Linear programming in clinical dental education

by C. E. CRANDELL

University of North Carolina
Chapel Hill, North Carolina

Linear programming techniques have seldom been used in studying educational processes and are just now becoming of interest in health care delivery systems.

The objectives of our pilot research project at the School of Dentistry, University of North Carolina, have been to: (1) demonstrate the feasibility and merits of linear programming for the optimum allocation, scheduling, and utilization of teaching staff and physical facilities in clinical dental education; (2) to demonstrate a practical application of linear programming by introducing the total patient care concept; and (3) to make these data available to other schools.

The introduction of the total patient care concept will provide students with a clinical experience in dental school which will more closely simulate the conditions to be encountered in private practice after graduation. Optimization techniques will permit a comparison of clinical dental education in which students provide comprehensive care to patients as opposed to the traditional point and block systems of fragmented care. Specifically, our pilot program at UNC has sought to demonstrate that the total patient care concept can be introduced without detriment to the quality of clinical teaching or without increasing the cost of clinical dental education. Hopefully, parameters will also be discovered which can be varied in such a way as to reduce costs without detriment to the quality of clinical teaching or to increase the quality of clinical teaching without increasing costs. Either of these worthy objectives would be to the benefit of the student, the school, and the population we serve.

Actually over the past three years, our work has been along the following lines: first, we analyzed the clinical teaching situation in the School of Dentistry and identified those significant factors relative to the effectiveness and efficiency of clinical instruction. These included an analysis of technique procedures that students are required to accomplish, a classification of students in terms of ability, and the time required with reference to these procedures; the rate of utilization of equipment and physical facilities; the rate of utilization of instructors' services and a classification of patients in terms of the complexity of their dental needs. Secondly, we assumed that the relationships between these factors were linear and simulated them conceptionally in a mathematical model of the dental clinic. This information was fed into the computer as representing a typical clinical situation. The functional relationships of these variables have been studied using linear programming techniques. We have identified variables which we feel might represent the dental clinic. The problem for the computer then was to select which set of factors in any of those equations would give us the most efficient operation of the dental clinic. Once we are satisfied that our mathematical model truly represents the clinical situation, we can then experiment with various changes in the operation of the dental clinic within the computer without making any changes in the real world or clinical situation.

The objective function formulation was done by William S. Jewell.

The initial computer experience was with M3LP (SHARE), using 73 equations, 113 variables, 1265 elements, and a density of 15.33. Later, MPS/360 was used on an IBM 360/75, with a preprocessor preparing the inputs.

A run has been made with an expanded matrix of 158 rows, 90 columns, 248 variables, 5990 elements, and a density of 15.28. A feasible solution was found after four iterations; the optimal solution was found on the ninth iteration. The full matrix is estimated to contain 800,000 elements. Consideration is being given to random sampling of inequalities to reduce the size of the matrix to more manageable size.

Early and tentative evaluation of the clinical phase or practical application of this project is probably not of great interest to this audience. However, the dental educators involved believe that linear programming and other operations research techniques will become