operating and patient travel costs is minimized? The solution must meet two constraints: 1) that the region's demand for CT scans is met, and **2)** that each scanner is assigned a patient load not exceeding its capacity. Other considerations, such as the desirability of placing CT scanning capability in centers of radiological excellence, were not included in the model, but easily could be if the potential locations of CT scanners were limited to those sites meeting certain criteria.

The authors showed that when patient travel costs are taken into account, more scanners can actually reduce the total cost of meeting a given level of demand. As demand for CT services increases or decreases, however, the optimal number of facilities also changes. Hence, the model begs the question of the optimal number of scanners by assuming that the answer to the prior question—under what conditions is CT scanning worth its costs — has a 1 read y been answered.

The mathematical programing approach to facility location has a rich history,'" especially with health care facilities. It is worth noting that if CT scanning is considered a necessary diagnostic tool for head trauma and other emergency situations, then the formulation suggested by Greenwald, et al. (18) may not be appropriate. Instead, a preferred formulation might be to minimize the number of scanners required to insure that all points in the region lie within some maximum time or distance criterion.[11] The resulting configuration of CT scanning facilities would very likely be quite different from that obtained in the Greenwald, et al, study.

[10]See, e.g., C. ReVelle, et al., "Facility Location: A Review of Context-Free and EMS Models," 1977 (39).

[11]For an application of such a method to the location of trauma services, see Orkand Corp., *Planning Approach, Criteria and Standards for Specialized Trauma Services: Optimal, Intermediate, and Minimal Levels of Care*, 1976 (37).

CONCLUSIONS

Taken together, the literature on the economics of CT scanning reveals a plethora of studies that either ask the wrong questions, or, in asking the right ones, must make heroic and unsupportable assumptions. Few studies have addressed the fundamental question of economic evalution: For what kinds of patients is CT scanning worth its costs?

The energy devoted to documenting historical cost savings resulting from CT scanning is particularly misplaced. This literature offers no real insight into the question facing health care decisionmakers today. Studies of the cost of case finding, which appear on the surface to be more useful in guiding resource allocation decisions, offer such a partial view of costs and effects of any diagnostic pathway that their results are more obfuscating than enlightening. Finally, those methods designed to assist directly in the big resource allocation decision—the placement of CT scanning capacity—must ignore the unanswered question of conditions of cost-effective use.

Although the methodological and conceptual obstacles to conducting useful economic evaluations are great, the literature shows that some can be overcome. Unfortunately, the obstacles have been dealt with in pieces—each study has offered a solution to a particular problem, but no study is completely satisfactory in all areas. In particular, the proper estimation of resource costs is an area that appears to be a good candidate for major improvements with relatively little effort, although some conceptual problems will continue to exist. Certainly the use of charges as a surrogate for cost can be *eliminated*. The identification of patients by specific signs and symptoms also appears to be feasible, although the cost of research based on specified patient groups will depend on the existence of good hospital data collection systems. The problem of identifying patients by signs and symptoms will be intensified with the use of CT body scanning because of the ambiguity of signs and symptoms related to diseases of the abdomen.