians built health complexes near hot springs to provide flowing pools to passing travelers. Having developed for thousands of years, the concept of medical tourism has developed into an organized system in recent years.[5] Recently, tourism and medicine have been combined in areas such as health care,[6] dental surgery,[7] organ transplantation,[8] and aesthetic surgery.[9] There are two kinds of patients looking at medical tourism to solve medical problems. One group is searching for less expensive services and the other group is looking for better medical services.[10] To sum up, medical tourism is a plan that optimizes medical resources among different countries which are subject to budget constraints, and attracts patients who need surgery and elderly patients who need care. Although medical tourism involves many ethical and medical legislation issues,[11,12] it is popular in Europe and is booming in North America because of lower costs and shorter waiting times.

In 2006, the average annual medical expenditure was US$6,714 per person in the U.S. compared with US$982 per person in Taiwan.[1] Most Americans pay at least five times as much for healthcare as each Taiwanese does. As the cost of surgery in the U.S. escalates (at least triple that in most Asian countries), and as waiting times continue to increase, medical tourism is becoming popular. In 2006, Newman discussed the benefits and disadvantages of the global medical system,[13] and concluded that medical tourism is an attempt by many Americans to save money by traveling to other countries for medical needs. This has become big business for travel agencies in the U.S.A.

Professional healthcare systems in Taiwan have several advantages such as high quality, advanced technology, and affordable cost. The Taiwan Task Force for Medical Travel (TTFMT) provides the main medical tourism services.[14] The TTFMT is the platform to integrate Taiwan's medical, governmental and tourism resources as a five-star medical travel offering for any patient around the globe who seeks excellent medical care. The TTFMT reports five major medical specialties in Taiwan, liver transplantation, cardiovascular surgery, craniofacial reconstruction, artificial reproduction, and joint replacement. Among these, joint replacement surgeries such as total hip replacement (THR) and total knee replacement (TKR) are much safer and more stable than other risky orthopedic surgeries such as spinal fusion, which have longer operation and anesthesia times with more blood loss. Many patients would like to have a joint replacement operation to improve their quality of life. Lee, at Chang Gung Memorial Hospital (CGMH),[15] estimated that in the coming twenty years there will be about 520,000 Americans in need of THR operations and roughly 3.5 million residents in the US seeking TKR surgery.

Although it seems that there are huge profits in medical tourism, there is no evidence to prove it.[16] Due to the complexity and intricacy of health care systems, there is little quantitative research focusing on medical tourism. Bies and Zacharia discussed

whether medical tourism is worth promoting in the U.S. by analyzing four strategic criteria, benefits, opportunities, costs, and risks.[17] They concluded that self-selected medical tourism is preferred over employer- or government-sponsored programs. Most recently, Heung *et al*. developed a conceptual model for theoretical investigation of medical tourism from the supply and demand perspectives,[18] but they failed to validate the model by quantitative techniques.

To ensure that patients from abroad do not risk wasting time and money on medical tourism and then discover they are unqualified for surgery after arrival in Taiwan, we are proposing an overseas Pre-Checking Medical Tourism System (PCMTS) for individuals from the U.S. to elect to have orthopedic surgeries in Taiwan. Through sensitivity analysis of the costs of undertaking TKR and THR in the U.S. and in Taiwan, we aim to examine how the pricing and the number of outsourced cases can affect the surplus from the proposed PCMTS. To the best of our knowledge, this study is the first to quantify the cost feasibility of a PCMTS in Taiwan. Such a system can provide hospital administrators with insight for promoting Taiwan medical tourism around the world.

METHODS

The PCMTS model

There are hundreds of different types of orthopedic surgery and TKR and THR are the two most suitably items for outsourcing. This paper takes joint replacement surgery as an example and evaluates the cost feasibility of the proposed PCMTS. The Figure depicts the flow of overseas patients undertaking pre-checking before medical travel to Taiwan. The PCMTS can either assess American patients individually or transfer them from local healthcare institutions to pre-checking stations nearby. At these stations, local medical staffs, in contract with the Taiwan medical travel system, will make judgments on the patient's suitability for medical travel. Those who are qualified will go through a video diagnosis at the pre-checking station; this will be done by the attending orthopedic surgeons in Taiwan. Using this double checking procedure will diminishes the possibility that the American patients, who are typically elderly, will fly to Taiwan only to discover they are unqualified for medical treatment. Once the medical staff approves patients for medical travel to Taiwan, U.S. patients will follow the same procedures as local Taiwanese patients with the help of U.S. travel agents and the local medical team. On arriving in Taiwan, the American patients can either check into a hospital and/or a TTFMT participating healthcare center. Once they complete the postoperative assessment and returned to the U.S., the local medical staff at the oversees pre-checking stations will follow their recovry and rehabilitation.

In summary, pre-checking stations in the U.S. would be able to screen American patients for medical travel to Taiwan and eliminate complicated and inappropriate cases. The stations would also provide postoperative care and be involved in the patient's recovery and follow-up. If the process used is both convenient and accessible in terms of the outsourced services, this will help to effectively recruit American patients, to come to Taiwan as medical tourists, in particular those who are in need of TKR and THR (Figure).

Cost analysis

The Figure shows the service flowchart, which aids in estimating the related costs and benefits for each patient going through all procedures in PCMTS. We computed the costs for each American patient involved in the proposed pre-checking system for medical travel to Taiwan, and from the point view of a hospital administrator, examined the benefits for a hospital providing joint replacement surgeries through the PCMTS. Some costs will be incurred when patients intending to use the PCMTS are still in the U.S. and some will be incurred in Taiwan. Hospital administrators in Taiwan can adjust the latter costs.

Costs incurred outside of Taiwan

Pre-Checking Process – At this stage, costs are separated as fixed and variable. Fixed costs are installment costs that include spending for medical consumables and rents/ leases for X-ray machines, clinic buildings, and so on. $C_{install}$ stands for fixed costs at the pre-checking stage to define the acceptable range for the feasibility of the PCMTS. The variable costs at this stage are mainly dependent on the wages paid for doctors and nurses involved in this process. A regular examination takes around two

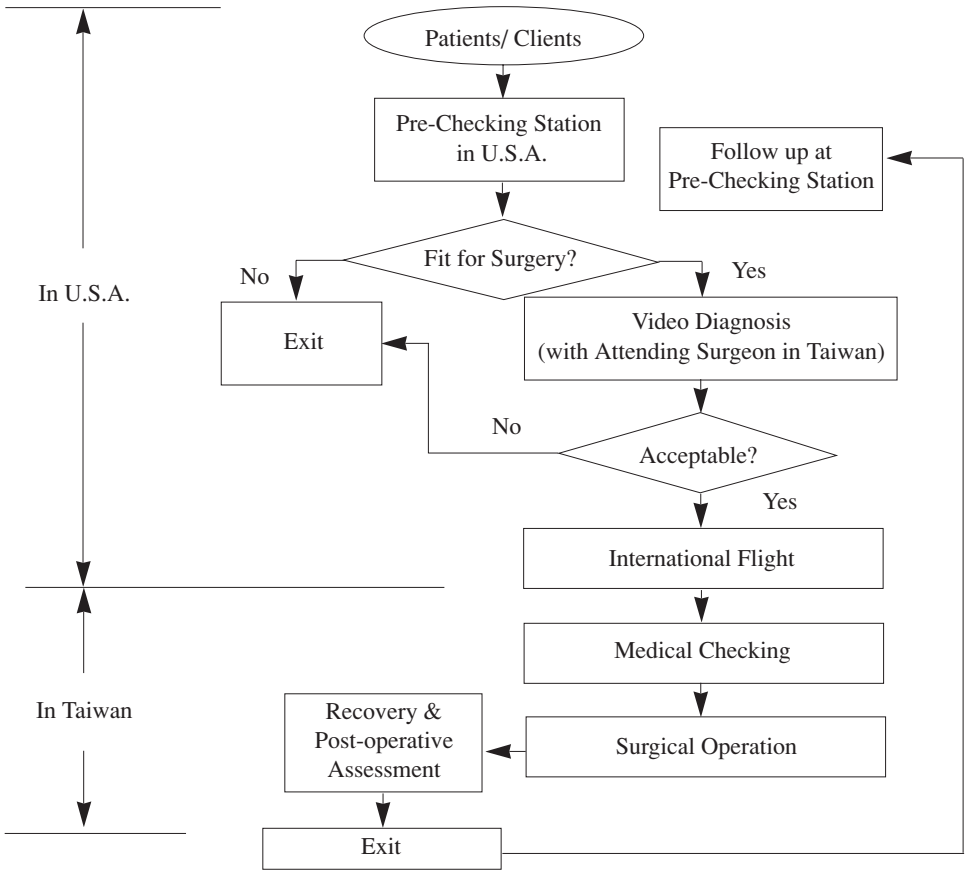

Figure Flowchart showing patient flow in the pre-checking medical tourism system (PCMTS). The *arrows* represent patient flow between activities.

hours for each patient and another half an hour for an X-ray examination, by a doctor and a nurse. A website of salary surveys for physicians and nurses shows the annual income of a sports medicine physician in the U.S.A. is around $208,000 and that of a licensed nurse is about $50,000.[19] A nurse in northern California may make $40 per hour while the salary of one in rural Oklahoma may be closer to $20 per hour. The market in medical travel makes a big difference in the hospital operations, if we assume the hourly wage of a doctor in charge of pre-checking is $80, with $20 for a licensed nurse. Therefore, the variable cost in this process is ($80 + $20) x 2.5 hr = $250, which accounts for the labor costs charged to clients for the pre-checking procedure in the U.S.

Video Medical Checking – C_{vd} is the fixed (sunk) costs that mainly denote investment in video equipment. The variable cost, again, is the labor fee paid to the doctor in Taiwan working for the medical travel destination hospital. The doctor must confirm through a video check that the American patient is suitable for joint replacement surgery. It takes approximately half an hour to make the final confirmation that a patient is qualified for the PCMTS. In Taiwan, the monthly salary of an attending orthopedic surgeon in a medical center is around US$6,000. Assuming a doctor works 8 hours a day, 24 days a month at the destination hospital, at this stage, the variable charge for half an hour is about US$15.

Flight – Airfare for a round-trip flight between Taiwan and U.S.A. changes constantly. Two important factors concern whether the flight is non-stop and whether the flight time falls during a holiday season. Hospitals in Taiwan typically team up with travel agencies in the U.S. to make medical travel

more affordable and more attractive for Americans. Charges for a round-trip direct flight between Taipei and the western U.S. during regular seasons range from US$800 to US$1,300 per person. This study used the upper limit, $1,300, in the estimate to include potential patients from places other than the west Coast of the U.S.

Follow Up – Having received medical treatment in Taiwan, the patients go back to the U.S. and receive follow-up procedures from the original staff at the PCMTS pre-checking station. Typically, each patient receiving either a TKR or THR operation needs follow- up three times at the checking station. Each visit takes about one hour for a medical doctor and a nurse to complete the post-treatment examination. Cost for the follow- up stage for a patient is estimated to be US$300, or 3 x ($80 + $20).

Costs charged in Taiwan: As hospital administrators are able to adjust the fees charged to patients seeking medical care in Taiwan, benefits come from the tradeoffs between health care costs and medical travel pricing.

Medical Checking and Surgical Operation (MC&SO) – Medical checking (MC) procedures include health history inquiry, radiographs, blood tests, and other examinations. The most important stage in medical travel occurs in the surgical operation (SO), which includes anesthesia, the operation, and nursing care. Table 1 shows the costs of the PCMTS charged in, for example, Chang Gung Memorial Hospital for this MC&SO stage,[20] with similar charges for surgery for TKR or THR. These potential American clients are not covered by Taiwan NHI privileges. In this study, the associated average, US$3,700, denotes the cost to each patient at this medical checking and surgical operation stage by assuming half the clients will have a TKR and the other half will have a THR (Table 1).

Recovery – In NHI reimbursement, the cost per day for a basic-level three-bed ward room in a Taiwan hospital is about US$17. Durations for surgical recovery may differ depending on patients' health complications and other personal considerations. The term of conditions in the medical travel contract often indicates a one-week recovery period. We estimate the charges for each foreign patient at this last stage of the PCMTS to be US$120. This amount may vary with the length of hospital stay and the level of ward room occupied by patients.

Table 1. Charges (in US dollars) for MC&SO for TKR and THR in Taiwan

Surgery	NHI Coverage	SO	MC	Total
TKR	With coverage	$120	$400	$520
	Without coverage	$1,250	$2,500	$3,750*
THR	With coverage	$125	$450	$575
	Without coverage	$1,350	$2,300	$3,650*

Abbreviations: SO: surgical operation; MC: medical checking; TKR: total knee replacement; THR: total hip replacement; NHI: national health insurance. *: medical charges for foreigners living in Taiwan who do not have national health insurance coverage. Data were obtained from the international service center at Chang Gung Memorial Hospital.[20]

RESULTS

This study classified and divided all related fees charged to each American patient undergoing either TKR or THR through the PCMTS into two categories. One is the costs incurred outside of Taiwan, such as those for pre-checking ($250), video checking ($15), international flights ($1,300), and follow-up procedures ($300). This part is beyond the control of hospital administrators in Taiwan, and is denoted as Cfixed. These fixed costs in the PCMTS proposal are calculated as follows:

$$C_{fixed} = \$250 + \$15 + \$1{,}300 + \$300 = \$1{,}865. \quad (1)$$

The other category consists of fees for MC&SO and recovery charged in Taiwan. This amount is adjustable and subject to hospital administrators' financial planning ability and market considerations. This adjustable charge for each patient undergoing joint replacement surgery is denoted as C_{adjust}, which adds the multiple of the base cost ($3,700) of MC&SO to that of base cost ($120) in recovery. That is,

$$C_{adjust} = \$3{,}700 \times k + \$120 \times h, \quad (2)$$

where the pricing coefficients "k" and "h" represent the different needs in MC&SO and recovery. This allows a hospital administrator to adjust revenue margins for providing medical travel. In summary, the total charges (TC) to an American patient using

the PCMTS for either TKR or THR surgery in Taiwan are estimated by adding (1) and (2):

$$TC = \$1865 + \$3,700 \times k + \$120 \times h. \quad (3)$$

Table 2, provided by the TTFMT, gives pricing information for an American undergoing either TKR or THR surgery in these two countries. An American patient will pay at least triple the cost to undergo joint replacement surgeries at home than in Taiwan. This proves the potential of developing medical tourism in Taiwan, as it offers the prospect of greatly reduced expenses for health care as well as reduced waiting times. Pricing the possibility of outsourcing common medical procedures, while promoting medical tourism from the U.S., is crucial. According to Table 2, the cost for an American client undergoing joint replacement using PCMTS falls between $10,000 and $30,000 (Table 2).

Cost could be the most important reason why individuals from the U.S. elect medical tourism. Other than the fixed costs, $1,865, in equation (3), hospital administrators providing medical tourism could opt to adjust the other part, $3,700 x k + $120 x h, where "k" means the pricing multiple for surgery, and "h" stands for different levels and number of days for room and board. Table 3 shows some combinations of "k" and "h", where legitimate pricing numbers are listed within the gray highlighted area. In contrast to the lower right counterparts, upper left pricings within the gray highlighted area fall between $10,000 and $20,000, which can attract more patients but contribute less profit margin per capita. For example, website information from the International Service Center at CGMH shows the single-bed room charge for medical tourism is approximately $1,200 per week and this is equivalent to a parameter "h" at around 10.[20] Hospital administrators can reasonably range the other parameter "k" between 2 and 7, and the price for the PCMTS increases accordingly from $10,465 to $28,965. This depends on the tradeoff between lower prices to attract more customers and higher prices to obtain a

Table 2. Surgery Charges for Americans in the U.S.A. and Taiwan

Surgery	U.S.A.	Taiwan	USA/TW
TKR	30,000*~53,000	10,000*	3~5.3:1
THR	33,000~57,000	8,800	3.75~6.48

Abbreviations: USA/TW: ratio of US costs to Taiwan costs. TKR: total knee replacement; THR: total hip replacement. *: upper and lower bounds of reasonable pricing ranges used in this paper to recruit American patients for the PCMTS. Data are obtained from the website of the Taiwan Task Force for Medical Travel.[14]

Table 3. Inpatient Pricing Table for TKR/THR Surgery in Taiwan via PCMTS

k \ h	1	5	10	25	50	100	150	200	250
1	5,685	6,165	6,765	8,565	11,565	17,565	23,565	29,565	35,565
2	9,385	9,865	10,465	12,265	15,265	21,265	27,265	33,265	39,265
3	13,085	13,565	14,165	15,965	18,965	24,965	30,965	36,965	42,965
4	16,785	17,265	17,865*	19,665	22,665	28,665	34,665	40,665	46,665
5	20,485	20,965	21,565	23,365	26,365	32,365	38,365	44,365	50,365
6	24,185	24,665	25,265	27,065	30,065	36,065	42,065	48,065	54,065
7	27,885	28,365	28,965	30,765	33,765	39,765	45,765	51,765	57,765
8	31,585	32,065	32,665	34,465	37,465	43,465	49,465	55,465	61,465

Abbreviations: TKR: total knee replacement; THR: total hip replacement; PCMTS: pre-checking medical tourism system. *: inpatient charges currently adopted at the international service center of CGMH.[20]

larger surplus per capita (Table 3).

Hospital administrators' estimation of the surplus per patient (SP) may change their pricing decisions to recruit more American customers to use PCMTS. Since the fixed cost (C_{fixed}) of $1,865 is charged for all services occurring outside Taiwan, and the base costs for MC&SO and a one-week hospital stay in Taiwan are $3,700 and $120, respectively, hospital administrators can estimate the SP undertaking joint replacement in the PCMTS as follows:

$$SP = TC - (C_{fixed} + \$3{,}700 + \$120)$$
$$= \$3{,}700 \times (k - 1) + \$120 \times (h - 1). \quad (4)$$

To attract patients from the U.S. to use the PCMTS for joint replacement surgeries in Taiwan, the price ceiling of the total charge (TC) of equation (3) should be no greater than the least possible charge at home, $30,000, as shown in Table 2. The surplus per patient in expression (4) is no more than $24,315, as follows:

$$SP = TC - (C_{fixed} + \$3{,}700 + \$120)$$
$$\leqq \$30{,}000 - (\$1{,}865 + \$3{,}700 + \$120) = \$24{,}315.$$

DISCUSSION

Pricing for the proposed PCMTS can definitely influence the number of American patients per year (denoted by NP) coming to Taiwan to undergo joint replacement surgeries. Marketing theory justifies that the number of patients per year (NP) decreases with respect to parameters "k" and "h" in the surplus per capita (SP). Knowing that the parameter "k" contributes greater marginal surplus in (4), hospital administrators have to select "the best" combinations of "k" and "h" to maximize the annual total surplus (ATS), which equals the product of the surplus per capita and the number of patients per year (SP x NP). For example, if k = 4 and h = 10, by equation (3) TC = $17,865, which is about half the charge for undergoing TKR/THR in the U.S., and by equation (4) SP = $12,180, which is halfway to its ceiling (or cap). This case has a better chance to maximize the ATS (= SP x NP) than using an SP which is either too large or too small, since NP goes in the opposite direction of SP. Managers are advised not to overestimate NP, particularly at the initial stages of PCMTS.

As the proposed business model is new and installation and operation costs will be high, managers may need to determine the number of years needed to turn this system into a profitable one to help hospital owners see the feasibility of PCMTS. Two main sunk costs throughout the PCMTS procedures consist of the installment cost at the pre-checking process ($C_{install}$) and the investment for equipment used for video medical checking (C_{vd}). Note that the yearly total surplus (ATS) brought by the PCMTS is equivalent to SP x NP. Managers need to determine the following to conclude the length of time for a break-even profit:

$$SP \times NP \times (\text{number of years}) \geqq C_{install} + C_{vd}. \quad (5)$$

Assuming that the sum of both sunk costs, $C_{install} + C_{vd}$, is $12,000,000 (twelve million US dollars) and the surplus per capita is SP = $12,180, if the number of potential patients undergoing TKR or THR in this hospital joint PCMTS is estimated as NP = 100 (one hundred American clients every year), it will take ten years to turn this business plan into a profitable venture. If hospital administrators are optimistic and double the estimate for annual numbers of clients (NP = 200), it will only take five years to make money.

Factors related to break-even analysis are numerous, and some exogenous conditions such as new health care policies for reimbursing diagnosis-related groups might even be crucial to hospital administrators' decisions in implementing medical tourism. The medical service market is huge and competitive; therefore, evaluation of cost feasibility of any new proposal must be done very carefully. Although healthcare goes along with society and/or community responsibilities, there is no reason for hospitals to sink into price competition and sacrifice quality in the international medical service market. Reasonable pricing adjustment for managers is very important in balancing the sound operation of hospitals and good service to patients, while considering the cost feasibility of implementing medical tourism.

Extra costs of medical disputes/lawsuits and care for patients are not taken into account in this study. Although the complexity of the PCMTS limits our exact estimation of all associated costs, this article is unprecedented in modeling pre-checking processes in overseas countries where Taiwan hospitals would like to promote medical services. In this novel business proposal, patients from abroad will no

longer risk wasting time and money for medical tourism for which they may not be qualified. Moreover, local pre-checking stations can function as recovery follow-up stations for patients who have previously undergone medical treatment in Taiwan. This operational design will increase potential patients' willingness to undertake medical tourism to Taiwan. The pre-checking model in this article is innovative, as it can be applied to patients in countries other than the U.S., and the feasibility evaluation framework by cost analysis is workable for outsourced medical procedures other than TKR and THR.

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從成本費用探討美國病患以境外預檢醫療旅遊赴台接受關節置換手術的可行性

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背 景： 目前亞洲國家開始注意到國際醫療旅遊對其經濟發展的重要性。事實上，由於許多台灣的醫療人員曾在美國接受訓練，因而能夠提供尖端的醫療服務，這對於台灣發展國際醫療旅遊具有相當的利基。尤其對需要接受膝、股關節置換手術的美國病患而言，台灣的醫院就能提供相對低價且短時間內就能進行手術的醫療服務。

方 法： 本文先建立一個適用於美國病患以境外預檢醫療旅遊赴台接受關節置換手術的系統流程，並以成本分析來估計此系統中各步驟所需之醫療成本。另外，針對檢查後手術與住院兩大項目的成本費用進行敏感度分析，以瞭解此兩項費用的定價是如何影響每位經由境外預檢來台接受關節置換手術之美國病患對醫院的獲利貢獻。最後先估算每年會透過境外預檢之美國病患人數，再藉由損益平衡來評估台灣醫院參與此醫療旅遊系統的可行性。

結 果： 本文建立了境外預檢的嶄新模式，對於美國病患經由醫療旅遊赴台接受手術返回後，原預檢站亦成爲其康復照顧的聯絡站。對有意實施境外預檢醫療旅遊系統的醫院而言，管理者可以彈性定價的兩個項目是診斷手術費用 (基礎成本約美金 $3,700) 與住院費用 (基礎成本約美金 $120)。考量每年參與境外預檢醫療旅遊來台接受關節置換手術的美國病患人數，本文也提供管理者在進行年度利潤最大化的彈性定價原則。另外，以關節置換手術的醫療旅遊而言，每位美國病患對實施醫院的邊際利潤貢獻最高可達約美金 $24,315。

結 論： 本文藉由成本分析的方法，完成應是第一篇有關境外術前檢查與入境手術替換膝與股關節費用之估計。對醫院管理者而言，本文的成本分析架構亦可適用於評估其他醫療旅遊手術專案之可行性。

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關鍵詞： 醫療旅遊，關節置換手術，成本分析，定價

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