

REIMBURSEMENT

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Estimates of total annual expenses for performing 3,000 examinations on a CT scanner in 1975 and 1976 ranged from \$259,000 to \$379,000. These expenses can be divided into professional expenses, \$20 to \$43 per exam, and technical expenses, \$50 to \$130 per exam. The price of the machine, the largest technical expense, has increased since the introduction of CT scanners, but less than inflation in most cases. Because CT scanning is a new and rapidly changing technology, expenses could continue to change.

Fees for head scans averaged \$240 to \$260 in 1976. Charges have exceeded annual expenses by 39 to 330 percent, and estimated annual profits per scanner have ranged from \$51,000 to \$283,000. Estimates of total expenditures on CT examinations alone ranged from \$189 million to \$206 million in 1976. Expenditures for those patients who were hospitalized while waiting for CT scans increased estimated total expenditures. But calculation of net expenditures on CT scanning must consider reductions in other tests and associated hospital days brought about by CT scanning.

Under Medicare and some individual Blue Cross and Blue Shield plans, reimbursement for CT head and body scanning is conditional upon a determination of efficacy. Increasingly, third-party payers are making reimbursement for medical services conditional on an evaluation of their efficacy. However, CT scanning illustrates the perverse incentives of current reimbursement methods that encourage increased provision of services and fail to encourage cost-consciousness and efficiency by providers. Both private insurance companies and public programs most frequently reimburse costs or charges retrospectively, and they also pay on a fee-for-service basis. Hospitals and physicians do not operate within a budget that leads them to constrain expenditures for services or to use less costly alternatives.

EXPERIENCE WITH CT SCANNING

Expenses of Operating a CT Scanner

The figures in table 15 suggest, rather than describe, actual annual expenses of operating a CT scanner. (See appendix IV for more detail.) Although some of the studies were based on actual experience, all but one are estimates. The report of actual expenses documents the experience of one hospital (81). As described more fully below, the estimates depend heavily on judgments about accounting techniques, staff time, and the like that vary widely among the different sources.

Table 15.—Estimated Annual Expenses of Operating a CT Scanner^a

Category	Range (Thousands of Dollars)
Technical expenses	\$177-337
Equipment ^b	76-117
Interest	0-28
Maintenance on scanner	3-40
Other maintenance and remodeling	0-13
Nonphysician staff	36-75
Supplies	15-38
Indirect expenses	2-112
Other	0-10
Professional expenses ^c	60-130
Total expenses ^d	\$259-379
<i>(Number of examinations per year.</i>	<i>2,600.3,828)</i>
	<u>Dollars</u>
Average technical cost per exam	\$59-130
Average professional cost per exam	20-43
Average total cost per exam _d	86-173

^aEstimates except for the report of one hospital's experience from reference 81. These reports are based on experience during 1975 and 1976 when most CT scanners were head scanners, and most scanning was of the head.

^bStraight-line, 5-year depreciation except for rental estimate of \$76,000 in reference 81. Depreciation was based on purchase prices of \$400,000 to \$585,000.

^cBased on 1 radiologist except for the highest estimate using 1.3 radiologists (577). These figures represent the cost to the institution of obtaining physician services, not revenue from physicians' charges.

^dHalf of the sources, including the two with the highest estimates of technical expenses, made no estimate of professional expenses. Adding the highest estimates of technical and professional expenses would result in average total cost of \$173. The highest total estimate made was \$126 per exam.

Source: Appendix IV.

Most estimates for the annual expenses of operating a CT scanner have been based on a rate of about 3,000 examinations per year (81,159,425,554,577,584). In effect, this rate assumes the machine is operating for one shift per day. These estimates are based on 1975 and 1976 figures when most scanners were head scanners.

Estimates of total annual expenses range from \$259,000 to \$379,000, or from \$86 to \$126 per examination (table 15 and appendix IV). Those making estimates distinguish between technical and professional expenses. However, the study with the highest estimate of technical expenses, \$130 per examination, made no additional estimate of professional expenses (159). Adding the highest estimates of technical and professional expenses would produce \$173, a more realistic figure for the highest estimate of total expense per examination.

Professional expenses ranged from \$20 to \$43 per examination. These figures represent the cost to the institution of obtaining physician services, not the revenue generated from fees charged. All estimates except one are based on the services of one radiologist. No specific information indicates what method is the most common one of paying physicians responsible for CT scanning. Possible variations include fee-for-service, a percentage of net or gross revenue the institution receives from scanning, and departmental or staff salary (577). The highest figure reported for the annual expenses of a physician, **\$130,000, was** based on an annual salary slightly higher than the others. This high figure also included fringe benefits and assumed the services of the equivalent of 1.3 radiologists (577).

Total annual technical expenses ranged from **\$177,000 to \$337,000**, or from \$59 to \$130 per examination. Most CT scanners are depreciated using the straight-line method* over 5 years, although standard procedure for depreciating equipment uses 8 years (577). The length of time chosen relates to the rapidly changing technology of CT scanning, that is, the issue of obsolescence.** An institution can reduce the risk of obsolescence by leasing a machine or updating older models. At least 26 percent of **96 institutions** surveyed in **1976** leased machines (159), and the annual rental charge has been estimated at **\$76,000 (81)**. This estimate suggests that rental is less expensive for providers than purchase and depreciation. Manufacturers also market kits to update older machines. The estimate of Evens and Jest, for example, includes **\$25,000** for the purchase of new equipment in addition to depreciation (159). In **1976**, EMI charged **\$100,000 to** update its original head scanner **(265)**.

Different ways of accounting for interest on loans explain one discrepancy among estimates in table 15. Health planning agencies in Indiana, which made the highest estimate for equipment, included interest on a loan to purchase the machine (554). No other estimate mentioned interest. Such interest represents a cost to an institution and should have been included in other estimates involving purchase of a machine.

Estimates for other technical expenses also vary. An institution has several choices for maintenance of a machine: a service contract with the manufacturer, maintenance by its own staff, or some combination of the two. Installation of a scanner may require remodeling of a building. The time over which remodeling expenses and general building depreciation are spread may vary, reaching 20 years in some cases (577).

The technical expenses noted above are, by and large, fixed costs; that is, their amount does not vary with the rate of the machine's output.*** Other expenses increase with the number of patients examined during the year. Some basic staff is necessary for operation of the machine. Increases in staff, however, are necessary, for example when a second shift is added. Opinions differ about the number of staff needed to operate the machine, even at roughly the same level of output. But most include the full-time equivalents of one or two X-ray technicians, one or two aides, and one other person for about 3,000 annual examinations. The quantity and cost of supplies such as film, X-ray tubes, and contrast material clearly vary with the rate of output .

*The straight-line method of depreciation divides the total dollar amount to be depreciated into equal annual parts. In contrast, the accelerated method depreciates a higher percentage of the total amount at the beginning and gradually diminishes percentages over the course of the depreciation cycle.

**Of course depreciation, an allowance for the equipment's wearing out, differs conceptually from obsolescence.

***Maintenance may in fact increase after some level of output, but estimates treat it as a fixed cost.

All estimates of expenses are divided into direct and indirect costs. Indirect costs attempt to measure that portion of an institution's general expenses attributable to the CT unit, including such items as administration, billing, collection, hospital or university overhead, and messenger service (159). Estimates of indirect costs vary widely, from 50 percent of direct costs by Evens and Jest, to 15 percent of direct costs by the Health Planning Council of Rhode Island, to \$2,000 per year by the Genessee Health Planning Council (159,577,584).

Because CT scanning is a new technology, changes in expenses over time are important. The price of a CT scanner is the largest single item in technical expenses. EMI manufactured 58 percent of all machines and 92 percent of all head scanners known to be installed by May 1977. During the three years from 1973 to 1976, the average price of an EMI head scanner rose at an annual rate of 17, 12, and 3 percent respectively (148) (table 16). The rate of price increase not only slowed, but in 1974 and 1976 fell below the increase in the Wholesale Price Index. More recently, some models of CT scanners have been priced under \$100,000.

Table 16.—Prices of EMI Scanners, 1973-77a

Type of Scanner	1973	1974	1975	1976	1977 ^b
Head Scanner	\$310,000	\$360,000	\$400,000	\$410,000	—
Change in Price	17%	120/0	30%	
Body Scanner	—	—	—	\$475,000	\$530,000
Change in Price ...	—	—	—	—	120/0
Change in Wholesale Price Index		190/0	90/0	50/0	

^aPrices of the most commonly purchased configuration of CT scanning equipment, i.e., the modal value, prices are in current dollars.

^bEstimated.

Sources: 148,501.

Diverse factors are at work here making future price projections difficult. According to the theory of a learning curve (238), the very process of production over time increases experience and leads to lower average costs. Insofar as economies of scale exist in the industry, average costs could also decrease as companies increase their levels of production. The entry of new firms into the industry is another potential force for lower prices over time, provided price competition exists. In 1976, six firms in the United States were in active production, and six were in the developmental stage. Other foreign manufacturers, such as the Japanese, may begin marketing machines in the United States at lower prices, adding to the competition and potentially driving prices down (491).

At the same time, other factors are likely to produce increases or restrict decreases in prices. The market for CT scanners is by no means a perfectly competitive one with free entry of firms. Thus, competition cannot be expected to drive the price of machines down to the point at which it equals marginal cost. * In addition, price comparisons over time are not completely valid in this market because the technology

*Marginal cost is the cost of producing an additional scanner.

of scanning is undergoing great change. Third-generation machines already being marketed have features that increase the potential rate of examinations and the clarity of the scan. Finally, because inflation occurred throughout the economy during the **1970's**, prices of CT scanners must be measured against general inflation, which may increase manufacturing expenses and ultimately prices of scanners.

The Veterans Administration (VA) found that it could purchase scanners at a lower price by requiring bids from manufacturers. In 1977, the VA solicited bids from all known manufacturers for three body scanners that fit the VA's specifications. The company whose bid was accepted offered a scanner that usually sells for \$450,000 for \$375,000. A further indication of savings was the wide spread between the lowest and highest bids, \$1 million for the three scanners (515).

Expenses of CT Examinations at Different Rates of Output

Within the ranges of operation reported, the average cost of a CT examination decreases as a scanner is used to produce more examinations per year. All of the expenses in table 15 have been calculated at the rate of about 3,000 examinations per year. Table 17 illustrates the differences in average costs per examination that result from higher and lower rates of operation. These estimates, made in 1975 and **1976**, were based primarily on CT head scanning.

Table 17.—Estimated Average Cost of a CT Examination at Different Rates of Output

Cost Per Examination (Dollars)	Annual Number of CT Examinations Per Scanner												
	Rhode Island, 1975			Indiana, 1976				Evans and Jest, 1976				Genessee, 1975'	
	1,000	2,000	3,000	1,500	2,500	4,500	7,500	2,080	2,600	3,120	4,160	3,000	5,500
Average Technical cost	175	91	62	140	97	60	46	157	130	112	89	59	42
Average Professional cost	72	36	24	—	—	—	—	—	—	—	—	43	36
Average Total Cost .	247	126	86	—	—	—	—	—	—	—	—	102	78

*Straight-line 4-year depreciation has been changed to 5-year here

Sources: 159,554,577,584.

An annual rate of 3,000 examinations has been considered average for a machine operated on one shift daily. However, according to the estimates of the Genessee Region Health Planning Council, the average total cost of an examination would be 24 percent lower, **\$78** instead of \$102, with two shifts (577). All of the other sources in table 17 also estimated lower average costs with increased operation of a CT scanner.

In **1976**, average use of a head scanner varied with the length of time it had been operational. Scanners in operation for less than 1 year averaged 11 examinations per day, and those in operation from 1 to 2 years averaged 13 examinations per day. Although a machine's output apparently increases over time, these rates of operation represent about 3,000 examinations a year, approximately one shift daily (265). The

experience with CT scanners therefore conforms to the observation that hospital equipment is typically used at only 50 to 70 percent of capacity (123).

These observations suggest that, other things being equal, a given number of CT examinations could be performed at lower cost on a smaller number of scanners operating more intensively, rather than on a larger number operating less intensively. Of course, cost, quality, and access must all be considered when deciding the number of CT scanners that are appropriate for sparsely populated areas. Operating a CT scanner more than one shift daily would also require adjustments in the work schedules of radiologists and technicians. It is interesting to note, however, that one estimate by radiologists calculated that certain CT head scanners can perform 6,600 annual examinations per machine if used 12 hours a day and 5% days a week (519).

Little information is available about differences in rates of use and costs of scanning between hospital and office settings. One survey distinguished between hospital and office scanners, but made no mention of variations in diagnoses and other characteristics of patients that could have greatly influenced utilization and costs. Although machines in hospitals operated an average of 1 hour a day longer, they performed 5 percent fewer examinations than the office-based machines (159). Hospitals took longer than offices to perform fewer examinations. This lower rate might not have resulted from the setting itself: patients in hospitals are often more seriously ill and could have taken longer to scan for reasons associated with their illnesses.

Fees Charged for CT Scanning

Several categories of fees are charged for CT scanning. Providers differentiate between scans with and without contrast material and between technical and professional services. About 59 percent of institutions surveyed in 1976 levied separate technical and professional charges (265).

According to a survey of CT head scanning, over 10 percent of the institutions charged a standard fee whether an examination used contrast material, no contrast material, or a combination of the two (265). The other 90 percent levied an additional charge for the use of contrast material. Experience indicates that about 60 percent of CT examinations involved scans with contrast material, either alone or in addition to scans without contrast material. About 60 percent of the institutions charged more for a contrasted scan when performed without an uncontrasted scan, than for an uncontrasted scan alone.

In 1976, fees for CT head scans covered a wide range. Surveys reported averages of **\$240, \$244, and \$260** for both technical and professional charges (**29,159,265**) (table 18). The lowest total charges were found at the Cleveland Clinic: **\$100** for a scan without contrast material, \$135 for a scan with contrast, and \$175 for scans with and without contrast (**102**). The highest total charge reported was \$325 without contrast and \$476 with and without contrast (265).

Average fees for body scans were slightly more than for head scans. The average charge for a basic body scan was \$228, and the average charge for an examination with and without contrast material was \$278 (265). A survey of CT body scanners in 1977 reported higher average total charges: **\$273** for a head scan and **\$286** for a body scan (158).

Table 18.—Fees Charged for CT Examinations, 1976
(dollars)

Type of Examination and Source	Total Charge		Technical Component	Professional Component
	Average	Range	Average	Average
Head Scans				
Basic scan				
40 sites	205	150-350	155	50
48 sites	220	—	157	63
96 sites	224	175-325	—	—
Scans with contrast				
40 sites	—	—	—	—
48 sites	—	—	—	—
96 sites	243	200-330	—	—
Scans with and without contrast				
40 sites	257	150-440	202	55
48 sites	260	156-410	186	74
96 sites	292	200-476	—	—
Average charge for CT examination				
40 sites	240	—	—	—
48 sites	244	—	—	—
96 sites	260	—	—	—
Body Scans				
Basic scan				
15 sites	228	200-335	—	—
Scans with and without contrast				
3 sites	278	—	—	—

Sources: 29,159,265.

Charges for specific kinds of scans have shown no variation between hospitals and offices. The average charge per examination did vary, however, from \$171 in hospitals to \$203 in offices (159).

Some evidence suggests that charges have increased over time. Sixteen sites surveyed in 1975 and again in 1976 had increased their charges for uncontrasted scans an average of 8 percent, from \$200 to \$216. Fees charged for examinations with and without contrast material had risen an average of 12 percent, from \$245 to \$274. Likewise, some increase had occurred in the percentage of scans with contrast material. In 1975, 35 to 40 percent of patients had scans with contrast material; in 1976 at least half of the same sites reported increased use of contrast material (265).*

*As noted earlier, in 1976 about 60 percent of CT examinations used contrast material

In another **1976** survey, no definite pattern emerged from historical charges reported by five institutions that acquired CT head scanners in 1973 and 1974. Two of the institutions, Massachusetts General Hospital and Cleveland Clinic, have lowered their rates; two others, George Washington University Hospital and the Mayo Clinic, have raised theirs; and one, Mallinckrodt Institute, reported no change (102,186,341,345,349).

Less weight should be given to changes in rates reported in the latter survey because it had a smaller sample of institutions, 5 compared to **16**. Furthermore, many of the five are large teaching hospitals, which are perhaps atypical of providers in general. However, increases in charges reported in the first survey also should be interpreted cautiously. The institutional composition of the **16** sites is unknown, and they represented only 9 percent of all scanners installed by the end of 1975.

Annual Profits From Operating a CT Scanner

Average charges for CT examinations have exceeded estimated expenses by 39 to **229** percent. Average total fees reported by different sources range from **\$240 to \$260, and the extremes of estimated technical and professional expenses** range from \$79 to \$173 (table 19). In general, providers initially set fees for CT scanning to cover expenses projected on the basis of about **2,000 examinations** yearly for each scanner. But in practice, the use turned out to be much higher, about **3,000 examinations** yearly (**564**). Because the cost of a CT examination decreases with greater use of a scanner, the average cost of an examination was lower than expected, and the gap between charges and costs was greater than expected.

Looking only at the difference between charges and costs would overstate profits (revenue minus cost) from operating a CT scanner. Providers do not receive 100 percent of charges for all examinations. Some examinations are paid on the basis of costs. Parties who provide services directly (the Department of Defense and Veterans Administration) or who reimburse on the basis of costs (Medicare, Medicaid, and some Blue Cross plans) account annually for about **30** percent of all personal medical expenditures. Furthermore, about 45 percent of annual expenditures for hospital services are based on costs or direct provision of services (**364,365**), and **81** percent of all installed CT scanners documented in May 1977 were located in hospitals. *

The percentage of CT examinations reimbursed on the basis of cost is not clear. Part of the expenditure for a CT examination performed in a hospital is for physician services, typically a charge rather than a cost. Such a charge may be 50 percent or more of estimated technical costs (tables 15 and 17 and appendix IV). Available information also indicates that scanners in ambulatory settings (private offices and hospital outpatient departments) may be used more intensively and hence may account for a higher percentage of examinations than their number would indicate (159). Insufficient data prevent calculation of profits separately for hospital and ambulatory settings.

*Expenditures based on costs included those for hospital services by Medicare and Medicaid, half of the benefit expenditures of Blue Cross, and health service expenditures by the Department of Defense and Veterans Administration. Expenditures based on charges included those for physician services by Medicare and Medicaid, the other half of the benefit expenditures of Blue Cross, all the benefit expenditures of Blue Shield and commercial insurance companies, and out-of-pocket expenditures of patients.

To calculate revenue and profit of a scanner, it is necessary to estimate how much revenue is based on costs and how much on charges. For the portion of a scanner's annual revenue based on costs, the estimates of profit in table 20 use 30 percent, the

Table 19.—Reported Charges and Estimated Expenses of a CT Head Examination^a

	Range (Dollars)
Average total charge	\$240-260
Average total expense ^b	79-173
Average technical charge	174-200
Average technical expense	59-130
Average professional charge	53-70
Average professional expense	20-43
(Annual number of examinations	2,600-3,000)

^aLevels of charges take into account relative use of contrasted and uncontrasted scans. Data are for 1975 and 1976.

^bAverage total expense differs from that drawn from the literature. Half of the sources in table 15 gave no estimates for professional expenses. Here the extremes of technical and professional expenses were added to produce a more realistic range, especially for the high estimate.

Sources: Table 18 and appendix IV.

Table 20.—Estimated Average Annual Profits From a CT Head Scanner, 1976
[dollars]

	Low	High
Average charge per examination	\$240	\$260
Average revenue ^a	222	210
(Number of examinations	2,600	3,000)
Total gross revenue	577,200	630,000
Less bad debts	-57,720	-63,000
Total net revenue	\$519,480	\$567,000
Average total cost per examination	\$180 ^b	\$92 ^c
(Number of examinations	2,600	3,000)
Total costs	468,000	276,000
Average profit	51,480	291,000
(Percent of original purchase price	11	65)

^aAverage revenue = .3 x average cost + .7 x average charge. Based on nonphysician expenditures by Medicare and Medicaid, personal health expenditures by Defense Department and Veterans Administration, and half of benefit expenditures by Blue Cross.

^bBased on estimate in reference 159 for technical cost and in reference 577 for physician cost. The latter estimates were prorated to a rate of 2,600 annual examinations, \$50 per examination.

^cBased on estimates in reference 577, with physician cost prorated to one radiologist, \$33 per examination.

Sources: 29,159,265,425, 554,577,584.

approximate percentage of overall personal medical expenditures reimbursed on a cost basis. The difficulty in approximating cost reimbursement underscores the rough nature of the estimating procedure. The cost statistics are themselves estimates, which vary widely among sources. Third parties define costs in different ways. In addition, methods for **cost** reimbursement are not limited to paying costs, but may include paying costs plus or minus some percentage.

In table 20, estimated annual profits from operating a CT scanner in **1976 range** from **\$51,000 to \$291,000**. The high boundary was constructed from high charges and low costs, and the low boundary from low charges and high costs. Bad debts were estimated at 10 percent of gross revenue, an average of estimates in the literature. It is interesting to note that a profit results even with low charges and high costs. For a scanner priced at **\$450,000**, **estimated annual profits** range from 11 to **65** percent of the original purchase price.

The estimates of profits in table 20 are approximations of average profits. Any one institution might have charges and costs outside the high and low boundaries. As noted previously, institutions have reported total fees as high as \$476 with and without contrast material (29,265) and as low as \$100 without contrast (102).

Evidence presented above indicates that fees have tended to increase over time (265) despite the gap between charges and costs and the resulting profits from operating a CT scanner. The gap between charges and costs does not deter use of scanners because use depends on decisions of physicians who order, but do not pay for, scans. When paying charges, third-party payers do not look at profit margins, and individual consumers are unable to affect providers' prices. In general, there is little stimulus from competition and free entry for fees to approach costs. However, there may be some competition among radiologists, especially in large urban areas with several CT scanners.

Although economic forces will not necessarily lead to lower profits over time, regulatory and political factors may have that effect. In some areas of the country, State rate review commissions are examining the gap between charges and costs. The Massachusetts Rate Setting Commission, for example, suggested that fees of physicians for CT scanning be reduced because annual use of scanners had increased (564). The Commission has, in fact, lowered allowable rates for scanning in some cases (346). Such instances, although rare, illustrate the potential effect of rate review on fees.

In addition, providers appear somewhat cautious about cost and price increases in an attempt to avoid formal regulation, especially after restrictions experienced under the Economic Stabilization Program (423). **Massachusetts** General Hospital and Cleveland Clinic have lowered their rates. They attributed their decisions to greater use of scanners and hence higher profits than originally expected (102,345). **Cleveland Clinic** also noted that it had paid off the original cost of a scanner installed in 1974 before reducing rates in 1975 (102).

Of course profits per se are not grounds for concern. A provider's profits from CT scanning may be counterbalanced by losses from other technologies. The level of profit is also likely to change over the history of a technology. At issue are net expenditures on CT scanning and, if net expenditures are positive, whether the extra benefits are worth the extra expenditures.

Gross and Net Expenditures

Estimated expenditures on CT examinations alone ranged from \$189 million to \$206 million in 1976 (table 21). In addition, expenditures for patients who were hospitalized while waiting for CT scans brought estimated total expenditures to \$278 million to \$377 million. Expenditures associated with hospitalization thus accounted for about 30 to 45 percent of total expenditures.

Net expenditures on CT scanning are those that remain after subtracting from total expenditures the savings that resulted from the replacement of other diagnostic

*These estimates used the mix of costs and charges in table 20; 327 scanners, the number installed by June 1976; 46 to 51 percent of examinations performed on inpatients; and a wait of 1.6 to 2.2 days for inpatients to receive a scan. Excluded are standard diagnostic tests performed on all inpatients. Also, calculations assume the extra hospital stay occurred only because of the wait for a CT scan. To the extent that other required procedures are performed during the wait, expenditures for CT scanning are overestimated. To the extent unnecessary procedures are added during the wait, expenditures connected with CT scanning are underestimated.

Table 21.—Estimated Expenditures for CT Scanning, 1976
[thousands of dollars]

	Low	High
Based on costs and charges^a		
Expenditures, all scanners	\$188,744	\$206,010
Hospital day expenses ^b	81,459	143,286
Inpatient physician charges ^c	7,917	27,853
Total expenditures on CT scanning	\$278,120	\$377,149
Based on charges only^d		
Gross expenditures, CT examinations	\$293,425	\$426,199
(Includes scans, hospital days, and inpatient physician visits)		
Reduced expenditures	- 113,318	- 38,336
(Includes reduced tests, hospital days, and inpatient physician visits)		
Radionuclide brain scans	37,499	- 17,375
Pneumoencephalograms	53,944	- 8,790
Arteriograms	-21,875	-12,171
Net expenditures on CT scanning	\$180,107	\$387,863

^a Based on the mix of costs and charges of CT examinations from table 20 for 327 scanners, the number installed by June 1976.

^b Based on 274 hospital scanners, 46 to 51 percent of hospital examinations for inpatients, a wait of 1.6 to 2.2 days, and adjusted hospital day expenses of \$155.36.

^c Based on 1 to 2 physician visits per hospital day by an internist charging \$15.10 for a followup hospital visit.

^d Based on charges, not costs, of procedures, except for hospital day expenses. See appendix V for calculations.

Sources: 29, 82, 159, 241, 507.

procedures by CT scanning. Estimated net expenditures on CT examinations ranged from \$180 million to \$388 million (table 21). Calculation of net expenditures was based on charges alone, rather than the mix of costs and charges used in table 20 and in the first part of table 21, because cost data for other procedures were not available. Substituting CT examinations for radionuclide brain scans, pneumoencephalograms, and arteriograms reduced average expenditures by an estimated \$38 million to \$113 million, or 9 to 39 percent. These estimates are rough, but the range includes the most likely figures. They make no allowance for reduced hospitalization independent of reductions in alternative procedures and do not differentiate between head and body scanners.

CT scanning has the potential to reduce expenditures further for other services and procedures. Patients receiving scans do not require hospitalization for the procedure itself, whereas arteriograms and pneumoencephalograms necessitate hospitalization. CT scanning subjects patients to less danger and discomfort. Furthermore, the marginal cost of a CT examination, which can be derived from the figures in table 17, falls below \$50 with an annual utilization rate of 3,000 examinations or more. These data suggest a need for exploration into the costs and benefits of using CT scanning compared to alternative procedures.

Three studies* have attempted to evaluate the cost-effectiveness or cost-benefit of CT head scanning as compared to other neurodiagnostic tests (160,440,538). All concluded that CT scanning lowered diagnostic costs while permitting diagnoses of equivalent accuracy. They found a decrease in hospital use due to CT scanning for a specific diagnosis, procedure, or department. However, they did not report whether hospital use changed overall. One study (538), for example, estimated only potential savings from CT scanning and stressed the necessity of closing facilities, such as hospital wards, to achieve actual reductions in use and expenditures for medical care in general.

Two other surveys of actual hospital use reported that 46 to 51 percent of patients scanned were inpatients, with ranges from 11 to 90 percent (29,82). None of these studies indicated whether changes in patient mix occurred after a hospital acquired a CT scanner. This information is necessary for evaluating the effect of CT scanning because patient characteristics greatly affect use and expenditures. Trends that existed before the introduction of CT scanning are also important. As noted earlier, some authors have reported declines in pneumoencephalography prior to and independent of CT scanning (4,33).

A study sponsored by EMI in 1977 investigated the costs and benefits of CT body scanners and concluded that they could reduce the costs of making certain diagnoses if used at the optimal time so that prompt diagnosis and treatment resulted. Costs could be reduced by eliminating other tests, shortening hospital stays and obviating surgery. The study, then, described typical and optimal courses of diagnosis and estimated possible savings, but did not present any evidence that savings had in fact occurred (149).

*Another study being conducted by Arthur D. Little, Inc., for Ohio Nuclear concerns the actual cost savings from the use of CT head scanning in cranial diagnosis. Arthur D. Little is also investigating body scanning for Ohio Nuclear (480).

GOVERNMENTAL AND NONGOVERNMENTAL REIMBURSEMENT POLICIES

Third parties in the United States pay two-thirds of all personal medical care expenditures and nine-tenths of expenditures for hospital care (364). The percentage paid by third parties for CT scanning probably falls somewhere between these two extremes since scans can be performed on an inpatient or ambulatory basis. No available information refers specifically to CT scanning. The policies of Medicare and some private third parties that have withheld reimbursement for CT body scans may have resulted in a lower percentage of body scans paid by third parties.

For all personal medical expenditures, Government programs have accounted for the largest share of third-party payments, 40 percent, compared to 27 percent by private insurance companies. For hospital care, Government programs have paid an even larger share of expenditures, 55 percent, compared to 36 percent by private insurance. The largest Government effort is Medicare, the Federal program for the aged and disabled. It accounted for about \$15 billion, or 15 percent of all personal medical expenditures in 1975. Medicaid, under which the Federal Government provides matching funds to States for medical care to welfare recipients and the medically indigent, spent \$13 billion or 13 percent of all personal medical expenditures in 1975 (364,365). All payments under Medicare, Medicaid, and Maternal and Child Health programs must be compatible with section 1122 (see chapter 4) and section 1151 (PSRO program; see chapter 5) of the Social Security Act.

Linking Reimbursement With Efficacy

Historically, third-party payers have made few attempts to link reimbursement with a determination of the efficacy of a new technology. With CT scanning, however, Medicare and some individual Blue Cross and Blue Shield plans have made reimbursement for head and body scans conditional upon an appraisal of their efficacy. These programs have also begun to link reimbursement of other services to a determination of their efficacy, a development that appears to indicate a new direction in reimbursement policy.

The Public Health Service evaluates the efficacy of technologies for Medicare under section 1862(a)(1) of the Social Security Act. That section states that Medicare shall pay for services only if they are reasonable and necessary for the diagnosis or treatment of illness or injury or for improved functioning. The Social Security Act thus restricts consideration of benefits to diagnosis, treatment, and functioning and apparently restricts the definition of efficacy of diagnostic technologies to Fineberg's third level, diagnostic accuracy. To put into effect any other definition of efficacy would appear to necessitate a change in the law.

The Public Health Service provides advice on efficacy under an interagency agreement with the Medicare program. For drugs, Medicare limits its coverage to the indications for use that the Food and Drug Administration (FDA) approves for labeling. Until the reorganization of the Department of Health, Education, and Welfare (HEW) in 1977, advice about the efficacy of other medical technologies was provided by the Bureau of Quality Assurance (BQA) of the Health Services Admin-

istration. Although Medicare is exploring the possibility of relying on FDA for advice about medical devices, FDA's experience under the 1976 Medical Devices Amendments is not yet sufficiently advanced to provide a basis for Medicare coverage.

In recommending whether or not a service should be covered by Medicare, BQA considered four factors: safety, efficacy, acceptance by providers, and stage of development. BQA had no formal, systematic mechanism for making these decisions: it identified certain Federal agencies, representatives of professional associations, and others and asked for their judgments. Its decisions were not necessarily based on formal studies, although if available, such studies were sometimes used.

Thus, BQA was an important decisionmaking agency in determining Federal policy about use of a new medical technology, even though it gave advice only when asked by the Medicare program. Under the 1977 reorganization, BQA was made part of the new Health Care Financing Administration, and its name was changed to Health Standards and Quality Bureau. At the same time, the responsibility for making recommendations on efficacy was left in the Public Health Service. This activity was subsequently assigned to the Office of Health Practice Assessment in the Office of the Assistant Secretary for Health.

After receiving advice from the Public Health Service, Medicare conveys its decisions to the intermediaries and carriers, who are responsible for implementing them. Carriers and intermediaries notify physicians and hospitals of coverage policies and institute administrative mechanisms to monitor compliance. Because of the large volume of services involved, especially drugs, implementation depends ultimately on the good faith of providers and the possibility of a future audit.

In 1973, the Bureau of Health Insurance (BHI), which administers Medicare, refused to reimburse for CT scans on grounds that CT scanning had not been established as a reasonable and necessary procedure (496). Such a course of action is open to Medicare under section 1862 of the Social Security Act. At the same time, BHI sought the advice of BQA, which advised Medicare that it considered head scanning an efficacious procedure, BHI then authorized reimbursement by Medicare for head scans. Because the data examined by BQA had pertained only to EMI machines, only EMI scans were authorized for reimbursement. Although other manufacturers began marketing scanners in 1974, Medicare reimbursement for CT scans was formally limited to EMI machines until October 1976. At that time, BHI changed its policy to authorize Medicare payment for scans performed on machines of several additional companies. Medicare coverage was later broadened to include head scans performed on both head and body scanners, but not body scans themselves. The issue of body scanning is still under consideration; coverage is expected for specified medical conditions.

At the Federal level, Medicaid does not consider efficacy in reimbursing for its share of expenditures. The States decide whether to pay for new procedures, and Federal administrators honor the States' decisions. No information has been compiled on the manner by which the 53 Medicaid regions make these determinations (510).

Blue Shield and Blue Cross plans contract directly with hospitals and physicians for payment of services to their beneficiaries. Provisions of contracts allow Blue Shield plans to exclude reimbursement for experimental procedures or to limit reimbursement to procedures considered part of accepted medical practice. The

national Blue Shield Association consulted with American College of Radiology (ACR) about the efficacy of CT head and body scanning. On the basis of that advice, the national Blue Shield organization advised individual Blue Shield plans to pay for CT head scanning only (374). Until 1977, the national Blue Shield advised against reimbursement for CT body scanning on the grounds that insufficient data supported its efficacy (91). In June 1976, only four of the 50 Blue Shield plans were reimbursing for CT body scans (374). In April 1977, ACR endorsed CT body scanning. Although Blue Shield is not bound by the decisions of ACR, in September 1977, Blue Shield's Board recommended that individual plans reimburse for body scanning. At the same time, the Board recommended that the plans establish local standards of appropriate medical indications for using body scans (174).

Under its Medical Necessity Program, Blue Shield has become more active in linking reimbursement with efficacy. In May 1977, the national Blue Shield Association announced that it would pay for **30** procedures only when physicians justified their medical necessity. The list included diagnostic and surgical procedures that were said to be outmoded, redundant in combination with others, unlikely to yield additional information through repetition, and of unproven value. Three societies of medical specialists helped to develop the program: the American Colleges of Physicians, Radiology, and Surgeons. Blue Shield planned to expand the list of procedures of undemonstrated effectiveness in the future (257, 35 I).

Individual Blue Cross plans, like those in Blue Shield, decide whether CT scanning is a reimbursable category. In November 1976, at least three Blue Cross plans were refusing to reimburse for body scanning because clinical evidence about its appropriate use was lacking. Individual Blue Cross plans vary greatly in the way they decide upon reimbursement for CT head and body scans. The Arizona Blue Cross-Blue Shield plan reimburses for CT scanning only for particular medical conditions. Some plans reimburse for CT scanning in general, and others base their decisions on the opinions of medical advisors (67).

Like Blue Shield, the National Blue Cross Association has also become more actively concerned with efficacy. In late **1976**, Blue Cross requested the Institute of Medicine to examine the policy implications of CT scanners. Linking reimbursement with efficacy, the Institute of Medicine recommended that third parties pay for CT head and body scanning when used appropriately. The report further recommended that usual standards of clinical practice be accepted as criteria of efficacy (258).

In their contracts with and payments to consumers, commercial insurance companies historically have not questioned appropriate use of particular technologies when used under a physician's direction. And individual patients who pay out-of-pocket for scans are inclined to accept physicians' judgments concerning the advisability of a procedure and to pay for charges as billed.

Third-Party Coverage

Third-party coverage affects total expenditures for CT scanning. Such coverage influences the setting in which CT scans are performed and the use of other procedures. If coverage extends to inpatient but not ambulatory diagnostic procedures, providers and patients are encouraged to favor hospitalization. Increased hospitalization would produce greater revenues for providers and lower out-of-pocket expenses for patients but higher per capita expenses. In contrast to ambulatory use, performing CT scanning on an inpatient basis increases total expenses and charges for a patient's medical care because of the costs of inpatient care and additional physician services. These related services taken together greatly raise total expenditures attributable to CT scanning. Running multiple diagnostic tests also results in greater expenditures for a patient work-up. Coverage that applies to diagnostic procedures as a category offers no incentive to substitute less costly procedures for expensive ones of equal value.

Third-party coverage typically does not encourage substitution of procedures on the basis of either lower costs or extent and accuracy of information. Incentives concerning hospitalization vary among third parties. Under Medicare, * a patient receiving a CT scan must pay a deductible for inpatient care (under Part A) or a deductible and coinsurance for ambulatory services (under Part B). For inpatients under Part A, Medicare pays 100 percent of the reasonable cost or charges of the CT scan itself and for ambulatory patients under Part B, 80 percent of costs or charges after the deductible. A patient who had no deductible for Part B accumulated for the year would probably be indifferent about the expense of being scanned as an outpatient or an inpatient. But a patient who had already met the deductible under Part B would pay less out-of-pocket for an outpatient scan. Section 1151 of the Social Security Act, which pertains to Professional Standards Review Organizations, restricts payment for inpatient services. Medicare and Medicaid are authorized to pay for services on an inpatient basis only if they cannot be provided effectively on an outpatient basis.

Although Medicaid covers the expenses of hospitals and staff physicians, the extent of coverage varies among States. For nonhospital physicians, Medicaid uses the reasonable and customary charge of physicians as an upper limit for the State's payment and often pays them much less than the upper limit.

Blue Cross plans typically cover inpatient diagnostic services and would therefore reimburse for CT scans on inpatients. Outpatient coverage would depend on a particular subscriber's policy. Most Blue Shield plans pay for the charges of physicians who are not on hospital salary and for some outpatient services. These plans would therefore pay the professional fees of nonhospital physicians for inpatient scans. Blue Shield plans, with appropriate coverage for diagnostic procedures, would pay professional fees of nonhospital physicians for outpatient scans in hospitals, and would pay both professional and technical fees for scans in physicians' offices (67).

Commercial insurance companies usually cover diagnostic services such as CT scans for inpatients, while coverage for outpatients is subject to more variation.

*Bills submitted for Medicare payment of inpatient services do not clearly identify the procedure. Consequently, it is difficult to distinguish a CT scan from another radiological procedure (106).

According to a small sample of companies, payment for CT scans ranged from 70 to 100 percent of total charges (29).

Retrospective Reimbursement

For the most part, third parties reimburse retrospectively, that is, they pay for costs after they have been incurred or charges after billing. Because of this policy, third parties often have an open-ended commitment to finance covered services that are provided.

Payments related to providers' costs are almost entirely based on those already incurred. Such payments include those by Medicare and Medicaid for institutional services (Parts A and B), about half of the benefit expenditures of Blue Cross, and medical services expenditures of other governmental agencies, such as the Department of Defense and Veterans Administration, that provide medical services directly to patients. Cost-based reimbursement for CT scans by Medicare, Medicaid, and Blue Cross would apply to costs incurred by hospitals in the course of performing the procedure. Both Medicare and Medicaid pay that portion of costs attributable to their own patients, but may use different definitions of costs. Cost-related formulas used by Blue Cross plans may have several bases, such as reasonable costs, costs plus a certain percentage, or costs minus a certain percentage.

Payments based on charges billed by providers include those of Medicare and Medicaid for physician services and certain noninstitutional ambulatory services, the other half of the benefit expenditures of Blue Cross, most of the expenditures of Blue Shield, payments by commercial insurance companies, and out-of-pocket payments by patients. Charge-based reimbursement could apply to CT scans in both hospitals and physicians' offices.

Several third parties use some variation of the "usual, customary, and reasonable" approach when paying charges. In some cases, limits apply to the charge for a service, but additional numbers and kinds of services may be performed. Medicare (under part B) pays "reasonable" charges for physicians' services. In establishing what is reasonable, Medicare compares the physician's customary charges with charges prevailing in the area for the specific service. Payment is then limited to the 75th percentile of the customary charges in the area (259). Under "assignment," physicians agree to accept as total payment for a service the limit determined by Medicare. The proportion of claims for which providers accepted assignment had fallen to 52 percent by 1975 (197). If a physician does not accept assignment, the patient is liable for any difference between the physician's charge and Medicare's limit. Medicaid uses "usual and customary" charges in an area as the ceiling for payments to physicians. Medicaid typically pays a smaller proportion of usual and customary charges than Medicare, and only a small fraction of physicians accept assignment under Medicaid (54).

For about half of its business, Blue Shield uses fee schedules or pays usual, customary, and reasonable charges up to a certain percentile. The rest consists chiefly of indemnity payments (374). Commercial insurance companies usually pay either indemnity payments or physicians' charges subject to coverage of specific policies.

Patients who pay out-of-pocket are liable for whatever providers bill for their services.

Recent activities by Blue Cross and Blue Shield indicate that they plan to take a much more active role in controlling expenditures. Blue Cross plans in May 1977 unanimously approved a program that requires each plan to put into effect certain measures to control costs. Each plan must keep data on and try to affect key statistics on use and expenditures. Programmatic requirements include multilevel claims review, educational programs for subscribers, investigation of fraud and abuse, and participation in health planning. Requirements also call for each plan to explore alternative payment systems by such methods as demonstration projects or comparison of costs under alternative payment methods. The national Blue Cross Association will monitor the effort and provide technical assistance as needed. The measures adopted were developed as part of a joint effort with the Blue Shield Association. Blue Shield plans have adopted similar standards aimed at cost control (68, 35 I).

Fee-for-Service Payment

Under the fee-for-service method of payment, providers receive more revenue from a service with a higher fee. Thus, relative charges can affect use and total expenditures. When the fee is higher for contrasted scans, providers have an incentive to perform more of those scans. In 1976, 90 percent of the institutions with scanners charged extra for scans with contrast material (265). One study examined relative fees and use of contrasted scans. But that study failed to give any information about other relevant factors, such as patient characteristics, that might have prompted use of contrast material independently of fee structure (159). Therefore, no conclusions may be drawn.

No third-party reimbursement policy considers relative prices of CT scans and other neurodiagnostic procedures. Therefore, third parties give providers and patients no incentive to prefer less costly substitutes.

Prospective Reimbursement

Prospective reimbursement on the basis of costs or charges exists, but mostly on a small and experimental scale. Prospective reimbursement refers to payment according to rates set prior to the time during which they apply; the unit of payment (case, physician visit, hospital day, plan member, institutional budget) may vary. In 1976,35 Blue Cross plans were engaged in prospective reimbursement, in some cases as an option for hospitals or as part of an experiment.

Some States have attempted to review the appropriateness of rates prospectively. The jurisdiction of State rate review bodies has usually been limited to hospitals. The potential and actual authority connected with rate review varies greatly among States. Of course, State laws do not apply to Medicare payments by the Federal Government. Laws in Massachusetts, Washington, and Maryland cover rates paid by other

purchasers of services, including self-payers (individual patients who pay out-of-pocket). * New York and New Jersey set rates for Blue Cross and Medicaid, but not for Medicare and self-payers. Indiana and Rhode Island have voluntary systems (344). As mentioned previously, the Massachusetts Commission has recently lowered some of its approved rates for CT scanning.

Medicare prospectively sets limits on its payment of routine operating costs to hospitals. Under a provision of section 1861 of the Social Security Act added in 1972, Medicare determines in advance limits that will apply, usually for the coming year. Limits vary according to bed size, SMSA or non-SMSA area, and per capita income of the area. Only about 750 hospitals have in fact had their payments limited under this provision. It is notable that only operating costs are restricted. Since other costs, such as costs of ancillary services, are not restricted, hospitals could channel costs into those categories (352, 508).

The Health Care Financing Administration in HEW is funding demonstration projects involving prospective reimbursement under the Social Security Act. A project in the State of Washington, for example, is comparing the results under prospective reimbursement of total budgets for hospitals, prospective reimbursement by hospital departments, and continuation of present retrospective reimbursement. The Maryland Health Services Cost Review Commission has a contract to review budgets and rate structures using a public utility approach. In the area of Rochester, N. Y., 23 hospitals together plan to stay within a total community budget rather than focusing on costs or charges of a single hospital. Other demonstration projects are taking place in Massachusetts, western Pennsylvania, Connecticut, New Jersey, and California (514).

The objective of section 1526 of the National Health Planning and Resources Development Act of 1974 is to evaluate the feasibility of rate regulation by State planning agencies. This section authorizes the Federal Government to award demonstration grants to a maximum of six State agencies. Provisions of the Act and proposed regulations go beyond the mechanics of rate review to the implications of reimbursement methods. For example, proposed regulations for awarding grants consider the extent to which a State agency offers positive and negative incentives for efficient and appropriate use of services (514).

In September 1977, final approval of the regulations was imminent. However, grants can be made only to fully designated State agencies, and no State agencies have been fully designated. Some State agencies will pass from conditional to fully designated status in mid-1978. Only then may they apply for these demonstration grants. Awards of grants and implementation of the program stretch further into the future (506).

*Connecticut's law technically applies only to commercial insurance companies and self-payers. To the extent that a hospital's costs are equal to or greater than charges, some cost-based payers pay the lesser of costs or charges, Connecticut rate review affects such cost payers as well (us). Under an experimental program in Maryland, Medicare is following decisions of the State cost review commission (54).

SHORTCOMINGS OF REIMBURSEMENT POLICIES

Because third parties, the Federal Government in particular, account for such a large portion of personal medical care expenditures, they have the potential to restrain expenditures on medical care and to channel funds into efficacious services. The data for CT scanning indicate that, although third parties have increasingly been taking an active role, they have not fully realized this potential.

Public and private third parties reimburse for services that have already been provided. Review processes question whether claims may be reimbursed in light of limits on services covered and expenses allowed, rather than whether production is efficient. Third parties then act as intermediaries in passing on any increased expenditures resulting from higher use or costs. Private companies raise health insurance premiums for subscribers, and governments increase taxes or decrease expenditures for other sectors of the economy.

In some cases, Federal and private programs have tried to link reimbursement of CT scans with efficacy and are exploring similar requirements for other procedures. But their efforts have been handicapped by inadequate procedures of evaluation and insufficient data. The Bureau of Quality Assurance did not consider itself well qualified to advise Medicare about new technologies (502), The Bureau had no formal mechanism for arriving at decisions about CT scanning. A small staff of one or two people, little money, and no formal procedure are problems that will continue under the new Office of Health Practice Assessment. Third parties interested in efficacy and appropriate utilization have often relied on medical advisors. But the medical profession itself has had insufficient information on appropriate indications for CT head scanning, as chapters 3 and 5 have discussed.

Apart from the issue of efficacy, this study of CT scanning illustrates the perverse incentives of reimbursement policies for medical care delivery in general. These policies have not been structured to encourage efficiency or to heighten concern about increased expenditures on CT scans or other medical services. Retrospective reimbursement, by costs or charges, existing third-party coverage, and fee-for-service payment all stimulate providers to increase services and result in higher expenditures. Payment methods generally fail to encourage efficiency or cost-consciousness by providers.

The experience of Kaiser-Permanente in Northern California is noteworthy as a contrast. Kaiser-Permanente receives a predetermined cavitation (per patient) payment that remains fixed regardless of the number of services provided. In Kaiser-Permanente's budget during 1976, CT scans added to expenses, but not to revenue. Kaiser did not own a CT scanner, but ordered about 2,500 annual examinations from outside providers, at the rate of **1,900 examinations** per million population for its 1.3 million members. Under the assumption that 3,000 annual examinations have been the equivalent of one scanner, Kaiser-Permanente has been using the equivalent of **0.65 scanner** per million population. That rate is roughly **23 percent** of the California rate of 2.8 scanners per million population, and 50 percent of the national rate of 1.5 scanners per million population. Kaiser-Permanente's rate of 1,900 examinations per million population compares to 8,400 estimated examinations per million in California. Standardization for age would raise Kaiser's relative rates: the Kaiser-Permanente membership has fewer persons **65 years and over than** California's population (4.9 percent compared to 7.8 percent). Kaiser also expects an increase in use after installation of its own scanner (283) because it will then internalize expenses

instead of paying charges to outside providers. Even with these qualifications, utilization under the Kaiser-Permanente system has been dramatically lower than that for the State or the country.

In contrast to Kaiser-Permanente's method of payment, retrospective reimbursement of services by costs or charges gives providers an incentive to order additional tests to gain revenue. It also provides no incentive for physicians and hospitals to try to lower costs of performing a CT examination by, for example, using a scanner more intensively. Existing reimbursement mechanisms contain no incentives for a CT examination to be performed when possible on an ambulatory basis. In fact, coverage, billing methods, and reimbursement policies often encourage the provision of scans on an inpatient basis, the more costly manner. In the absence of a budget or fixed payment, providers have no need to consider total costs when choosing which neurodiagnostic procedure to order for patients. Undercurrent policies, providers are reimbursed for many tests performed, even if some provide the same or little additional information. No mechanism stimulates providers to make trade-offs between increased information and increased costs.