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Economic Impact of CT Scanning on the Evaluation of Pituitary Adenomas

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The medical and financial records of three cohorts of 20 consecutive patients with pituitary adenomas surgically treated in 1976, 1978, and 1980 were evaluated to assess the impact of changing technology on the cost of preoperative diagnostic evaluation. The average preoperative length of hospital stay decreased from 6.8 days in 1976 to 1.9 days in 1980. The average diagnostic radiologic charge adjusted to 1980 dollars decreased from $1,747 in 1976 to $585 in 1980, while the radiologic bill as a percentage of the total hospital bill changed from 17.3% in 1976 to 11.9% in 1980. The decline in cost parameters coincided with the dramatic increase in the use of cranial computed tomography and the sharp reduction in the use of angiography and pneumoencephalography. These findings suggest that computed tomography is a highly efficacious technique for the evaluation of patients with suspected pituitary adenoma, resulting in significant savings in the costs of diagnostic evaluation.

The economic impact of advances in imaging technology on the practice of medicine is difficult to evaluate. New technologies are often characterized by high initial costs, followed by an extended period of seemingly random clinical application. Although the cost per patient for a particular study may be relatively easily quantitated, it is far more difficult to assess the impact of a study on the overall cost of medical care for a specific disease entity. Well designed and effective clinical research protocols are ultimately required if sound evaluation of new technologies is to be accomplished. In this study we have attempted to characterize the effect of changing technology on the cost of the preoperative evaluation of patients with pituitary adenomas. This clinical problem is one for which the methods of treatment have not changed over the study period, but in which clinical research and advancing imaging technology have, in fact, significantly altered the diagnostic approach.

Materials and Methods

The study group comprised three cohorts of 20 patients who underwent transsphenoidal surgery for pituitary adenomas. The tumors were of similar size in all three groups. The three groups were selected from consecutive patients evaluated at the University of California, San Francisco, in 1976, 1978, and 1980. Patients with incomplete hospital records and those whose preoperative radiologic evaluation was partly performed at referring institutions were excluded from the study. The medical records and hospital charges were reviewed. Parameters analyzed included the length of preoperative hospitalization, total length of hospital stay, types of diagnostic radiologic studies performed, costs of radiologic studies, and total hospital bill. Results were analyzed for actual costs during the study period, and were then adjusted to 1980 values.

Results

The average total length of hospital stay of 14.9 days in 1976 was reduced to

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TABLE 1: **Changes in Length of Hospitalization, Costs, and Radiologic Studies over a 6 Year Period in Patients with Pituitary Adenomas**

	1976	1978	1980
No. of patients	20	20	20
Average length of hospitalization (days):			
Preoperative	6.8	3.9	1.9
Postoperative	8.1	6.5	6.2
Totals	14.9	10.4	8.1
Average costs/patient adjusted to 1980 levels (in $):			
Total hospital bill	$10,092	$6,829	4,899
Diagnostic radiology (% of total)	1,747 (17)	1,045 (15)	585 (12)
Types of studies:			
Plain skull radiography	5	0	1
Sellar tomography	10	15	16
Pneumoencephalography	20	20	0
Carotid arteriography	17	4	0
CT	2	3	20

10.4 days in 1978 and 8.1 days in 1980 (table 1). This reduction in the hospital stay primarily reflects a decrease in the duration of preoperative evaluation from 6.8 days in 1976 to 3.9 days in 1978 and 1.9 days in 1980. The cost of radiologic procedures (technical fees only), adjusted to 1980 levels, decreased from $1,747 in 1976 to $1,045 in 1978 and $585 in 1980. The average total hospital bills (not including professional charges) were adjusted to 1980 levels. These charges decreased from $10,092 in 1976 to $6,829 in 1978 and to $4,899 in 1980 (table 1). The average total radiologic procedure charge as a percentage of the total hospital bill also decreased from 17.3% in 1976 to 11.9% in 1980. Analysis of the neuroradiologic studies performed shows an increase in the use of computed tomography (CT) during the study period, associated with a dramatic decrease in the use of pneumoencephalography, carotid angiography, and skull films (table 1).

Discussion

CT units are relatively expensive pieces of diagnostic equipment that were introduced at a period when increasing pressures were being exerted for containment of health care costs. Many clinicians recognized that promising technologic advances may be misapplied or fall short of initial expectations, but were reluctant to deny patients a relatively safe and potentially beneficial examination. Health planners, although acknowledging the clinical potential of CT, feared excessive proliferation of these costly units and sought ways to control scanner distribution in an attempt to restrain increasing health care costs [1]. CT thus came to symbolize the dilemma posed by medical technology, namely, advances in diagnostic potential versus high costs and increasing demand. Thus it has served as a paradigm for regulation by agencies attempting to effectively deal with soaring medical costs.

The establishment of clearly defined guidelines for optimal utilization of imaging techniques in the evaluation of clinical problems requires an analysis of complex data, comparing such parameters as diagnostic accuracy, safety, cost of the diagnostic evaluation, and changes in utilization of other diagnostic and therapeutic procedures. A number of studies that have looked at some of these factors have attested to the efficacy of cranial CT in the evaluation of brain tumors in general [2–14]. However, early studies evaluating the accuracy of CT in the assessment of one subset of tumors, sellar and parasellar lesions, were not particularly encouraging [3,15–20]. There seemed to be agreement among radiologists in the early years of CT that small, purely intrasellar tumors could not be demonstrated by CT. Subsequent studies, using overlapping slices, intravenous contrast enhancement, and equipment with higher resolution, yielded more positive results, allowing a diagnosis of pituitary adenoma with or without suprasellar extension in most patients. These studies suggested the superiority of CT in diagnostic accuracy as compared with other conventional methods [21–24], and CT has become the primary imaging method for the evaluation of supra- or parasellar lesions, as well as intrasellar adenomas.

In addition to assessments of diagnostic accuracy, some previous studies have looked at the impact of cranial CT on the use of other neurodiagnostic procedures. Concomitant with the rise in CT use was a decrease in other neuroradiologic studies, including angiography and pneumoencephalography [5, 10, 25–32]. It has been concluded by a number of authors that any potential increase in cost as the result of installation and continued use of a CT unit is more than compensated by the savings achieved by the concomitant reduction in other procedures [30–32]. In addition, reductions in the use of more invasive diagnostic procedures have resulted in a decline in morbidity and mortality, leading to additional savings in both economic and psychosocial costs [9, 28].

Increasing numbers of patients who are evaluated on an outpatient basis and the associated decrease in the length of hospitalization for diagnostic evaluation have also contributed significantly to reduced patient costs [26, 32–34].

Continued studies of the efficacy of new technologies, particularly in evaluation of *specific* disease entities, are

needed to further define guidelines for optimal use of these advanced diagnostic tools. The Department of Neurosurgery at the University of California, San Francisco, is a large referral center for patients in whom a pituitary adenoma is suspected. The same surgeon was primarily involved with the workup and care of these patients during the period of the study. In 1976, the diagnostic evaluation of these patients consisted of pneumoencephalography, angiography, hypocycloidal tomography of the sella, and skull radiography. The preoperative evaluation was altered in 1978 because a retrospective clinical research study determined that angiography contributed no significant information to diagnosis or treatment [35]. In 1979, a high-resolution CT scanner replaced an earlier unit. The quality of diagnostic information available from this unit made CT the primary diagnostic study in evaluation of pituitary tumors.

Our studies have indicated that CT is a highly cost-effective modality in the evaluation of patients with suspected pituitary adenomas. The dramatic changes in cost parameters from 1976 to 1978 coincided with the decline in the use of arteriography. The further reduction in costs between 1978 and 1980 reflected the elimination of pneumoencephalography and the concomitant increase in the primary use of CT. Preoperative length of hospitalization declined as increased CT use obviated more invasive procedures such as angiography and pneumoencephalography. Similarly, the need for fewer studies significantly contributed to the decrease in radiologic procedure charges as a percentage of the total hospital bill.

Since the close of this study in 1980, the trends outlined above have continued and further reductions in patient evaluation costs are anticipated in the future. We find that increasing frequency of outpatient evaluations continues to decrease hospitalization costs. As CT attains higher and higher levels of resolution, further decline in the number of tomographic studies necessary for preoperative evaluation is anticipated.

REFERENCES

1. Fineberg HV. Evaluation of computed tomography: achievement and challenge. *AJR* **1978**;131:1–4
2. Alderson PO, Mikhael M, Coleman RE, Gado M. Optimal utilization of cranial computed tomography and radionuclide brain imaging. *Neurology* (NY) **1976**;26:803–807
3. Ambrose J, Gooding MR, Richardson AE. An assessment of the accuracy of computerized transverse axial scanning (EMI scanner) in the diagnosis of intracranial tumour: a review of 366 patients. *Brain* **1975**;98:569–582
4. Baker HL, Campbell JK, Houser OW, et al. Computer assisted tomography of the head: an early evaluation. *Mayo Clin Proc* **1974**;49:17–22
5. Baker HL. The impact of computed tomography on neuroradiologic practice. *Radiology* **1975**;116:637–640
6. Baker HL, Houser OW, Campbell JK. National cancer institute study: evaluation of computed tomography in the diagnosis of intracranial neoplasms. I. Overall results. *Radiology* **1980**; 136:91–96
7. Christie JH, Mori H, Go RT, Cornell SH, Schapiro RI. Computed tomography and radionuclide studies in the diagnosis of intracranial disease. *AJR* **1976**;127:171–174
8. Davis KR, Poletti CE, Roberson GH, Tadmor R, Kjellberg RN. Complementary role of computed tomography and other neuroradiologic procedures. *Surg Neurol* **1977**;8:437–446
9. Evens RG, Jost RG. The clinical efficacy and cost analysis of cranial computed tomography and the radionuclide brain scan. *Semin Nucl Med* **1977**;7:129–136
10. Fineberg HV, Bauman R, Sosman M. Cranial computed tomography: effect on diagnostic and therapeutic plans. *JAMA* **1977**;238:224–227
11. Gawler J, Bull JWF, DuBoulay GH, Marshall J. Computer assisted tomography (EMI scanner): its place in investigation of suspected intracranial tumours. *Lancet* **1974**;2:419–423
12. Gawler J, DuBoulay G, Bull JWD, Marshall J. A comparison of computer assisted tomography (EMI scanner) with conventional neuroradiologic methods in the investigation of patients clinically suspected of intracranial tumor. *J Can Assoc Radiol* **1976**;27:157–170
13. Knaus WA, Davis DO. Utilization and cost-effectiveness of cranial computed tomography at a university hospital. *J Comput Assist Tomogr* **1978**;2:209–214
14. Pendergrass HP, McKusick KA, New PFJ, Potsaid MS. Relative efficacy of radionuclide imaging and computer tomography of the brain. *Radiology* **1975**;116:363–366
15. Gyldensted C, Karle A. Computed tomography of intra- and juxtasellar lesions: a radiological study of 108 cases. *Neuroradiology* **1977**;14:5–13
16. Leeds NE, Naidich TP. Computed tomography in the diagnosis of sellar and parasellar lesion. *Semin Roentgenol* **1977**; 12:121–135
17. Naidich TP, Pinto RS, Kushner MJ, et al. Evaluation of sellar and parasellar masses by computed tomography. *Radiology* **1976**;120:91–99
18. Naidich TP, Solomon S, Leeds NE. Computed tomography in neurological evaluations. *JAMA* **1978**;240:565–568
19. Weisberg LA. Computed tomography in the diagnosis of intracranial disease. *Ann Intern Med* **1979**;91:87–105
20. Reich NE, Zelch JV, Alfidi RJ, Meaney TF, Duchesneau PM, Weinstein MA. Computed tomography in the detection of juxtasellar lesions. *Radiology* **1976**;118:333–335
21. Syvertsen A, Haughton VM, Williams AL, Cusick JF. The computed tomographic appearance of the normal pituitary gland and pituitary microadenomas. *Radiology* **1979**;131:385–391
22. Wolpert SM, Post KD, Biller BJ, Molitch ME. The value of computed tomography in evaluating patients with prolactinomas. *Radiology* **1979**;131:117–119
23. Chambers EF, Yeager L, Wilson CB, Newton TH. Diagnosis of pituitary prolactinomas with high resolution multiplanar computed tomography *Radiology* (in press)
24. Chambers EF, Turski PA, LaMasters D, Newton TH. Regions of low density in the contrast-enhanced pituitary gland: normal and pathologic processes. *Radiology* (in press)
25. Abrams HL, McNeil BJ. Medical implications of computed tomography (''CAT scanning''): first of two parts. *N Engl J Med* **1978**;298:255–261
26. Bahr AL, Hodges FJ. Efficacy of computed tomography of the head in changing patient care and health costs: a retrospective study. *AJR* **1978**;131:45–49
27. Baker HL. Computed tomography and neuroradiology: a fortunate primary union. *AJR* **1976**;127:101–110
28. Enlow RA, Hudak JA, Pullen KW, et al. The effect of the computed tomographic scanner on utilization and charges for alternative diagnostic procedures. *Radiology* **1980**;136:413–417
29. Evens RG, Jost RG. Economic analysis of computed tomography units. *AJR* **1976**;127:191–198

30. Evens RG. The economics of computed tomography: comparison with other health care costs. *Radiology* **1980**;136:509–510
31. Larson EB, Omenn GS, Margolis MT, Loop JW. Impact of computed tomography on utilization of cerebral angiograms. *AJR* **1977**;129:1–3
32. Larson EB, Omenn GS. The impact of computed tomography on the care of patients with suspected brain tumor. *Medical Care* **1977**;15:543–551
33. Wortzman G, Holgate RC, Morgan PP. Cranial computed tomography: An evaluation of cost effectiveness. *Radiology* **1975**;117:75–77
34. Margulis AR. Radiologic imaging: changing costs, greater benefits. *AJR* **1981**;136:657–665
35. Richmond II, Newton TH, Wilson CB. Indications for angiography in the preoperative evaluation of patients with prolactin-secreting pituitary adenomas. *J Neurosurg* **1980**;52:378–380