Chapter 5

The Costs and Economics of ESWL

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INTRODUCTION

The costs and economics of providing extracorporeal shock wave lithotripsy (ESWL) are central to public policies regarding this technology. Lower provider costs can lead to lower health care expenditures, an important goal of payment policies. Also, to the extent that the total system costs of ESWL are minimized, resources are freed for other uses, The interaction between provider costs and public policies works both ways; the decisions of health care payers and planners can affect the cost of providing ESWL, because these policies influence decisions to purchase and use the technology.

ESWL equipment is very expensive to purchase and maintain. Consequently, if only a few patients are treated, the cost to the ESWL center of treating each patient is high; as more patients are treated, per-patient costs decline. But the economics of ESWL involve more than a consideration of facility costs. Professional costs are also vital because patients are referred to ESWL centers by physicians, and physicians perform the procedure. Physicians' access to ESWL and their income from performing ESWL relative to other treatment technologies, which depends on relative costs and payment rates, affect their willingness to recommend and perform ESWL treatment.

As background for the discussions of payment and planning policies and their implications, this chapter reviews the available literature on the current costs of ESWL to hospitals, physicians, and other providers, and to some extent to patients. [1] Constraining this review is the fact that the literature on ESWL costs is very sparse, and the fact that the resource costs of many of the components of hospital and physician services are unknown or controversial. For example, the dollar value of costs such as physician time can be calculated in several ways; a physician's own charges can be interpreted (after accounting for overhead) as the value that he or she places on the time spent providing a service. Consequently, charges are often used in the medical literature as a proxy measure of costs. The proxy may sometimes be a very poor one, and the charges reported here do not necessarily indicate the actual input costs to physicians, hospitals, or other facilities of providing any one technology. Charges as well as costs are nevertheless discussed in this chapter because in many cases they are the only cost-related information available, because they may give some indication of the relative costs of providing one technology compared to another, and because they matter to many payers of health care services.

The costs of providing ESWL vary greatly with the number of patients treated, the site of care, the device used, and the mix of physicians and technicians performing the procedure. The first part of this chapter reviews the major components of the costs of ESWL to the hospital or other purchaser and discusses the implications of ESWL's high fixed costs. The chapter then describes the costs and economics of physicians' ESWL services. Finally, it discusses comparative costs and charges for alternative technologies to treat upper urinary stones, including the disability time (hospitalization and recuperation) associated with ESWL and with its alternatives.

[1] Unless otherwise specified, "cost, " as used in this chapter, refers to the resource costs to the provider for the inputs purchased, Hospitals and other facilities purchase inputs such as supplies, employee time, and equipment; physicians' costs include time, educational expenses, and office overhead. "Charges" are the prices that providers (hospitals, ambulatory treatment facilities, and physicians) attach to their services and are not necessarily directly related to their costs To complete the circle, what third-party payers actually pay to providers for these services is not necessarily equal to either providers' costs or charges.

COSTS TO THE HEALTH CARE FACILITY

The facility-related costs of ESWL can be divided into three categories: 1) the fixed capital cost of purchase and installation, 2) the costs of operating the machine, and 3) other institutional costs of caring for ESWL patients. These costs vary depending on the extent of renovation or construction necessary, the number of patients served, and the type of facility (such as a free-standing ambulatory clinic or a hospital). They will also vary, in the future, depending on which ESWL device is used.

Capital Costs

The two major components of fixed capital costs for ESWL are the cost of the machine itself and the cost of the facility to house it. Because the Dornier lithotripter is manufactured in West Germany, its cost varies somewhat according to the international exchange rate but has been approximately $1.7 million for the past year. The cost of an ESWL facility is much more variable, because it depends on the needs and goals of the hospital or other organizations that own it. The installation (construction and renovation) costs of the first six hospitals in the United States to acquire the device averaged $375, 000 and ranged from *$200,000* to $1,080,000 (3,11). In the latter case the new facility included not only a room to house the lithotripter but accommodations for a vastly expanded patient load, physicians' offices, and a 50-seat auditorium (3,82).

The installation costs of future hospitals acquiring ESWL will depend on the extent to which ESWL will expand (rather than replace) current services. If renovation of existing cystoscopy rooms and office space are sufficient, construction costs will be low. The American Hospital Association estimates that most future hospitals can adapt their facilities for ESWL at a cost of about $250,000 (3). Dornier itself has estimated that, when only renovation of existing surgical space is necessary, installation can be performed for as low as $100,000 (14). The Blue Cross and Blue Shield Association chose to use a figure halfway between these two *($175,000)* **as** its estimate (14). Considering these and the previous figures, it is reasonable to assume that the total fixed, capital cost of purchasing and installing a Dornier lithotripter at present is around $2 million. A lithotripsy center requiring substantial new construction, of course, would have higher costs.

Following standard practice, current estimates assume a 5-year life of the present machine (14). The Blue Cross and Blue Shield Association estimated interest expenses in 1985 at an additional $219,000 per year (14) (see table 5).

The anticipated lower purchase and installment costs of second-generation ESWL devices are a major selling point for their manufacturers. An important point to note is that some of these devices are expected to lower the installment costs of ESWL because they do not require a separate room, devoted to ESWL, to house the devices; they can be used in established surgical suites. The purchase costs are also expected to be lower than for the Dornier device, although since only Medstone had installed one in a U.S. hospital as of December 1985, the extent of savings is still uncertain. Medstone expects to price its device at approximately $850,000 (31). Northgate plans to price its device at approximately $400,000 (153). EDAP's lithotripter is tentatively priced at around $500,000, depending on the exchange rate (2,49). The effectiveness of these devices compared to the Dornier lithotripter cannot be known until they have been tested on a number of patients.

Operating Costs

Compared to fixed capital costs, the costs of operating an ESWL device probably will change somewhat less with the advent of the smaller devices. Typical costs of operating a lithotripter unit include the costs of technical and nursing staff, administration, insurance,[2] supplies (such as X-ray film, electrodes, and anesthesia), and the maintenance contract for the machine. The cost of a maintenance contract and the cost of the

[2]In addition to the insurance that the owner of an ESWL device , and facility carries to protect itself, Domier requires that purchasers of its lithotripter indemnify the manufacturer against any liabilities not attributable to Dornier's own negligence (81).

Table 5.—Two Estimates of Hypothetical Annual Facility Costs of the Dornier Lithotripter, 1985

	Cost estimates				
	American Hospital Association		Blue Cross and Blue Shield Association		
Input	800 cases/year	1,000 cases/year	1,000 cases/year	1,500 cases/year	2,000 cases/year
Capital costs:					
Interest	$120,000	$120,000	$219,000	$219,000	$219,000
Depreciation (equipment and facility)	40,000	400,000	365,000	365,000	365,000
Subtotal	520,000	520,000	584,000	584,000	584,000
Capital cost per case	650	520	584	389	292
Technical operating costs:					
Salaries for additional full-time employees	$131,000	$131,000	130,000	130,000	130,000
Insurance	75,000	75,000	75,000	75,000	75,000
Office and building expenses	26,000	26,000	30,000	30,000	30,000
Lithotripter annual service contract	188,500[b]	271 ,500[b]	1 17,500b	1 17,500b	1 17,500b
Electrode costs (est. $300/procedure)	240,000	300,000	300,000	450,000	600,000
Medical supplies (est. $30/procedure)	24,000	30,000	30,000	45,000	60,000
Collection fee[c]	192,000	240,000	—	—	—
Subtotal	864,000	978,000	655,500	807,000	958,500
Technical operating cost per **case**	**1,080**	***978***	***656***	***538***	***479***
Total technical cost	$1,384,000	$1,498,000	$1,239,500	$1,391,000	$1,542,500
Total technical cost per case	1,730	1,498	1,240	927	771
Ancillary and routine operating costs:					
Ancillary services per case	—	—	300	300	300
Routine inpatient services per case	—	—	800	800	800
Total operating costs per patient			**$1,756**	**$1,638**	**$1,579**
Total facility costs per patient.			**$2,340**	**$2,027**	**$1,871**

[a]Includes salaries **arid** benefits for additional nursing, technical, and administrative personnel Does not Include physician salaries or charges
bAs of December 1985, Dornier's quoted price for a maintenance contract was $87,0130 for the first year and $125,000 for each subsequent year, yielding an average of $11 7,500 over 5 years
c"*Collection* fees are assumed to be the gross revenue less uncollectible charges, multiplied by 10 percent, which amounts to $240 per case This is the fee the hospital's patient billing department may impose on a lithotripter treatment center that is not Integrated with the hospital, such as a free-standing, outpatient treatment center" (3)

SOURCES H C. Alder, *Lithotripters: Non/n vasive Devices for the Treatment of Kidney Stones, AH A-012828* (American Hospital Association, Chicago, I L), 1985, Blue Cross and Blue Shield Association, *Extracorporeal Shock Wave Lithtripsy: Clinical Assessment, Utilization and Cost Projections* (Chicago, IL BC/BSA, May 1985)

energy source (the electrode, in the Dornier device) are the operating costs most likely to vary among different ESWL models. For example, Dornier charges $200 per electrode for small orders and $160 per electrode for large orders (2,000 or more) (125). At present, ESWL requires approximately two electrodes per patient. In contrast, Medstone plans to charge *$750* per patient for electrodes for the first 300 patients served by a unit and assumes a use of one Medstone electrode per patient. The price will decrease to $500 per patient for the second *300* patients, *$250* for the third *300,* and $100 for each patient after (31). Other methods of generating the shock wave, or longer lasting, inexpensive spark-gap electrodes, might lower operating costs further.

Preliminary and follow-up lab tests, X-rays, and routine hospital care (when the patient is hospitalized) are additional costs of caring for ESWL patients. Adjunct procedures, such as placement of a ureteral catheter, may also raise costs. Some of these costs may change as experience with ESWL technology increases, but they are not likely to be greatly affected by alternative devices currently under development unless those devices differ significantly in effectiveness from the Dornier lithotripter and require a different level of patient care.

Effects of Patient Caseload

The most important aspect of the cost to the facility of providing ESWL, other than the fact that it is high, is that it declines dramatically as caseload (the number of patients served) increases. This characteristic of ESWL is largely due to the high fixed costs of purchasing and installing a lithotripter, costs faced by a hospital or other lithotripsy facility regardless of how many patients are actually treated (although the costs might be slightly higher if the initial planned caseload was high). The consequence of this characteristic is that, at high volumes and constant per-case revenues, providing ESWL can be a very profitable venture[3] as well as an advancement in treatment alternatives and quality of care. Methodist Hospital of Indiana, for example, estimated that during its first year of offering ESWL it realized a profit of *$400* per case *(92).* This potential profitability of ESWL makes it very attractive to many hospitals and physician groups. Ironically, if many facilities provide the technology, the caseload of each facility will be low, and few may actually realize those profits. Even so, a hospital might choose to acquire an ESWL unit and accept little or no profit per case if, by doing so, it could avoid losing patients to competing providers.

Two independent estimates of the total facility-related costs of providing ESWL, for a hypothetical hospital-based ESWL facility, are summarized in table 5. These hypothetical costs of an efficient facility can be contrasted with the average reported operating costs of several hospitals with ESWL units, as summarized in table *6.* Clearly, the actual operating costs of these latter hospitals were substantially higher, with most of the difference in the routine and ancillary costs. A substantial portion of these high ancillary costs may be due to the requirements of the investigational protocol when ESWL was first introduced, since the early ESWL centers were included in the surveyed hospitals in table *6.*

Table 6.—Average Per-Case ESWL Operating Costs of Hospitals As Reported in Two Surveys, 1985

	Prospective Payment Assessment Commission[a]	Georgetown University[b]
Number of hospitals surveyed	7	16
Utilization:		
Number of cases/year	1,200[c]	1,042
Number of ESWL shocks/case	1,100[c]	1,594
Operating costs per case:		
Technical costs	$ 667	$1,163
Room	777	637
Other services	1,268	1,320
Total	$2,712	$3,120

[a] Figures used by the Prospective Payment Assessment Commission are, with the exception of utilization assumptions, derived from costs reported by seven of the first hospitals to establish ESWL units in the United States (19).
[b] Figures used by Georgetown University are average reported costs of treating Medicare patients, from a survey of 16 hospitals (131).
[c] Utilization figures used by the Prospective Payment Assessment Commission are not actual figures reported by the hospitals, but rather are assumptions derived from data provided by the American Urological Association and the American Hospital Association (19). The fact that the Commission's assumed figures are higher than Georgetown's actual utilization averages may account for Georgetown's higher technical costs, which are sensitive to caseload.

SOURCE: Prospective Payment Assessment Commission, *Report and Recommendations to the Secretary, U.S. Department of Health and Human Services* (Washington, DC: U.S. Government Printing Off Ice, Apr. 1, 1986).

[3] "In economic theory, profits are expected to be just high enough to induce suppliers of a product to stay in the market to meet the demand. In a perfectly competitive industry, where entry and exit are entirely free and no artificial pricing policies are followed, profits would tend to stay at the minimum level. Excess profits higher than that level can occur when the producers of a service have some measure of monopolistic power" (181).

To the extent that serving a very large caseload requires additional construction and facilities, the decline in per-case costs as patient load increases that is demonstrated in table 6 may be overstated. However, it is notable that even substantial increases in the estimated costs presented in this table have only a small effect on per-case costs. For example, for a facility serving 1,500 patients per year, actual annual costs that were $100,000 higher than the costs estimated by the Blue Cross and Blue Shield Association (see table 5) would increase per patient costs by only $67, from $2,027 to $2,094.

That the first hospitals to provide ESWL are probably all profiting from offering this service is evident from comparing table 6 with table 7, which lists the 1985 charges for ESWL treatment (not including charges for physician, ancillary, or inpatient care services) at each of the first six institutions to furnish it. There is no clear pattern between caseloads and charges for these hospitals.

Ambulatory Centers

One strategy for lowering ESWL-associated facility costs, attractive to many current and potential ESWL providers, is to lower or eliminate the patient care costs associated with a hospital stay. From its introduction in the United States until June 1985, ESWL was performed almost exclusively as a hospital inpatient procedure, in which the patient w-as hospitalized the day before the procedure and stayed in the hospital 2 or 3 days afterward for observation. Fewer than 3 percent of all treatments in the United States had been performed on ambulatory patients (no overnight hospital stay) as of May 1985 (11), and all existing ESWL units were in, or adjacent to, hospitals. In the future, ESWL could become an ambulatory procedure in a substantial number of cases, although the comparative quality of care when patients receive ESWL in this setting has not yet been assessed.

Table 7.—Approximate Average Technical Charges and Caseloads at the Six Longest-Operating Extracorporeal Shock Wave Lithotripsy Sites in the United States, May 1985

Hospital	Technical charge	Estimated patients per year
Methodist Hospital (Indianapolis, IN)	$1,600	2,000-2,200
University of Virginia Hospital (Charlottesville, VA)	2,800	1,800-2,000
Baylor Unwersity-Methodist Hospital (Houston, TX)	3,000	1,300-1,500
University of Florida-Shands Hospital (Jacksonville, FL)	3,000	900-1,100
New York Hospital-Cornell Medical Center (New York, NY)	3,600	1,100-1,300
Massachusetts General Hospital (Boston, MA)	4,050	1,000-1,200

SOURCE Blue Cross and Blue Shield Association, *Extracorporea/ Shock Wave L/thotr/psy C/inica/ Assessment, Uti/izat/on and Cost Projections,* Chicago, IL, May 1985

An obstacle to routine ambulatory use of ESWL is the need for patients to have rapid access to emergency health facilities if complications arise or intramuscular pain medication becomes necessary. In one of the first U.S. hospitals to offer ESWL, for example, 6 of 31.5 ESWL patients were treated as outpatients, but 2 of these were subsequently readmitted to the hospital for relief of pain that did not respond to oral medication (11). If a large number of patients must be treated in emergency rooms, or must be admitted to the hospital, the extent and cost savings of ambulatory treatment may be far less than currently anticipated.

Nonetheless, three free-standing extracorporeal lithotripsy facilities that intend to treat primarily ambulatory patients opened in 1985, and thus far these facilities have succeeded in avoiding hospitalization for the great majority of their patients (86). For example, the first of these, a free-standing facility in northern California that opened in June 1985, treated 277 patients, ranging in age from 14 to 77 years, between June 20, 1985 and October 1, 1985. Twenty-five of these patients (12.1 percent) were admitted to a hospital after treatment (86). Patients at this facility are referred by their urologists, visit the facility on the day preceding treatment, and may either return home or stay at a local hotel the evening after treatment (68). The facility charges approximately **$7,200** for a simple ESWL treatment, including the physician's fees (68), and was treating about 20 patients per week after 2 months in operation (86).

IMPLICATIONS OF HIGH FIXED COSTS

The high fixed costs of ESWL have important implications for its financial costs and benefits, both when it is considered alone and when it is compared with alternative technologies. If there are many ESWL centers, each one will treat fewer patients, have higher per-patient costs, and probably require more payer expenditures than would otherwise be the case.

As large numbers of patients are treated at an ESWL facility, costs decline for two reasons. First, and most importantly, the capital costs of purchase and installation are spread across a larger number of individuals. The effect of spreading costs is evidenced in table 5, which demonstrates that doubling caseload could reduce per-case technical costs for the procedure by as much as one-third. Second, the unit cost of electrodes for the Dornier lithotripter-a significant component of operating costs—declines if the electrodes are purchased in large volumes.

The direct association between volume of *use* and per-case cost of ESWL has prompted a number of individuals and organizations to estimate the number of ESWL centers that can or should be established, given a large caseload (and thus lower costs) at each center. As indicated in chapter 2, the number of patients with urinary stones who might be treated with ESWL rather than surgery could be as low as a small proportion of the *65,000* patients per year who undergo surgery on the upper urinary tract; it could be as high as the roughly *874,000* patients per year who are diagnosed with some type of urinary stone. Estimates of a number for whom ESWL might be reasonable and necessary range from 26,000 to 140,000, all based on patients hospitalized with stones but varying depending on the proportion of these for whom ESWL is judged to be appropriate. Similarly, an appropriate caseload for an ESWL center has been assumed to be as low as *800* patients treated per year (11,71) and as high as 2,000 patients (14). (The first figure is actually quite low, and the latter is by no means a practical maximum; a few hospitals are already serving 2,000 or more patients per year.) On the basis of these estimated caseloads, the number of ESWL centers required in the United States to treat patients who would otherwise require invasive treatment has been estimated at between 17 and 175 (11,155).4 These estimates are summarized in table 8.[5]

The importance of these estimates is not the actual quantities but their use as a baseline comparison and as an indication that the number of devices needed to serve the population with stones requiring aggressive treatment is not large. The estimates offer a stark contrast with the reality: Dornier had delivered 50 lithotripters to hospitals in the United States by the end of 1985, and the company plans to have a total of about 100 installed by the end of 1986 (125). The locations of the ESWL units installed through December

'The lowest estimate of ESWL units needed (17) was based on an estimated 26,000 patients undergoing surgery for upper urinary stones but used only 1,500 patients as an appropriate caseload. Applying a caseload of 2,000 patients per year, used in a separate estimate, to this number of eligible stones would yield a minimum of 13 ESWL units needed in the United States.

[5]The American College of Physicians has recommended regionalization of ESWL but has not specified an "appropriate" number of devices (s).

Table 8.—Estimates of Number of Extracorporeal Shock Wave Lithotripters Required in the United States

	Estimated lithotripters required		
	Low	Middle	High
U.S. Department of Health and Human Services, ., .,	–	100	–
American Hospital Association ...	28	–	48
American Urological Association[a] (1)	–	100	–
American Urological Association (2)	42	–	170
American Urological Association (3)	45	–	175
Blue Cross and Blue Shield Association	28	50	93
Showstack. et al. .	17	–	106

aThe American Urological Association estimated the number of lithotripters required under several different assumptions.

SOURCES: H,C. Alder, ***Lithotripters: Noninvasive Devices*** *for* ***the Treatment of Kidney*** *Stones* **AHA-012828** (American Hospital Association, Chicago, IL, 1985); American Urologic Association, "Summary and Recommendations of the Ad Hoc Committee To Study the Safety and Clinical Effectiveness of the Current Technology of 1) Percutaneous **Lithotripsy,** and 2) Non-Invasive **Lithotripsy,"** presented to the American Urologic Association as a Preliminary **Report,** New Orleans, LA, May 9, 1985, unpublished **mimeo;** Blue Cross and Blue Shield Association, ***Extracorporeal Shock*** *Wave* ***Lithotripsy: Clinical*** *Assessment,* ***Utilization*** *and Cost Pro/actions,* May 1985; *HHS News,* statement by Margaret M. Heckler, Secretary of Health and Human Services, Dec. 19, 1984; **Showstack,** J. A., Perez-stable E. J., and **Sawitz,** E., **"Extracorporeal** Shock Wave **Lithotripsy**: Clinical Application and Medicare Physician Payment," paper prepared for Office of Technology **Assessment,** Aug. 1, **1985**.

1985 are given in table 9. A notable point from this table is that while 26 States did not yet have an ESWL unit by the end of 1985, 13 States already had more than one.

The decreases in per-case costs that accompany increases in caseloads provide a strong incentive for hospitals to attempt to increase the number of patients using this treatment. If a large number of devices are purchased and their services offered to patients, per-case costs to the ESWL center will rise unless other stone patients, who would not previously have been considered for surgery, are treated. The high estimate of *874,000* newly diagnosed stones each year indicates how large this potential market could be. ESWL centers will have strong incentives to encourage physicians to prescribe ESWL treatment for patients who formerly would have been treated medically. Rather than being treated conservatively with pain medication and fluids, patients with newly diagnosed stones and in acute pain may be scheduled for immediate ESWL, regardless of the size of the stone. Indeed, at least one hospital already offers ESWL on this basis to some patients *(82).*

Table 9.— Dornier Lithotripters Installed in the United States as of December 1985

State	City	Purchaser	State	City	Purchaser
Alabama	Birmingham	AMI-Brookwook Medical Center		New Orleans	Tulane Universlty
	Mobile	Springhill Health Service	Massachusetts	Boston	Massachusetts General Hospital
Arizona	Phoenix	St, Joseph's Hospital		Burlington	Lahey Clinic
Arkansas	Little Rock	St, Vincent Infirmiry	Michigan	Ann Arbor	Universlty of Michigan
California	Burbank	St Joseph Medical Center		Detroit	VHA– Henry Ford Hospital
	Glendale	Glendale Adventist Hospital	Minnesota	Minneapolis	University of Minnesota
	Long Beach	VHA– Memorial Medical Center		Rochester	Mayo Clinic
	Los Angeles	University of California	Missouri	St. Louis	Barnes Hospital
	Los Gates	NME–Community Rehabilitation Center	New Jersey	Marlton	Garden State Community Center
			New York	New York	Cornell University/New York Hospital
	San Francisco	University of California			
	San Jose	Los Gates Medical Center	North Carolina	Winston-Salem	North Carolina Baptist Hospital
	Tarzana	AMI– Medical Center of Tarzana		Winston-Salem	Hawthorn Medical Mall
Florida	Fort Lauderdale	North Broward Hospital		Durham	Duke University
	Orlando	Florida Medical Plaza	Ohio	Cinncinati	Bethesda Oak Hospital
	Gainesville	University of Florida		Cleveland	Calicilex Corporation
Georgia	Atlanta	Georgia Baptist Hospital		Columbus	Ohio Kidney Stone Management
	Atlanta	Emory University		Toledo	Genito Urinary Surgeons
	Macon	HCA–Coliseum Park Hospital	Pennsylvania	Philadelphia	Unwersity of Pennsylvania
	Savannah	Memorial Medical Center	Tennessee	Knoxville	HCA– Park West Hospital
Illinois	Chicago	University of Chicago		Nashville	VHA–Baptist Hospital
	Chicago	Rush Presbyterian/St. Luke's Hospital	Texas	Dallas	Presbyterian Hospital
				Houston	The Methodist Hospital, Texas Medical Center
	Peoria	St. Francis Medical Center			
Indiana	Indianapolis	Methodist Hospital	Virginia	Charlottesville	Virginia Kidney Stone Foundation
Iowa	Iowa City	University of Iowa			
Kentucky	Louisville	Humana–Suburban Hospital	Washington.	Seattle	Mason Clinic
Louisiana	New Orleans	VHA–Ochsner Foundation Hospital			

TOTAL: 50 units

Acronyms AMI—American Medical International
HCA—Hospital Corporation of America
NME—National Medical Enterprises
VHA—Voluntary Hospitals of America

SOURCE' E Polzer, Dornier Medical Systems, Marietta, GA, personal communication, October 1985

COSTS AND ECONOMICS OF PHYSICIAN SERVICES

Physicians have both direct and indirect effects on the cost of ESWL to facilities and the payments for ESWL by patients and third-party payers. Physicians make the actual decision to refer or not to refer patients for ESWL, and thus they control the number of patients treated at each facility, which in turn affects both per-treatment and total costs. Because financial factors can influence physicians' decisions, the relative cost to physicians of performing alternative treatments has significant implications for the use of, and total costs for, ESWL. Financial incentives to treat patients with ESWL are especially powerful when the physician is a part owner of the ESWL center. And, finally, to the extent that payers attempt to adjust payments to costs, physicians' costs affect expenditures directly.

Physicians, with the exception of some hospital-based physicians, have traditionally billed for their professional services separately from the services provided by the health care facility. The actual costs of providing services are exceedingly difficult to define. Not only are the relative amounts of various inputs (surgical time, advisory time, administrative time, office overhead, etc.) difficult to determine, but the value of those inputs, and their relationship to physicians' charges, is an unending subject of debate.

At least three types of physicians may be involved in a lithotripsy case. The physician in charge of the patient is most likely to be a urologist, trained in the diagnosis, removal, and other treatment of urinary stones. Urologists currently perform most surgical stone removals and most percutaneous removals and transurethral manipulations. An anesthesiologist and a radiologist may also be involved in performing ESWL, although a nurse-anesthetist may provide anesthesiology services, and the radiologist's role may be largely confined to preprocedure diagnosis of the stone and radiological follow-up.

Whether physicians other than urologists should be in charge of some ESWL cases is a matter of debate. Nephrology, for example, is a subspecialty of internal medicine centering on disorders of the kidney. However, nephrologists have traditionally not performed surgical treatment of kidney stones, and there is resistance on the part of many urologists to permitting nephrologists to perform ESWL. In the short run, at least, it is unlikely that physicians other than urologists will be in charge of the ESWL procedure itself. [b]

The fact that only urologists are likely to be performing ESWL in the near future has implications for the costs of the procedure both to those who perform it and to those who pay for it. The cost to a urologist of performing ESWL can be thought of as the opportunity cost of not spending time in alternative ways, such as in performing open surgery or percutaneous lithotripsy. If ESWL takes time, training, and skill comparable to these alternatives, then its costs are comparable. At present, there are no data on these factors, although the little evidence available indicates that ESWL takes less time—usually an hour or less (137), compared to reported percutaneous or open surgery times averaging 2 hours or more (129). To the extent that a urologist can perform ESWL more quickly than alternative procedures, the costs of ESWL to the urologist are lower.

The time it takes physicians to perform ESWL (and, hence, their costs) are, like facility costs, sensitive to the volume of services provided. Physicians will not only increase their efficiency as they perform more procedures after learning the technique, but they are likely to continue to perform it both quickly and effectively if they perform it often.

Other professional costs associated with ESWL, such as patient evaluation and follow-up services, should be roughly comparable to those required for alternative procedures. These costs may even become lower over time, since ESWL should require fewer follow-up hospital visits by the physician due to the shorter hospitalization that ESWL requires. It has been noted that ESWL currently

[b] The American Urological Association has recommended that only individuals ". . . who have expertise in surgical and endoscopic skills equivalent to those certified by the American Board of Urology; or, Urology residents in training . ." operate a lithotripter (11). Since all training is currently done by ESWL-experienced urologists, nonurologists are unlikely to be permitted to train in ESWL in the near future.

requires extensive patient-physician discussions that include informing the patient about the new technology and evaluating which patients are more suitable for a technique that is still novel. Over time, however, these costs should more closely approximate the routine evaluation necessary for any major treatment alternative.

Despite the fact that actual costs of ESWL to physicians performing it are probably lower than the costs of performing alternative procedures, and will probably decrease further, many urologists argue that charges for ESWL should be comparable to those for the surgical alternatives. Bases for this argument are, first, that ESWL requires substantial additional training on the part of the physician, and second, that ESWL replaces surgical procedures and should be charged a comparable price. These arguments carry the highest weight in the short run, when learning and evaluation costs are relatively high. However, as discussed in the next chapter on payment, price may not decline even after costs have done so. This problem makes the quantification of physician costs important to payers who wish to adjust relative payments to relative costs.

Box A presents a possible model for quantifying the costs to a urologist of performing ESWL. The model is based on opportunity costs to the physician, of which time is the most important. This example uses a surgical income (including benefits) of $218,750 per year as the basis for the value of time to a urologist. This income can be thought of as either the gross (before tax) income, after deducting office expenses, of a self-employed urologist, or as the gross income of a salaried urologist.[7] A crucial assumption of the model is that the physician values all time equally. If the time spent on services associated with ESWL is valued more highly than other time, or if the physician spends more time in preparation and evaluation than is allowed in the model, the model may undervalue the costs associated with ESWL patients. The surgical income base, however, may overvalue costs if there is a protechnology bias in the present reimbursement system (155). A lower income base would result in lower costs, since it represents a lower value for time.

Although this model relies on broad general assumptions that undoubtedly do not hold true in many cases, it does offer a basis for discussion for future estimates of the cost of performing ESWL-related services over time and for comparative costs among alternative technologies. Note that the model does not include the anesthetist's component of the total professional fee.

[7]This number appears to be a reasonable but somewhat high approximation of gross personal income. An ongoing, self-reported survey conducted by *Medical Economics* found that average gross practice earnings for urologists in 1984 were $221,230 (116). The median professional expenses for this group were $78,060 (117), yielding gross personal earnings of roughly 143,170. Note that with lower earnings, the opportunity cost of spending time performing ESWL is also lower.

COMPARING COSTS OF ALTERNATIVE TECHNOLOGIES

Data in the existing literature do not permit direct comparisons of the costs of alternative technologies for treating upper urinary stones. Charges, however, have been compared across technologies at several institutions, with results that are occasionally surprising. Table 10, for example, presents charges for stone removal at two institutions. These institutions are in different States, and interinstitutional comparisons of charges may not be entirely appropriate, but the within-institution comparisons permit some interesting insights. At the institution that performs both ESWL and percutaneous lithotripsy, total professional charges for simple ESWL are substantially less than for simple percutaneous nephrolithotomy. This difference results not from lower fees by the urologist, but from the lower anesthesiology fees and the lack of need for a radiologist. However, ESWL savings disappear when more than one treatment or additional stone manipulation is needed; total professional fees are higher for complicated ESWL cases than for open kidney surgery for stones at this institution (11).

Researchers at a second institution compared charges for three different methods of perform-

Box A.—A Model of Physician Opportunity Costs of Peforming ESWL[1]

Description of the Model

One way to estimate physician costs of performing ESWL is to calculate the opportunity costs to the physician of performing the procedure. It is perhaps easiest to understand this model if one thinks of a prepaid group practice calculating the number of procedures, including pre- and post-procedure visits, that could be completed by a urologist who is hired full time to perform ESWL.

It is assumed in this model that a physician provides patient care 35 hours per week for 46 weeks per year, totaling 1,610 patient care hours per year. This model includes both uncomplicated and complicated cases. A prototypical uncomplicated case might include:

- one prehospital office visit that includes a patient history and physical exam,
- a hospital visit,
- the procedure itself,
- two subsequent hospital visits after the procedure, and
- two office visits after hospital discharge.

The prototypical complicated case includes three additional visits in the hospital and two additional ambulatory visits as well as the visits and procedure outlined for the uncomplicated case.

The total amount of professional time calculated in this model to take care of an uncomplicated case is 5.0 hours; a complicated case is calculated to require 7.5 hours. The estimates of time include routine tasks, such as writing notes and taking phone calls. It is estimated that if all - are uncomplicated, approximately 322 procedures per year could be performed by a urologist. If all cases were complicated, approximately 215 procedures per year could be performed.

The model assumes that the cost to the group practice of hiring a full time urologist to perform procedures is $175,000 per year salary, P1us $43,750 in fringe benefits, for a total cost of $218,750.[2] Dividing this by the number of procedures per year implies that the actual opportunity cost to a urologist of performing ESWL full time, rather than spending it on other activities, is approximately $679 for an uncomplicated case and $1,017 for a complicated case. If most cases are uncomplicated, the typical cost per case might be approximately $800–approximately one-half the fee that a group practice would have to pay if a urologist were paid the same rate as urologists currently charge for open stone surgery (see table 10).

The model also assumes that a referring physician would transfer total responsibility for the patient or would perform the procedure and followup visits him/herself. Malpractice insurance fees are assumed not to change as a result of substituting ESWL for other services and are therefore omitted from the model. The fees of an anesthesiologist are also omitted from the calculation.

The Calculation

Annual opportunity costs:
$175,000 presumed annual wages for a salaried urologist
43,750 fringe benefits (25 percent of salary)
$218,750 total income expected from alternative activities

Total time available: 35 hours/week X 46 weeks/year = 1,610 hours per year (assumes 5+ hours/week for continuing education, etc.; 6 weeks vacation per year)

Potential time devoted to ESWL and related activities:

	Uncomplicated case	*Complicated case*
Prehospital history and physical exam.	1.0 hour	1.0 hour
Procedure	1.5 hours	1.5 hours
Hospital visits (0.5 hr. each)	1.5 hours	3.0 hours
Posthospital visits (os hr. each)	1.0 hours	2.0 hours
Total	5.0 hours	7.5 hours

Cost per ESWL case:
Uncomplicated case: 1,610 hours/5.0 hours per case = 322 cases; $218,750/322 cases = $679 per case
Complicated case: 1,610 hours/7.5 hours per case = 215 cases; $218,750/215 cases == $1,017 per case

*Adapted from J.A. Showstack, E.J. Perez-Stable, and E. Sawitz, "Extracorporeal Shock Wave Lithotripsy: Clinical Application and Medicare Physician Payment," paper prepared for the Office of Technology Assessment, Washington, DC, Aug. 1, 19S5.

*In 1979, the most recent year for which American Medical Association data for urologists' earnings are available, the median net incomes for urologists in solo practice were $93,530 (for those in solo practice) and $99,060 (for those in partnerships) (7). The median net income for general surgeons in solo practice in this year was $96,000. Based on the reported rate of rise in general surgeons' incomes through 19S2, the approximate median net income of a general surgeon in 19SS was $175,000; thus, this figure was used as an approximation of a urologist's median net income in 19S5 (136).

Table 10.—Examples of Average Hospital Charges for Alternative Methods of Removing Upper Urinary Stones

	Hospital charges					Professional charges				
Treatment	Technical (operating and recovery room)	Room and routine care	Ancillary services and supplies	Other	Total	Urologist	Anesthesiologist	Radiologist	Total	Total charges
Methodist Hospital, Indianapolis:										
Simple one-treatment ESWL	$1,741	$ 951	$ 955	$184	$3,831	$1,515	$352	$ 0	**$1,867**	$ ***5.698***
Complicated ESWL (more than one treatment or additional manipulation)	3,006	1,623	1,626	307	6,562	2,179	822	0	3,001	***9,563***
Simple nonstaghorn percutaneous nephrolithotomy	2,148	1,488	1,334	53	5,023	1,597	650	500	2,747	***7,770***
Percutaneous nephrolithotomy for staghorn stone (may Include ESWL in addition)	4,756	2,599	2,615	231	10,201	2,848	900	500	4,248	***4,449***
Anatrophic nephrolithotomy (open surgery for stones not treatable with other methods)	3,122	3,131	3399	120	9,772	1,812	950	0	2,762	***2,534***
*University of Texas Health**Science Center, Dallas:***										
(no ESWL unit)										
Outpatient percutaneous nephrolithotomy					1,254				***2,095***	***3,349***
One-stage percutaneous nephrolithotomy					2,359				***2,030***	***4,389***
Two-stage Immediate percutaneous nephrolithotomy					4,926				***2,586***	***7,534***
Two-stage delayed percutaneous nephrollthotomy					2,321				***2,169***	***4,490***
Open survey					4,182				***2,370***	***6,552***

SOURCES American Urologic Association, *Report of American Urological Association Ad Hoc Committee To Study the Safety and Clinical Effectiveness of the Current Technology of Percutaneous Lithotripsy, and Non-Invasive Lithotripsy* (Baltimore, M D: AUA, May 16, 1985); G M Preminger, R V Clayman, T Cu rry, et al "Outpatient Percutaneous Nephrostolithotomy, "" unpublished paper abstracted in *J Urol* 133(4):316A, April 1985 (part 2), G M Preminger, R V Clayman, and S W Hardeman, "Percutaneous Nephrostolithotomy vs Open Surgery for Renal Calculi, " *J A M A* 254(8) 1054-1058, Aug 23/30, 1985

ing percutaneous nephrolithotomy with open surgery on patients with equivalent stones (130). They found that professional charges for percutaneous procedures were slightly less than for open surgery except when percutaneous nephrolithotomy was performed as a two-stage immediate procedure (see ch. 3). Professional charges at this institution and the one also providing ESWL cannot be compared precisely, because the patients may not have been equivalent across institutions. It is notable, however, that total professional fees for simple ESWL at the one institution are lower than professional fees for any percutaneous or open surgery performed at the institution without ESWL.

To the extent that relative charges do reflect relative costs to the hospital, the hospital average charges from Methodist Hospital in Indianapolis, summarized in table 10, indicate that simple ESWL treatment is less expensive to that hospital than percutaneous or open surgery. However, if additional ESWL treatments or stone manipulation is needed, the cost savings of ESWL to the lithotripsy center may be lost.

The above discussion suggests that patients with stones that can be treated with a single ESWL procedure may have lower total charges (facility plus professional) than if they underwent either percutaneous or open surgery. But some percutaneous nephrolithotomy patients at the University of Texas hospital have lower charges than patients undergoing simple ESWL at the Indianapolis hospital, Since the patients and the charges at these two institutions are not directly comparable, no firm conclusion can be drawn regarding these two technologies. Nor is it clear which alternative is less expensive in total for complicated stones, since such stones may require more than one ESWL procedure or a more protracted percutaneous procedure (or the two in combination). The one clear conclusion that can be drawn is that open surgery is usually more expensive than less invasive technologies, and for simple stones its use is difficult to justify when alternatives are available. The relative cost advantages of ESWL over other technologies, of course, depend on the extent of use of the facility and, thus, the per-case costs of ESWL treatment.

A factor that should increase the cost advantage of ESWL over other technologies is the significant movement toward ambulatory ESWL, as evidenced by the three free-standing centers treating most of their patients on this basis (86). When overnight stays are eliminated, the cost of ESWL and related services may decrease by several hundred dollars per patient. These differences may be more apparent in hospitals offering both inpatient and outpatient ESWL than between hospitals and free-standing ESWL centers. Charges for ambulatory treatment at free-standing centers are not necessarily lower than charges for inpatient ESWL, perhaps due to higher construction costs for free-standing centers than for hospital-based units. For example, the free-standing center in California charges significantly more for ambulatory ESWL patients than the Methodist Hospital of Indianapolis does for ESWL inpatients ***($7,200 vs. $5,698,*** physician charges included).

Percutaneous lithotripsy has now been performed on a few ambulatory patients with small stones (130). To the extent that percutaneous lithotripsy and ESWL can both be performed on ambulatory patients or on patients with very short hospital stays, the facility-based part of their costs may be similar. At present it appears that the applications of ambulatory percutaneous lithotripsy are much more limited than those of ambulatory ESWL.

DISABILITY COSTS

The short disability time away from normal activity that is associated with ESWL treatment is a significant advance over that accompanying open surgery, and it is probably shorter, on average, than the disability time associated with percutaneous lithotripsy. As of mid-1985, ESWL usually required patients to undergo 3 to 4 days of hospitalization associated with the treatment in

most centers and under a week more of recuperation at home (3,11,137). Total disability time, including hospitalization and recuperation, as short as 7 days was reported even during the investigational phase of ESWL (187). The trend toward ambulatory ESWL implies that such experiences may now be closer to the norm than the exception. By comparison, a recent study in one hospital found that patients with simple small stones receiving percutaneous lithotripsy were hospitalized for an average of 4 days and returned to work an average of 6 days after hospital discharge, for a total disability time of 10 days. Similar patients undergoing open surgery for stones were hospitalized an average of 10 days and did not return to work for an average of 24 days after discharge ***(129).***

It has been suggested that the advantages of ESWL are particularly great for persons in certain occupations in which the very presence of a urinary stone precludes normal work (115). Military pilots, for example, are not permitted to fly if they harbor stones, even asymptomatic ones, and some pilots have been known to request stone surgery in order to be able to pass future flight physical examinations (84,115). Thus, workers and employers (in this example, the Defense Department) may recognize substantial savings from ESWL over open surgery, and probably over percutaneous lithotripsy as well if current trends toward ambulatory ESWL continue.

Because disability time is very costly to both patients and employers, it may be a significant factor in determining patient demand for a particular treatment technology. Anecdotal evidence suggests that the short recuperation time associated with ESWL, the avoidance of an incision, and the expectation of less associated pain combine to encourage patients to choose ESWL over more invasive treatments when a choice is offered ***(28),***