4.
The Costs of Digital Subtraction Angiography

4. The Costs of Digital Subtraction Angiography

The costs of acquiring digital subtraction angiography (DSA), building or modifying an existing physical facility to house the equipment, and initiating the service in an operational mode are of many forms. This chapter attempts to summarize existing experience with respect to the costs of DSA in the United States.

PURCHASE AND UTILIZATION COSTS

A technology such as DSA requires both capital and operating expenditures. Capital outlays are necessary in most instances for the equipment itself and for the physical space within which to operate the equipment. Unfortunately, it is difficult to estimate the rate of amortization of DSA equipment at this stage in the development and implementation of the technology.

Freedman (33) estimated that the investment in a DSA computer, X-ray equipment, and room will range from $400,000 to $800,000. The costs a hospital or clinic may incur depend on whether the radiographic/fluoroscopic equipment is already present. If so, most hospitals can add a digital computer to their radiography rooms for an average cost of $250,000. The price range for these "add-on" systems in January 1982 was $135,000 to $350,000 (61). In the future, considerable savings are expected from combining the data processing and storage requirements of the various kinds of computer-assisted radiographic techniques, such as the use of a single computer to retrieve and store information from more than one DSA machine (1,29).

Operating costs include fixed personnel costs and variable supply costs. Personnel costs, although fixed for a given facility, vary considerably among facilities depending both on the facility's caseload and the configuration of DSA in relation to other radiologic technologies. For example, a physician is required to be physically present in or around a DSA unit to supervise the injection of the contrast agent, but this physician can also service a second adjacent room where another DSA or computed tomography (CT) scan unit is operating. There are circumstances where a physician could supervise a third room as well, possibly a room equipped with a real-time ultrasound unit.[1] Thus, a rotating physician can effectively supervise several radiological procedures in different, but adjacent, rooms simultaneously, therefore reducing the fixed personnel costs of all of these procedures.

With a caseload of six to eight cases per day (1,500 to 2,000 annually), it is commonly estimated that two full-time technicians (requiring a total of $50,000 in salary and fringe benefits annually) will be required to operate a DSA efficiently (33). A secretary is required to make appointments, complete insurance forms, and to perform other activities. Because this secretary *is* likely to participate in other activities, such as scheduling patients for other radiologic examinations, this fixed personnel cost is factored into a miscellaneous category (of about $50,000 annually) which includes insurance, administrative costs, utilities, etc.

Supply costs were estimated in 1982 to average approximately $100 per DSA examination, allowing for 20 percent waste and repeating the study (33). Since that time, special DSA *procedure* kits have been developed which cost approximately $60 each. Allowing for a 10 percent waste factor, current supply costs should range between

[1]See ch. 2 for a description of real-time ultrasound.

$65 to *$75* per case. Some variation in costs is associated with the way in which the contrast medium is injected. A peripheral injection usually requires a supply cost of approximately *$80* per case; when the catheter is placed in the superior or inferior vena cava, these costs are approximately $100. Among the more expensive items that contribute to variable costs are the catheter ($18), floppy disk for the computer ($10), and the contrast agent (150 cc. at $15) (33).

It is useful to summarize these cost data by way of a breakeven analysis. If it is assumed that *variable* (supply) costs are $80 per case (with peripheral injection of contrast agent), and there is a caseload of eight patients per day, 250 days per year, the total variable costs would be **$160,000** per year. If this figure is added to an annual *fixed* cost of $400,000, **a** figure within the range of actual experience in late **1982 (33),** the total annual costs of operating a DSA unit on a per case basis can then be calculated. Using these figures, one can estimate a total annual cost of $560,000 assuming a total of 250 working days per year. With an annual caseload of 2,000 patients (250 days X *8* patients per day), this yields a breakeven cost of $280 per case.

PATIENT COSTS AND CHARGES

The total expenditures associated with performing a procedure such as DSA also include institutional and professional charges billed to the patient or the insurance carrier. Reports of billed charges in the literature **(24,33,61)** average between $175 and $300 for institutional providers. These figures incorporate fixed overhead costs, variable supply costs, and the volume of DSA procedures performed. As the volume increases, the cost per procedure may decrease, although the actual charges to the patient may not.

On a national level, third-party insurer responses to DSA are difficult to summarize. As an example, however, in **1983** physicians and hospitals in New Jersey were paid at the rate of $500 per DSA examination. The basis on which this figure was determined is not clear, but informal conversations with individuals directly involved with setting the charge suggest that the figure was derived by examining the costs of inpatient arteriography, a more expensive procedure that produces similar information. Detmer and colleagues (24) assumed a charge of $1,120 for inpatient arteriography in their study, including the cost of hospitalization and professional fees. In New Jersey, however, the arteriography charge appears to be substantially higher, perhaps in the neighborhood of $2,300 per arteriogram.

Despite the seemingly arbitrary current rates of DSA reimbursement, it is clear that third-party payers view DSA as a potential cost-saving tool. Not only does DSA eliminate the necessity for hospitalization of the patient, but there is the possibility that with time and experience, as well as further technological advances, this procedure will substantially replace a large portion of the current demand for inpatient cerebrovascular arteriography. A reduction in inpatient arteriography will lead to overall lower costs for each patient examined.

IMPLICIT AND INTANGIBLE COSTS

The costs as delineated above are likely to change. Thus, a long-range evaluation of the cost effectiveness of DSA as compared to alternative imaging technologies is very difficult. This is an inherent problem of evaluating the costs and benefits of an evolving technology.

Another significant problem with this type of evaluation is that the future level of use of conventional arteriography is uncertain. Currently, arteriography is available in most U.S. hospitals. If DSA substantially reduces the need for arteriography, as is contemplated, the costs of maintaining the fixed arteriography facilities will rapidly increase on a per-arteriogram basis. These unit cost increases may be partially offset by the integration of DSA and arteriography units, or by the closure and consolidation of arteriographic facilities among inpatient care institutions. The adoption of Medicare's diagnosis-related group (DRG) and other prospective payment systems is likely to further stimulate this consolidation process.

On the other hand, arteriography use may remain high despite the widespread introduction of DSA. The digital subtraction processes used in intravenous DSA are now being applied to conventional arterial studies; the improvements in computer data processing and image quality may allow the study of previously inaccessible vascular structures. Thus, a prospective cost analysis cannot treat arteriography as a "steady-state" technology, nor its current level of utilization as a stable pattern. The cost-effectiveness analysis of DSA in chapter 5 incorporates flexible levels of arteriography use to reflect this uncertainty.

The costs of DSA equipment may change dramatically as well. Presumably, the high costs of research and development (R&D) are incorporated into the early models. These R&D costs should decrease over time, and with economies of scale in production, *lower* the cost, and hence the price, of the equipment. One possible offsetting factor, though, is that manufacturers maybe able to make continual qualitative improvements in the technology and thereby maintain a high price. If present equipment becomes obsolete, this will stimulate either the purchase of new equipment before the existing units are fully depreciated or the upgrading of existing equipment through the purchase of additional components. It is likely that DSA is not yet a mature technology—either in technical development or in its medical applications—and will experience significant changes similar to the CT scan in years ahead.

DIFFUSION AND SOCIAL COSTS

Diffusion of a technology may lower per procedure expenditures, depending on economies of scale in production and further innovations of the technology. Similarly, the per procedure costs of DSA may decrease in association with its increase in availability. This could further result in reduction of the economic and social impact of stroke (3,103).

However, technology diffusion also has the potential for enormous aggregate costs as well as *savings.* Any assessment of DSA must consider not only how the costs of DSA compare with arteriography, but the extent to which DSA leads to increases in the total volume of diagnostic studies performed. Thus, the evaluation of the economic impact of DSA should include the change in expenditures per examination as well as the increase (or decrease) in total examinations performed.

It seems certain that the demand for DSA technology by many clinical specialists will be very high. Neurosurgeons, cardiologists, vascular surgeons, neurologists, and other physicians will make frequent use of DSA. Also, general practitioners and family physicians learn of diagnostic imaging breakthroughs in primary care journals *(29)* and may refer their patients for those imaging studies.

If diffusion of DSA is unconstrained, utilization of DSA will undergo rapid growth. This will occur because: 1) the lower complexity and risks of DSA will make it useful for large numbers of patients who would not ordinarily undergo arteriography; *2)* the applications of DSA are increasing; 3) the numbers of specialists who would use DSA (and are being trained in its use) are growing, and they are more widely dispersed geographically; and 4) the ambulatory nature of DSA makes it available to a greater number and variety of health care institutions, including group practices, multispecialty clinics, and hospitals.

Restraints on the diffusion of DSA can come from at least two sources, health planning agencies and third-party payers for medical care. A 1980 OTA study found that health planners were primarily oriented toward health "needs," usually consider only capital costs, and never explicitly weigh costs and benefits in certificate-of-need recommendations (as reported in 8). The economic (or political) reason for this behavior is that there is no mechanism for effecting a direct budget constraint in the health planning process (8). It is therefore disadvantageous for a local agency to deny specified medical needs and benefits when the costs of adopting the new technology are spread throughout the insurance system.

Similarly, the enthusiasm of technology manufacturers, providers, and insured patients for the expanded use of DSA is not likely to be offset by the reimbursement procedures of third-party payers. Medicare and Blue Cross/Blue Shield, as examples, make coverage decisions based on: 1) efficacy, 2) safety, 3) state of development, and 4) acceptance by the medical community (8,44,51). Billed charges are not a criterion for deciding *whether* to cover a new procedure. Charges become relevant only with respect to decisions regarding the level of payment.

Since fee schedules generally reward the use of technology-intensive services *(68)*, "it may be more advantageous to a physician to order and read diagnostic tests than to expend the time he spends with a patient performing a physical examination" (23). It has been demonstrated that a physician can triple his/her income merely by ordering a higher volume of tests for the same number of patients (93).

Greenberg and Derzon (44) note these and other difficulties with medical payment policies, and offer four general options: 1) restrict coverage of "unproven" procedures, presumably those whose efficacy has not been demonstrated in controlled, randomized clinical trials; 2) introduce cost effectiveness criteria; 3) educate physicians in appropriate uses of technology; and 4) educate consumers. The introduction of these criteria for insurance coverage, particularly cost effectiveness, is not likely to have a substantial impact by itself (8). For reasons already stated, there are strong forces operating against the control of technology development and diffusion in the case of DSA.