

DENTAL MANPOWER PLANNING:
A SYSTEMS-ANALYTIC VIEW

A THESIS

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TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	ii
LIST OF TABLES	iv
LIST OF ILLUSTRATIONS	v
SUMMARY	vii
Chapter	
I. INTRODUCTION	1
II. A REVIEW OF SELECTED LITERATURE	17
III. DENTAL MANPOWER AND THE SUPPLY OF DENTAL SERVICES	33
IV. REQUIREMENTS FOR DENTAL SERVICES	70
V. DENTAL MANPOWER PLANNING CRITERIA AND STRATEGIES	102
VI. PROSTHODONTIC SERVICES: A CASE STUDY OF NEED AND AVAILABILITY IN THE UNITED STATES	133
VII. CONCLUSIONS AND RECOMMENDATIONS	158
APPENDIX A	166
APPENDIX B	201
BIBLIOGRAPHY	207
VITA	215

LIST OF TABLES

Table		Page
1.	Percentage of Nonsalaried Dentists Employing Auxiliary Personnel, by Type of Practice and by Type of Personnel	35
2.	Percent of Dental Assistants' Time Spent Performing Various Duties	52
3.	Distribution of Georgia Dentists and Population by County Groupings, 1966	55
4.	Percentage of Dentists Replying as Indicated to the Question "How Did You Arrive at the Fees You Are Now Charging?" by Age of Dentist	60
5.	Family Income Effects on Selected Health Care Expenditures, Derived from Simple and Multiple Regression Analyses	85
6.	Some Trends in Total and Per Capita Dental Services Expenditures, 1960 - 1970	101
7.	Nature of Dental Treatment Provided in Fluoridated and Fluoride-Deficient Communities, 1966	121

LIST OF ILLUSTRATIONS

Figure		Page
1.	Conversion Graph to Convert Relative Values of Services into Fees for Those Services	62
2.	Number of Decayed, Missing, and Filled Teeth per Person (DMF Rate) for Two Child and Three Adult Populations in Fluoridated and Nonfluoridated Areas	74
3.	Percent of Teeth Indicated for Extraction for Reasons of Decay, Periodontal Disease, and Other Oral Disorders	76
4.	Dental Visits per Person per Year by Family Income and Age, Fiscal Year 1964	88
5.	Predictor Trees for Analysis of Dental Expenditures	91
6.	QQE Versus Percentage of Health Goal Satisfied	126
7.	QQE Versus Cost of Alternative Health Services Strategies	127
8.	Costs and Achievements of Alternative Health Strategies	128
9.	Health Goal Satisfaction Versus Cost for o Different Health Strategies	129
10.	Current Status of Manpower Production as a Dental Health Policy	131
11.	Current Status of Directed Dental Health Improvement as a Dental Health Policy	132
12.	General Relationships Among Elements of the Dental Health Services System	135
13.	Method of Calculation of Annual Levels of Untreated Need for Complete Denture Prosthetics	142
14.	Projected Level of Untreated Need for Complete Dentures Through 1985	145

LIST OF ILLUSTRATIONS (Continued)

Figure		Page
15.	Projected Level of Untreated Need for Crowns, Bridges, and Partial Dentures Through 1985	147
16.	Effects of Alternative Programs on the Level of Untreated Need for Complete Dentures	148
17.	Effects of Alternative Programs on the Level of Untreated Need for Crowns, Bridges, and Partial Dentures	149

SUMMARY

This was a study of the structure and behavior of the dental health services system and the implications of that structure and behavior for the formulation of dental manpower strategies. The specific objectives of the study were to:

1. Describe and conceptualize the structure and behavior of component subsystems of the dental health services system.
2. Develop qualitative and quantitative descriptions of the character of need and demand for dental services.
3. Describe and examine conceptually alternative dental manpower planning criteria and strategies in the context of the structural and behavioral characteristics of the dental services system and achievement of dental health goals.
4. Develop an illustrative application of quantitative modeling and analysis to a specific set of dental health problems, services, and alternative dental health strategies.
5. Identify critical areas in which dental manpower policy changes and further health systems research could have significant effects on dental health objectives.

This exploratory investigation was based upon information acquired through actual experience in dental manpower planning, accounts of related studies and proposals in the literature, a variety

of dental practice and public health survey publications, and interviews with dentist educators, researchers, and practitioners.

The characteristics of professional dental practice that affect its status as the principal source of dental services in the United States were conceptualized. A conceptual model of the production of a heterogeneous dental services mix was presented as a departure from traditional views of production and productivity of the dental services system. Definitions of and estimated trends in dental services needs and demands were developed to describe the scope and magnitude of dental health service requirements.

These dental services supply and requirements concepts were then used as the context for describing and evaluating several traditional and potential dental manpower planning criteria and strategies. An illustrative application of quantitative modeling and analysis, using these concepts, was then developed as a case study of prosthodontic services and edentulousness in the United States.

It was concluded that traditional approaches to dental health planning through profession-oriented dental manpower planning do not appear to be economical or effective strategies. Health-directed dental manpower strategies, of which examples were discussed, were concluded to be feasible, economical, and more effective alternatives. Suggestions for appropriate follow-on systems and developmental research in dental health and manpower planning were then presented as study recommendations.

CHAPTER I

INTRODUCTION

This is a study of the structure and behavior of the dental health services system and of their implications for the formulation of dental manpower strategies. The purposes of the study are: to provide clarification of some of the dental health issues which affect and are affected by dental manpower planning efforts and the policy recommendations which flow from them; to identify and examine critical areas in which manpower policy changes are likely to have significant effects on dental health objectives; and to identify opportunities for improvements in dental health services planning through health systems research and improved availability of data.

The original motivation for this study was engendered by involvement in the preparation of projections of dental manpower requirements for the State of Georgia at the request of the Georgia Office of Comprehensive Health Planning. That study effort and the reactions it elicited from practicing dentists, dental educators, public health officials, officers of dental professional groups, and representatives of health planning agencies emphasized the need for development of a better conceptual description of the dental health services system that would serve as a framework within which the effectiveness, efficiency, and equity of various dental health policies could be examined.

Subsequent participation by the writer as a member of a task group on dental manpower of the Georgia State Dental Association and

and as an active participant in dental manpower research under the aegis of the Academy of Denture Prosthetics has served to reinforce the notion that rational dental manpower planning in the public interest can take place only if there is substantial improvement in understanding of the structure and behavior of the health system within which such manpower resources will be deployed. This view apparently was shared by Kissick as he wrote in 1968:

...thorough review and analysis of the forces influencing both the preparation and the utilization of health manpower deserves the highest priority. Careful assessment of the relevant issues is needed as a prerequisite to the formulation of a rational manpower policy to guide the investment of vast sums of public monies during the years ahead. Lacking such a policy, billions of dollars could be expended without significantly increasing the availability and accessibility of health services to meet the population's rising expectations.¹

General Nature and Significance of the Problem

The achievement and maintenance of adequate levels of health among all segments of the U. S. population through provision of health services in an effective, economical, and equitable fashion has been adopted as a high priority national objective. Manpower-intensive services, which account for two-thirds to three-fourths of the operating costs of existing health programs, are being demanded and planned in increasing quantities as consumer incomes and private and

¹Kissick, W. L., "Health Manpower in Transition," The Milbank Memorial Fund Quarterly, XLVI: 53, January, 1968.

governmental financial aid programs increase in magnitude and scope at an accelerating rate.²

The costs of increasing capacities to produce health manpower -- and of associated institutional research and service commitments -- are substantial. Because of the relatively long lead times involved in producing dentist and physician manpower, the self-perpetuating nature of professional academic programs, and the myriad research and service programs which are said to be necessary for health professions education, decisions to undertake or to expand significantly health professions education involve the allocation of large sums of public and private funds for long periods of time.

The manpower base for health manpower planning is itself largely a health-professions base. The viewpoints of health professionals involved in such planning often are affected strongly by their own professional experiences and education and the pressures of their own professional interests and organizational problems. At best, manpower planning by health professional groups seems to be profession-bound and crisis-oriented. In any case, objective approaches to the analysis and treatment of public health problems through manpower planning have not been readily forthcoming from the health disciplines. Knowles apparently shared this concern as he wrote in 1969:

²For example, see: American Dental Association, Bureau of Economic Research and Statistics, "Expenditures and Prices for Dental and Other Health Care, 1935-68," J.A.D.A., Vol. 79, Dec. 1969, pp: 1447-50; U. S. Bureau of the Census, "Occupational Trends in the United States: 1950-1950," Washington, U. S. Government Printing Office; U. S. Department of Labor, "Manpower Report of the President," Washington, U. S. Government Printing Office, 1967, 285 pp.; U. S. Department of Health Education, and Welfare, "Health Manpower Perspective: 1967," Washington U. S. Government Printing Office, 1967, p. 5.

Assessments of manpower needs by various medical professional groups have generally not been adequate, suffering as they do from the lopsided view of the professional ... There are few ... comprehensive studies of the health field and pertinent information is scattered widely. As a result, many of us responsible for planning ... are sadly lacking in sufficient information to make rational decisions, both and short and long range, designed to meet and solve local and national health relating to manpower shortages, in turn relating obviously to all the social and economic crises besetting contemporary medicine.³

In attempting to plan for the growth of health professions educational programs, manpower planners and policy makers commonly have utilized population projections and fixed manpower-to-population ratios to establish levels of manpower that will be "needed" or "demanded" at some future time. This traditional approach to health manpower planning requires the assumption that existence of a specified number of health professionals will assume the delivery of adequate health services for a predetermined number of people. However, little attention has been given to the types and quantities of services that will be needed or demanded by the public, the ability of projected numbers of health professionals to deliver those services, and the effects on health of either specific or alternative manpower programs.

Health manpower policy formulation, approval, and implementation are carried out at a number of different levels of state and national governments and in health professional organizations. Planning commissions, society committees, individuals, ad hoc study teams, and

³Knowles, John H., "The Quantity and Quality of Medical Manpower: A Review of Medicine's Current Efforts," The Journal of Medical Education, Vol. 44, No. 2, Feb. 1969, pp. 81-118.

others all appear to influence the nature, scope, and magnitude of health manpower policies and decisions. However, there seem to be few formal -- or even well-understood informal -- arrangements within and among these groups to coordinate health manpower planning activities. Thus the problems associated with a lack of understanding of the role of manpower in the health system are compounded by organizational difficulties among the groups who affect or are affected by health manpower planning.

Certain kinds of health manpower strategies which involve actions or accessions by individual health professionals are complicated further by the absence of centralized bodies empowered to assure that such strategies are implemented. Moreover, when health manpower strategies seem not to be in the best personal interests of a group of health practitioners, they often are resisted locally. In most areas, individual professionals also find their professional societies to be effective fora for their opinions and lobbyists for their causes. Thus, even the most rational health policies -- from the public's point of view -- may be rejected or weakened by the passive and active resistance of the private practitioner.

There is no formal literature of health manpower planning in general or of dental manpower planning in particular, nor does there appear to be an identifiable literature or discipline of general manpower planning to which one can turn for guidance in structuring an approach to health manpower planning. Nevertheless, health manpower planning, policy formulation, and program implementation continue to be carried out with increasing fervor in response to pressures for

more and better health care. Concomitantly, inadequate data for planning and a lack of understanding of the role of manpower in the health services system appear to be leading to relative ineffectiveness in the allocation and consumption of human and economic resources in the pursuit of health objectives. Widespread expressions of concern about the quality and quantity of health care and manpower "crises" have become commonplace.

It is not the intent of these comments to condemn the efforts of health professionals as health planners; but rather it is to point out the need for supplementary and complementary efforts from other disciplines which can demonstrate competence and which have shown concern for problems of health planning. Within these "other" disciplines, it seems clear that industrial and systems engineering has useful contributions to make to the study of health manpower problems.

The Need for a Systems - Analytic Approach

The literature of public and private agencies whose interests lie in the health affairs area is replete with statistics, reports of surveys, personal and group philosophies and conjecture, and other expressions of concern about requirements for and availability of health manpower at all levels. However, there have been few attempts to deal directly with questions related to health manpower in a systematic fashion. Assessments of the effects of historical and proposed manpower policies and decisions on public health are practically nonexistent. However, a number of writers have recognized several of the shortcomings of existing health manpower planning efforts.

Hubbard described one of the most widespread problems -- the lack of specificity of manpower objectives -- when he stated in 1965:

When we say "we need health manpower," what leads us to this conclusion? How do we identify the quantitative need in various settings? The need for more people working in the various health professions, if all who benefit are to receive health services, is probably beyond dispute. This generalization does little to help us understand how many altogether, or how many in each category, should be available. To begin to understand, our goals in health need to be defined, and the means to these goals examined.⁴

Kissick, in 1968, called for broad, basic study of the system in which health manpower is imbedded as a key resource, but as only

...one of three basic health and medical resources --
 1. health manpower (professional, technical, and supportive);
 2. facilities, including equipment and supplies; 3. biomedical knowledge, or "state of the art." In this context, organization and financing are the intangible resources or mechanisms that serve to translate the three basic resources into health services for the consumer. An adequate analysis of health manpower at a minimum requires its consideration in this, or an alternative, context that attempts to relate these variables, which together make up a highly complex, interdependent systems.⁵

Hansen, a health economist, wrote in 1970:

The first observation to make is that little can be gained by attempting further refinements of the methodologies employed in (manpower) projections ... Admittedly, some alternative sets of assumptions might be employed to suggest a range of estimates; yet it appears that we do not really know enough to pick out sensible alternative assumptions that would lead to useful results. And so ... we need to develop a more comprehensive model of the entire health manpower market. Obviously, this is a big undertaking -- in conceptualizing the problem, in tackling it empirically, and in interpreting the results. Yet this is clearly what is needed...⁶

⁴Hubbard, William N., in Proceedings of the White House Conference on Health, U. S. Department of Health, Education, and Welfare, Washington, 1965, p. 77.

⁵Kissick, op. cit., pp. 53-54.

⁶Hansen, W. L., "An Appraisal of Physician Manpower Projections," Inquiry, VII: 102, March 1970.

Striener recognized the relevance of the "systems" disciplines to the study of manpower problems when he wrote in 1966:

...(there are) five objectives of (manpower) research strategy that will prove important in the next half-decade. These five, which are hardly exhaustive and not necessarily independent of each other, will surely command much attention: 1) Redefinition of manpower problems in a "systems" context. 2) Clarification of new requirements for local socio-economic data. 3) Increasing cooperation among the disciplines -- social, behavioral, and physical. 4) Increasing service of private, independent research organizations in a catalytic role. 5) Development of new techniques to facilitate implementation of research results.⁷

Recognizing simultaneously the advantages of a "systems approach" and the elusive nature of health planning criteria and objectives, Striener also observed:

During recent years there has been an increasing use of such terms as "systems analysis" and "operations research," which may suggest to some a laboratory science, perhaps devoid of humanity or humanism... Any close evaluation of the work of "systems" organizations reveals that less quantitative or hardware-oriented techniques are also used as required. Intuitional and subjective inputs must be, and are, utilized where relevant. In particular, the extension of the systems approach to the manpower field will, of course, require many "soft" inputs to complement quantitative "facts" for the attainment of results that seem sensible to the ultimate decision-maker.⁸

Ginzburg and Smith concluded that:

The effectiveness of a manpower study is the extent to which it uncovers critical points where policy can impinge to secure a better result. Facts, figures, and understanding may be interesting and illuminating, but every country needs much more from research. It needs information from the specialist as to how their findings can be used to bring about a more

⁷Striener, Herbert B., "Research Strategy for Manpower Policy," Dimensions of Manpower Policy: Programs and Research, Levitan, S. A. and Siegel, I. H., editors, The Johns Hopkins Press, Baltimore, 1966, p. 230.

⁸Ibid.

effective use of scarce human resources so that the society can move more speedily toward the realization of its goals. The test of a manpower study is the new guidelines which it can draw for policy in such important areas as education, training, wage structures, and utilization.⁹

Lester concurred with other authors' conclusions about the need for and value of a systems-analytic approach when he wrote:

Recognition of the limitations of benefit-cost analysis and the importance of broad social and international interest should not ... deter efforts to apply systematic reasoning to pressing issues in the manpower field. In the absence of a proper framework for thought, decisions tend to be made by hunch or compromise of personal views supported only by emotional and ideological appeals... We need to reexamine the size and scope of the manpower program in the United States and the content of each of its functions in the light of benefit-cost analysis and of other systematic approaches.¹⁰

Dental Health Services -- The Matter of Uniqueness

There are a number of reasons for dealing separately with the roles of various kinds of health manpower in the delivery of specific classes of health services. Health services are made up of motley component services, each of which can be needed, sought, and made available according to different levels of priorities, for different prices, under different modes of financing, and subject to a wide variety of professional and consumer behavior.

Dental services, provided in a direct, labor-intensive fashion by dentists, dental hygienists, dental assistants, and dental laboratory technicians in a predominantly "solo practice" setting, comprise a relatively unique segment of the health services complex in the U. S. The dental profession maintains its own professional society, the

⁹Ginzburg, E. and Smith, H. A., p. 9. ...

¹⁰Lester, R. A. ...

American Dental Association (ADA), through which it affects strongly the education, licensing, and practice of dentists and parodontal personnel.

Dental health services are one of the few sets of health services for which the consumer usually pays directly; dental services are not yet generally included in individual or group insurance or prepayment plans. Moreover, the nature of many oral disorders is such that most persons seem to deem treatment postponable to the point of crisis, especially when personal resources are a limiting factor.* Thus, one might suspect that the demand for dental services is highly income-elastic and relatively more price-elastic than for other kinds of health services.

That dentists are as public-welfare-minded as any health professional group is a moot point; that they are economic men seems well established. Dentists are perhaps the only health professional group whose formal education includes courses in the management of the financial aspects of the private solo and group practice. That fees-for-service and income considerations are extremely significant factors to the dental profession is emphasized by the nature of the triennial and other surveys of dental practice conducted and published by the ADA for distribution to its members. The surveys' allocations of time and space to analyses of gross and net incomes, comparisons of financial well-being among various categories of dentists, and the like seem to

*Unlike many "medical" problems, however, dental disease does not usually improve with time. Most oral disorders are irreversible and cumulative and cannot be alleviated except through active therapeutic intervention.

support the strong economic orientation of the dentist. Conversations with private practitioners -- and especially with dental educators who were practitioners -- support that contention.

The dentist is at once both a specialist and a generalist. He is a specialist in terms of organ systems, since he is concerned primarily only with the oral cavity and its supporting structures and functions. Most dentists are generalists in terms of the spectrum of oral health services performed, although a number of dentists specialize in providing a specific limited set of oral health services.

As is true for physicians and surgeons in medical and surgical practice, once the patient has sought dental care the dentist is in the enviable entrepreneurial position of being both the decision-maker and the supplier in respect to the selection and provision of specific oral health services. While the dental patient frequently has more control over the choice of the final combination of treatment, price, and aesthetics than does the medical or surgical patient, it is the dentist who essentially limits the selection to or suggests the type of treatment which he thinks the patient should have. In some respects, nevertheless, dental patient behavior is somewhat more discretionary than is true for persons seeking other kinds of health services.*

*For example, a patient experiencing a severe toothache may decide to treat his problem with home remedies. If he seeks dental care, he may be offered a number of treatment-cost options: extraction, restoration, extraction with replacement bridge, gold crown, acrylic jacket crown, etc. The dentist could, of course, affect the patient's decision through his explanation of the costs and consequences of each form of treatment or through recommending a specific treatment.

Objectives

The following specific objectives were established in order to achieve the general purposes of this investigation:

1. Development of descriptions and conceptualizations of the structure and behavior of component subsystems of the dental health services system.
2. Development of a description of the character of need and demand for dental services.
3. Description and examination of alternative conceptual dental manpower planning criteria and strategies in the context of the structural and behavioral characteristics of the dental services system and consumer need and demand for dental services.
4. Development of an illustrative application of quantitative modeling and analysis to a specific set of dental services to evaluate the effects of some alternative strategies on achievement of specific dental health goals.
5. Identification of critical areas in which dental manpower policy changes and further health systems research would be likely to have significant impacts on dental health objectives.

Nature and Method of Inquiry

This study can be characterized relatively well by Hall's concept of the "exploratory planning" phase of systems engineering.¹¹ The research was exploratory in that considerable emphasis was given

¹¹Hall, Arthur D., A Methodology for Systems Engineering, D. Van Nostrand Co., Inc., Princeton, N.J., 1962, 478 pp.

to identifying, describing, understanding, and synthesizing the "needs" and "environmental" aspects of a relatively complex, previously unstructured area of inquiry -- the dental health services system. The research was planning-oriented in that newly-derived structural and behavioral knowledge was used to suggest directions for dental manpower program development planning and in-depth systems analysis studies.

The method of procedure for this investigation followed closely the sequence of study functions outlined by Hall.¹² The general pattern of the study consisted of the following sequence of actions:

1. Collection of information on the nature of the dental health services system, needs and demands for dental services, existing dental manpower programs, and problems associated with the state of the art of dental manpower planning, through active participation in state and national dental manpower studies, in order to

- a. isolate, quantify, and relate those factors which characterize the dental health services system and its environment.
- b. ascertain the nature of dental disease and requirements for dental services.

2. Concomitantly with step 1, conduct of extensive searches of the literature of the management sciences, service and manufacturing industries, economics, dentistry, other health professions, and government to identify opportunities to improve dental manpower planning through adoption or adaptation of demonstrably better approaches developed elsewhere.

¹²Ibid, p. 9.

3. Correspondence with authors of existing health manpower planning literature and with officials and manpower research staffs of state and national offices of the American Dental Association, state and Federal government health manpower planning groups, and universities engaged in health manpower research to confirm, modify, and expand the findings of steps 1 and 2.

4. Informal discussions and interviews with persons having backgrounds such as those in step 3 and with administrative officers and faculty of the Medical College of Georgia School of Dentistry in Augusta, Georgia,* to ascertain the general boundaries of feasibility in respect to proposed changes in dental manpower policies, dental professional behavior, modes of dental practice, control of dental disease, and similar planning considerations.

5. Compilation of traditional and currently-proposed dental manpower strategies and synthesis of alternative approaches.

6. Selected analyses of the relative adequacy of each of the dental manpower strategies compiled in step 5 in the contexts of feasibility, costs, and achievement of dental health and dental service objectives.

7. Discussion of a number of philosophical, strategic, and policy issues of dental manpower planning.

*A number of the administrators and faculty of the School hold offices in national dental professional groups whose activities affect dental manpower policies; many are former or active dental practitioners; and several are prominent dental researchers and authors.

8. Exploration of opportunities for industrial and systems engineering to contribute to resolution of some of the issues in 7 through additional in-depth health systems research.

9. Formulation of conclusions and recommendations regarding the status and proposed directions of dental manpower planning vis-a-vis the interests of the public and the dental profession.

Since the objectives and purposes of the investigation reported herein were expository, the methods adopted for communication of findings are substantially descriptive essay.

Scope and Limitations

Emphasis in the present study was upon the provision of general dental health services to the civilian, non-institutional population. General dental services are defined to be the preventive, restorative, and prosthetic services associated primarily with oral disorders resulting from caries and periodontal disease. This class of services accounts for most of the oral health care requirements of the population and is provided by general dentists who represent over ninety per cent of all dentists in civilian practice.

Clearly, the solution of problems as complex as those surrounding dental health and dental manpower issues demands a multidisciplinary, multi-organizational research, development, and implementation effort. The present study is not a unilateral attempt to solve these problems or to resolve these issues; rather, it is intended to describe and conceptualize certain basic characteristics of various parts of the dental health system, to attempt to synthesize from these concepts an

improved framework for analysis and design of dental manpower policies, and to promote the involvement of the management sciences -- namely of industrial and systems engineering -- in the development of rational plans for the allocation of limited human and economic resources in the pursuit of health objectives.

No overt attempt was made to prescribe or proscribe any specific dental manpower strategies or dental health programs, although the results reported herein may have implications for policy changes.

In a number of instances in the study, it was necessary because of limitations on personal resources, time, or availability of information to substitute informed opinion, reasoned argument, and experiential judgments for completely objective observations and quantitative data. In each such case, the subjective nature of the subject matter is indicated clearly.

The next chapter of this report consists of a historical account of health manpower planning approaches and a review of several recent attempts to improve the state of the health manpower planning art. Although health manpower planning in general is the theme of the chapter, those aspects that relate strongly to dental manpower and dental health are emphasized.

CHAPTER II

A REVIEW OF SELECTED LITERATURE

The purposes of this chapter are to present a brief historical account of major health manpower planning efforts in the United States and to review several recent attempts to improve the state of the art of health manpower planning. The literature to be reviewed certainly is not exhaustive of the plethora of surveys, philosophies, and other expressions of concern about health manpower supplies, requirements, and "crises". Rather, it is intended to be representative of the most predominant approaches to health manpower planning, illustrative of the results of recent health manpower planning research, and indicative of the need for development of an improved conceptual frame for analysis and design of health manpower plans.

Historical Perspective

Probably the first attempt to study health manpower requirements and supplies in a systematic, comprehensive fashion was described in the 1933 monograph by Lee and Jones.¹³ These two physicians estimated national health manpower needs on the basis of professional opinions about the amount of care needed to provide adequate preventive, diagnostic, and therapeutic services. The authors computed the number of hours required to treat specific diseases and conditions and

¹³Lee, R. I. and Jones, L. W., The Fundamentals of Good Medical Care, University of Chicago Press, 1933, 302 pages.

translated those time requirements into requirements for specific numbers of physicians, nurses, and dentists. They estimated that the national need for dentists ranged from 99 to 179 per 100,000 population, compared with the actual 1930 ratio of 56 dentists per 100,000 population. Although Lee and Jones concluded that there was a shortage of dentists, they doubted that the United States would be able to support an increased supply of professional personnel to satisfy needs at that time. They concluded that the availability of sufficient health care services to meet specified standards of need depended more upon a revision of organizational and economic arrangements than upon increases in the number of professional personnel.

In 1938, a Federal committee examined health manpower requirements vis-à-vis what it considered to be "effective modern health service."¹⁴ The committee found that a number of areas of the United States lacked an adequate supply of physicians, dentists, and nurses, and that even in better-supplied areas, economic barriers to care often prevented full utilization of professional personnel who were available. The committee concluded that the number of dentists was grossly inadequate to meet epidemiological needs, although the supply seemed to be adequate to satisfy demands for dental services under then current methods of payment. The committee recommended development of a national health program to improve the distribution of health services in under-privileged areas and to remove economic barriers to health care.

¹⁴The Need for a National Health Program, Report of the Technical Committee on Medical Care, Washington, D. C., 1938, 36 pages.

The National Health Assembly, convened from 1948-1958 to assist President Truman to develop plans to improve the national level of health, considered the country's need for physicians, dentists, nurses, and certain ancillary personnel. The assembly assumed three bases for estimating the number of professional personnel in various fields that would be needed by 1960. Although one of the bases used in the assembly's deliberations was the Lee-Jones ratio recommendations of 1933, the assembly did take into account some changing factors which might affect demands for dental care and the productivity of dental personnel. Using those data, the assembly anticipated an increase of about 0.5% a year in the number of dentists needed. The assembly projected a total requirement of about 2,900 dental school graduates a year through 1960. They also recommended expansion of existing dental schools and establishment of new schools in each of nine geographic regions to achieve their projected requirements.

On the basis of the National Health Assembly's deliberations, and as a result of consultations with various advisors, Ewing, Federal Security Administrator, advised the President in 1948 that response to effective demand for health services in the face of large-scale epidemiological need was not a desirable manpower policy. His manpower targets for satisfaction of health needs included one dentist for every 1,400 persons or 72 dentists per 100,000 population. He then recommended aiming first toward meeting the effective minimum demand for health services but, beyond that, to achieve nationally the manpower supply-population ratio already achieved by the twelve

highest-supply states.¹⁵

In 1952 the President's Commission on the Health Needs of the Nation relied primarily on historical manpower-population ratios as "standards" upon which manpower requirements for 1960 were based. Six different premises were examined: (1) maintain the national average health manpower-population ratios of 1940; (2) maintain the national average health manpower-population ratios of 1949; (3) maintain 1949 ratios and meet defense needs; (4) meet specified standard manpower-population ratios (e.g., one physician per 1,000 people); (5) bring those regions of the country below the 1949 average manpower-population ratios up to the national average ratio and meet the needs of the armed forces, (6) achieve in all regions the ratios already achieved in New England and the Central Atlantic states and meet military needs.¹⁶

The commission made no judgments as to how severe the manpower shortages alleged to exist in 1952 actually were, nor did they estimate what the consequences would be of not achieving by 1960 any of the projections based upon the six premises.

The Surgeon General's consultant group on medical education attempted in 1959 to ascertain future needs and demands for health care and the manpower supply required to meet those expectations. Although the primary emphasis of the group's study was on the education of

¹⁵Ewing, O. R., The Nation's Health: A Ten Year Program, A Report to the President, U.S. Government Printing Office, Washington, D.C., 1948, 186 pages.

¹⁶Building America's Health, Vol. II, "America's Health Status, Needs, and Resources," U.S. Government Printing Office, Washington, D.C., 1953, pp. 183-191.

physicians, a summary statement on the requirements for dentists was prepared. The statement pointed to the need for an estimated 75 percent increase in the number of dental school graduates by 1975 in order to maintain the 1959 ratio of dentists to population. A general conclusion of the group was that the challenge of just maintaining the 1959 levels of health manpower supply vis-à-vis anticipated population growth through 1975 was so great that a more sophisticated index of need would not be useful.¹⁷ This report often is referred to as the "Bane report."

The most ambitious governmental attempt to study requirements for and supplies of health manpower in a systematic fashion was the 1967 study of the National Advisory Commission on Health Manpower. The Commission's report emphasized the shortcomings of previous manpower studies which were based upon fixed ratios of physicians and dentists to population.

The shortcomings of this approach are apparent when past increases in the provision of health services are compared with increases in these two professions. While the numbers of physicians and dentists have grown at approximately the same rate as population in recent decades, the volume of medical and dental services has increased far more rapidly...¹⁸

A major premise of the commission's report was that

¹⁷Physicians for a Growing America, Report of the Surgeon General's Consultant Group on Medical Education, U.S. Public Health Service Publication #709, U.S. Government Printing Office, Washington, D.C., 1959.

¹⁸Report of the National Advisory Commission on Health Manpower, Vol. I, U.S. Government Printing Office, Washington, 1967, page 7.

The health sector has demonstrated during the past decade its ability to respond to increased demand. While the supply of physicians and dentists has not responded rapidly to increased demands for health care, the supply of nurses and auxiliary personnel has expanded remarkably. Furthermore, the lead time for the training of health personnel-with the exceptions of physicians, dentists, and nurses - is relatively short; thus a rapid response to rising demands is possible. The serious policy questions therefore relate to the adequacy of the future supply of physicians, dentists, and nurses.¹⁹

In respect to dental manpower, the commission concluded

...the shortage of dentists does not appear to be comparable to that of physicians...however, most persons in low income families still do not receive adequate dental care...

In short, significant discrepancies between supply and demand for dental services do not appear to have developed. ...our calculations, based on the experience of the last decade, indicate that the demand for dental services (in current dollars) will increase between 100 percent and 125 percent in the period 1965-1975. The supply of dentists is expected to increase by only 16%; however, as a result of the continued increase in the use of auxiliary personnel and further improvements in dental technology, the total productivity of dentists will increase much more -- perhaps by as much as 50%. Such an increase would, however, still fall short of the expected increase in demand.²⁰

The commission recommended that, in order to meet anticipated increases in demand, the number of dentists needs to be increased above planned levels. The commission further recommended that the capacities of existing schools of dentistry be expanded substantially and that federal funds in support of capital or operating costs should be provided to schools of dentistry in such a way that they would create economic incentives for the schools to expand enrollment while improving educational quality.

¹⁹Ibid, p. 13.

²⁰Ibid, p. 21.

Many of the commission's conclusions regarding dentist productivity increases were derived from the work by Weiss, which will be discussed in the next section of this chapter. The commission adopted Weiss's approach with some reservations, noting that

...despite its shortcomings, this procedure is the handiest for providing an overall measure of the direction and pace of productivity changes. Put another way, there is little evidence to refute the results.²¹

The 1970 report of the Carnegie Commission on Higher Education²² delineated a number of problems associated with the rationales of previous health manpower analyses and projections. Nevertheless, the Commission offered only its "judgment" as an alternative methodology. Typical of the Commission's judgments were conclusions such as:

Although there is debate over the extent of shortages of health manpower, critical shortages do exist. ...although there is no clear agreement on what ratio of, say, physicians to population is adequate, there is little question that the supply of health manpower is gravely deficient in some parts of the nation.²³

In respect to dental manpower, the Commission concluded:

On the whole, there is less evidence of a shortage of dentists than of physicians, in relation to current demand. ...it is difficult to estimate the ratio of dentists to population that might be "adequate" in 1975 or 1980.

Existing projections of the demand for dentists are based on maintaining the existing ratio of dentists to population and take no account of either an accelerated increase in demand, on the one hand, or a change in the rate of increase in productivity on the other.

²¹Report of the National Advisory Commission on Health Manpower, Vol. II, U. S. Government Printing Office, Washington, 1967, p. 259.

²²Carnegie Commission on Higher Education, Higher Education and the Nation's Health, Policies for Medical and Dental Education, McGraw-Hill Book Co., Hightstown, N.J., 1970, 128 pp.

²³Ibid, p. 18.

...estimates provided by the Council on Dental Education of the American Dental Association project an increase from 4,430 dental school entrants in 1970-71 to 5,400 in 1980-81...

The Commission believes that at least the expansion of dental school places indicated by these projections is needed.

The Commission recommends that...the number of dental school entrants should be increased at least to 5,000 by 1976 and to 5,400 by 1980.²⁴

The Commission also recommended expansion of programs of education of medical and dental ancillary personnel and reductions in the durations of educational programs for dentists and physicians.

The Carnegie Commission report seems to exemplify current approaches to planning and policy formulation in respect to health manpower in general and dental manpower in particular. In respect to dental services and dental manpower, the Commission only reiterated and gave additional support to previous findings of the American Dental Association. Of course the Commission's action in this regard is not necessarily deleterious of itself. However, the widespread acceptance of a number of apparently unexamined premises and methods of health manpower planning seems to be accelerated and reinforced by the publicity given the conclusions drawn by the Commission.

The traditional approaches involving the use of fixed population-manpower ratios and/or apparently arbitrary manpower quantity objectives are, of course, justifiable if in fact the premises implicitly underlying them are well-founded and if little would be gained by attempting improvement of planning methodologies. Unfortunately, the premises remain substantially unexamined. Moreover, there is considerable

²⁴Ibid, pp. 37-38, 44-45.

evidence that health manpower questions continue to be addressed out of context; health manpower continues to be treated predominantly as a health goal rather than as one of a number of health system input resources.

The Lee-Jones study²⁵ of 1933 seems to have been a reasonable initial attempt to systematize the study of health and health manpower issues. However, despite the recent development of capabilities to collect and manipulate large quantities of data and the large-scale national concern and effort directed toward health manpower issues, the Lee-Jones study has not been updated, nor has the approach been replicated. Moreover, despite known changes in the epidemiology of a number of diseases, medical and dental knowledge, technology, drugs, and use of ancillary personnel, and dramatic changes in socioeconomic conditions, references continue to be made to the Lee-Jones findings as desirable targets for current health manpower planning efforts.

Some Recent Analytic Studies of Health Manpower
Services Characteristics

A number of researchers recently have completed analytic studies of certain aspects of the health manpower-health services system. Although specific emphases and methods vary among these works, most have focused upon the relationships between the utilization of certain health services and the factors which determine utilization. Some of the most recent efforts have been directed toward analyses of health services production functions for selected health manpower categories.

²⁵Lee, R. I. and Jones, L. W., op. cit.

And, in a few instances, attempts have been made to develop improved understanding of the nature and goals of health services systems. Brief overviews of several of these analytic works are presented in the following paragraphs.

Since about 1964, a number of authors have developed multivariate statistical models to explain differences in consumption of medical and dental services among individuals and families.²⁶ Most of these approaches have used gross health expenditures as surrogate measures of demand for health services, the dependent variable. The independent variables typically have included various indices to represent social, economic, and health status factors. All the analyses which dealt with dentistry showed that expenditures for dental service were very strongly related to personal and family income.

Feldstein's analyses indicated that income accounted for almost all the 50 per cent explained variation in dental expenditures.²⁷ He also found that, in simple and multiple regression analyses, an increase in income of about 10 per cent in each case yielded increases in dental expenditures of about 14 per cent and 12 per cent, respectively.

²⁶For example, see: Andersen, R., "A Behavioral Model of Families' Use of Health Services," Center for Health Administration Studies, Graduate School of Business, The University of Chicago, 1968, 111 pp.; Feldstein, P., "Demand for Medical Care," in The Cost of Medical Care, Vol. 1, American Medical Association, 1964, pp. 57-76; Wirick, G., "A Multiple Equation Model of Demand," Health Services Research, Winter 1966, pp. 301-346; Wirick, G., and Barlow, R., "The Economic and Social Determinants of the Demand for Health Care Services," in The Economics of Health and Medical Care, University of Michigan, Ann Arbor, 1964, pp. 95-127; Reinke, W. A. and Baker, T. D., "Measuring Effects of Demographic Variables on Health Services Utilization," Health Services Research, Spring 1967, pp. 61-75.

²⁷Feldstein, op. cit., pp. 69, 72-76.

Andersen's model was able to explain only about 20 per cent of the variability in dental expenditures;²⁸ however, income was again shown to be the dominant determinant of utilization for this discretionary health service.

Although these multivariate approaches give some insight into factors which contribute to levels of expenditures for dental and other health services, they share several shortcomings. First, family or individual expenditures for health services do not appear to be adequate measures of utilization of health services. Prices of particular services may vary depending upon the ability of the patient to pay, his health insurance coverage, the relative "luxury" of the service he chooses, and similar factors. In both medicine and dentistry, the "sliding fee scale" is still used by some practitioners. Expenditures may not reflect use accurately because low-priced or free care may be consumed by certain groups far in excess of the amount indicated by their income.

Health care prices vary in different geographic areas. Families and individuals in areas of high health care prices will appear to consume greater quantities of services per capita than in areas of low prices, whether or not they actually do. Of course expenditures for care are a "common denominator" in a sense and are more easily obtainable than other measures of use -- hence the popularity of this measure.

The primary findings of analyses of the foregoing types are that there probably are statistically significant relationships between certain economic, social, and health status characteristics and

²⁸ Andersen, op. cit., pp. 49-51.

expenditures for certain health services. There is little information, however, about which kinds of services are utilized or desired, about what should be done to accommodate demands, or how to project changes in utilization of services as the several determinants change over time. Even in the case of dental services, for which income was found to be the dominant use determinant, policy implications for improved services are not clear. Moreover, prices of dental services were omitted from the analyses because of the dearth of price data.

In 1966, Weiss²⁹ developed a "job classification" scheme to analyze changes over time in the utilization of health manpower. He placed each health care job into a group according to its technical focus or major function and its level of "job content." He used relative professional income levels and minimum educational requirements as surrogate measures of "high", middle", or "low" job content. He assumed that the dental services production function was linear within the range of interest, so that a percentage increase in the number of persons employed at all dental care jobs should yield that same percentage increase in the quantity of services rendered. This assumption is identical to the one implied in traditional approaches which deal with manpower-population ratios.

Weiss then estimated the per cent increase in output of dental services from 1950-1961 using total expenditures on dental care less the cost of facilities and the net cost of health insurance deflated by

²⁹Weiss, J. H., "The Changing Job Structure of Health Manpower," Ph.D. Dissertation, Harvard University, Cambridge, Mass., July 1966.

the Consumer Price Index for Urban Wage Earners and Clerical Workers for dental services as a surrogate measure of output.

Using this output measure, Weiss estimated an increase of 50.5 per cent in deflated gross expenditures on all dental care from 1950-1961. Weiss then compared the actual 1961 numbers and proportions of dental manpower at various levels of job content with those which would have been required, under the linearity assumption, to achieve the 1961 gain in "output". He concluded that there had been a 41 per cent increase in "real" output of services per active, non-Federal dentist--an annual increase of about 3.2 per cent. Weiss estimated that the annual increase in output per dentist-hour during the same period was 3.1 per cent. Maurizi³⁰ later found similar results using a similar methodology.

In both the Weiss and Maurizi studies, it appears that the authors were attempting to estimate changes in the financial production of the dentist rather than in the product productivity of the dental practice. Although Weiss attributed most of the increased output to more widespread use of dental ancillary personnel, he did not explicitly consider those new personnel as resources consumed in his "productivity" calculations. Weiss assumed, moreover, that no appreciable changes in dental product mix or relative prices had occurred from 1950-1961.

These considerations, in addition to the inherent biases of the dental consumer price index, leave some questions as to the relative

³⁰ Maurizi, A., Economic Essays on the Dental Profession, Bureau of Business and Economic Research, University of Iowa, Iowa City, 1969, pp. 65-69.

accuracy and reliability of the estimates. Nevertheless, Weiss's findings have formed the bases for several subsequent sets of manpower policy recommendations, as described earlier.

In 1967 Fein³¹ presented a relatively comprehensive monograph on the economics of the physician manpower segment of the medical services system. His primary emphases seemed to be that: (1) health policy-makers should be aware that they are dealing with marginal, not total, changes in medical care systems; (2) physician manpower should be distinguished from physician services; (3) the nature and magnitude of a physician services shortage are a function of economic demand, not epidemiological need; and (4) rising demands for physician services should and can be met through increases in physician productivity yielded by greater use of ancillary personnel and medical group practice. Fein appeared to subscribe to Weiss's approach and findings regarding increases in productivity through increased use of paramedical personnel.³²

In 1967, Butter³³ attempted to formulate a general schematic framework to categorize the variables that affect the supply and demand for health workers. Butter recognized most of the major areas of concern and difficulty to conducting manpower studies. She enumerated in

³¹Fein, R., The Doctor Shortage: An Economic Diagnosis, The Brookings Institution, Washington, D. C., 1967, 199 pp.

³²Ibid, pp. 119-121.

³³Butter, I., "Health Manpower Research: A Survey," Inquiry, Vol. IV, No. 4, December 1967, pp. 5-41.

general the various kinds of factors that ought to be studied, measured, and understood in order to conduct effective manpower studies. And she expressed concern about the inconsistencies among existing projections of physician manpower requirements. Butter concluded:

...there is considerable room for progress in defining, conceptualizing, quantifying, and compiling relevant data for the study and diagnosis of health manpower shortages. Progress in this area will not be forthcoming in the absence of an analytic framework for the study of the health professions.³⁴

It appears that, despite attempts at objectivity and comprehensiveness, most of the studies cited and numerous others remain oriented toward traditional profession-directed health manpower planning perspectives and notions of health manpower crises.

Although several authors seem to appreciate the difficulties of proceeding further without a "comprehensive framework for analysis," the nature and implications of such a framework continue to be elusive.

It is the intent of the present study to deal more directly with the nature and relative magnitudes of problems related to achievement of dental health goals through dental manpower programs. It is hoped that the approaches developed here will: (a) improve understanding of the role of dental manpower as a resource in the dental health system; (b) promote and provide direction for the in-depth study of specific dental health subsystems problems whose solutions would be of significant value and (c) to encourage formulation and achievement of well-defined, realistic, and rational dental health goals and policies. As a first step in developing improved understanding of the dental

³⁴Ibid, p. 35.

services system, the following chapter describes the role of dental manpower in the production of dental health services.

CHAPTER III

DENTAL MANPOWER AND THE SUPPLY OF DENTAL SERVICES

Private dental practice is the primary source of dental services in the United States. A dentist may offer general dental services or he may specialize in a particular set of dental services. He may practice independently of other dentists (solo practice) or he may choose to enter into some cooperative arrangement with one or more dentists (e.g. group practice). It is estimated that about 85 percent of U.S. dentists practice solo³⁵ and that about 90 percent of U.S. dentists are generalists.³⁶

Some of the characteristics of the practice of dentistry, with emphasis upon the nature of the solo general practice, are described in the present chapter. An attempt is made to describe those characteristics that appear to be relevant to the dentist's present and future role as a principal source of oral health services. More detailed descriptions of dental practice may be found in the existing literature.^{37,38}

³⁵Commission on the Survey of Dentistry in the United States, The Survey of Dentistry, Final Report, 1961, American Council on Education, Washington, D.C., p. 117.

³⁶Bureau of Economic Research and Statistics, "Facts About States for the Dentist Seeking a Location," American Dental Association, Chicago, 1969, pp. 6,7.

³⁷Bureau of Economic Research, "The Survey of Dental Practice," American Dental Association, Chicago, 1950, 1953, 1956, 1959, 1962, 1965, 1968.

³⁸Hollinshead, B., The Survey of Dentistry, American Council on Education, Washington, D.C., 1961, 603 pp.

The General Nature of Dental Practice

The dentist typically practices as an independent health professional entrepreneur in a location of his own choosing. He appears to have more freedom in selecting the location of his practice than does the physician, because the dentist is not so dependent upon hospitals or colleagues in specialty practices. Other characteristics of the distribution of dentist practice locations are discussed later in this chapter.

The dentist offers a variety of oral health services; however, through either formal professional training or selective scheduling of patients, he can specialize in providing a limited set of services. To assist him or to provide directly certain dental services, the dentist usually employs one or more dental chairside assistants, hygienists, technicians, or receptionist-secretaries as ancillary personnel. Table 1 indicates approximately the percentages of general dentists and specialists who employed various kinds of personnel in 1967. Clearly, the most popular kind of dental auxiliary, employed by about 80 per cent of all dentists, was the dental chairside assistant. In Georgia in 1966, dentists employed an average of about one dental assistant, one-half dental hygienist, and one-tenth laboratory technician each.³⁹

The chairside dental assistant plays a highly interactive role with the dentist. The assistant participates in practically all procedures performed by the dentist. She may also perform certain set-up

³⁹Board of Dental Examiners in Georgia and American Association of Dental Examiners, "1966 Survey of Dentists Licenced in Georgia," (unpublished), Augusta, Georgia, 1968, 15 pp.

Table 1. Percentage of Nonsalaried Dentists Employing Auxiliary Personnel, by Type of Practice and by Type of Personnel.⁴⁰

Type of Practice	Type of personnel							
	<u>Hygienists</u>		<u>Technicians</u>		<u>Assistants</u>		<u>Secretaries and receptionists</u>	
	Full time	Part time	Full time	Part time	Full time	Part time	Full time	Part time
General practitioner	12.9	13.3	3.4	1.3	82.8	17.0	24.9	5.0
Specialist	8.3	3.9	10.7	6.0	88.4	21.5	45.5	6.3
Oran surgeon	2.4	0.0	0.0	0.0	80.5	21.0	58.5	9.9
Orthodontist	3.2	0.6	20.1	10.4	90.9	24.7	40.9	6.5
Pedodontist	17.1	5.7	2.9	5.7	88.6	14.3	42.9	5.7
Other	23.1	15.4	6.2	3.1	92.3	18.5	41.5	1.5
All types of practice	12.4	12.2	4.2	1.9	83.5	17.5	27.2	5.6

⁴⁰Bureau of Economic Research and Statistics, "The 1968 Survey of Dental Practice," Journal of the American Dental Association, 78:127, January 1969.

or preparatory tasks relatively independently of the dentist. In virtually every state, the duties of the chairside assistant are limited through dental practice acts of state legislatures. However, a number of dentists admit privately that their ancillary personnel are allowed to perform certain prohibited tasks independently, with periodic supervision.

The dental hygienist is the principal source of disease-preventive dental services in the dental practice. The hygienist performs prophylactic services, such as scaling, polishing, and applying topical fluoride compounds, essentially independently of the dentist. Indeed, it is not unusual for a hygienist to work for more than one dentist as a "salaried entrepreneur" in her own right.

Technical dental laboratory work involving fabrication of oral appliances is now done predominantly by the dental laboratory firm, centrally located to serve many dentists. Few dentists employ their own technicians or do extensive appliance fabrication themselves.

Fees for services performed within the dental practice are determined by the dentist himself. The dentist is constrained in setting his fees by his intuitive sensitivity to the price-elasticity of demand for his services, by legislation that may place ceilings on prices for services, and by perceived pressure from peers to keep fees in line with local or national trends. The dentist's fee structure is discussed in more detail later in this chapter.

Quality control in the dental practice appears to depend entirely upon the judgment and skill of the dentist and of his ancillary personnel. Many of the skills and attitudes that affect the quality of dental

services seem to be acquired during formal dental school training. However, the economic pressures of private practice, some dentists admit, cause them occasionally to "compromise" on quality in order to "get the work done" and "make a living," especially in respect to difficult, time-consuming services with low economic yield to the dentist. Certain pressures, such as patients' complaints requiring no-charge adjustments and word-of-mouth referrals, as well as referrals of patients to other dentists, tend to enforce, to some degree, maintenance of adequate quality levels in the dental practice. The services performed by ancillary personnel are monitored and supervised to varying degrees by the dentist, as required by state licensure regulations and the dentist's desire to protect his patients' welfare, his image, and his economic well-being.

Clearly, the dentist can operate as a relatively independent health professional entrepreneur, subject to few exogenous economic or quality constraints. He can essentially determine the service mix he will offer, the prices of services, the numbers and kinds of patients he will see, his working hours, and his annual income. He is, at the same time, the only readily available source of oral health services in the United States for the civilian, non-institutional population.

Dental Manpower and Educational Costs

In 1968 there were about 92,013 active non-Federal dentists in the United States. In the same year, there were 52 schools of dentistry in operation in 28 states, producing about 3,457 graduates per year. Seven additional schools of dentistry were being planned in 1968,

although 19 states had neither active nor planned dental schools at that time.⁴¹

Using estimated annual numbers of graduates and mortality rates for white males, it has been estimated that the supply of active non-Federal dentists will increase to about 107,359 in 1975 and to 116,031 by 1980.⁴² It has been projected also that, in relation to projected population growth, the number of active U. S. dentists per 100,000 population will be very stable at 49 dentists per 100,000 persons through at least 1975.⁴³ That ratio varies, however, from 22 dentists per 100,000 population in South Carolina to 92 in the District of Columbia and is not an adequate indicator per se of the availability of dental services to local populations.

U. S. dental schools are virtually the sole source of dentists in the United States. No state will license graduates of dental schools outside the United States and Canada.⁴⁴ (Indeed, in 1967 eleven states had neither reciprocity nor endorsement provisions for recognition of dental licenses issued by other states.⁴⁵) The U. S. dental educational

⁴¹U. S. Department of Health, Education, and Welfare, "Manpower Supply and Educational Statistics for Selected Health Occupations," in Health Manpower Source Book, Section 20, U. S. Government Printing Office, Washington, 1969, pp. 79-86.

⁴²Ibid, p. 86.

⁴³Ibid.

⁴⁴Report of the National Advisory Commission on Health Manpower, Volume II, U. S. Government Printing Office, Washington, 1967, p. 257.

⁴⁵Ibid, p. 502.

process is typically a four-year process involving education in the so-called "basic sciences" for one to two academic years and in the "clinical sciences" for two to three years.

Although difficult to document, there has been apparently increasing conviction among U. S. health educators that adoption of three-year dental curricula will lead to substantial increases in the supply of dentists. The U. S. Government is encouraging this philosophy by offering special capitation grant awards to U. S. dental schools that adopt three-year curricula.

The concept of reducing the duration of the dental curriculum from four academic years (12 academic quarters) to three calendar years (12 academic quarters) is relatively simple. In the three-year "full-time" curriculum vis-a-vis the traditional four-year curriculum, annual faculty workloads, annual number of graduates, and similar indicators of resource requirements and output remain essentially unchanged. For a fixed entering class size, moreover, the number of graduates per year for the three- and four-year programs is the same, although in converting to the three-year schedule it may be possible to "gain" the equivalent of one single additional graduating class in one single year only. Thereafter, the number of graduates per year, ceteris paribus, is the same under both programs.

Although the inherent advantages to the public of the three-year curriculum are not completely clear, it appears that some potential economies could exist within the three-year program that might allow nominal increases in entering enrollments, yielding somewhat larger graduating classes. The principal economy of the three-year program

seems to lie in the fact that the total number of students present at any one time would be reduced by one-fourth from the number in the four-year program, thus making available certain physical and logistical resources potentially for use in increasing class size. Similar economies in respect to student contact resources such as faculty effort do not seem to exist, since they would be required in the same fashion under either curriculum.

In summary, it appears that the future supply of U. S. dentists will not vary appreciably from the projections presented earlier. Even if all U. S. dental schools adopted a three-year curriculum, the projections would change at most by about 3,000 to 4,000 dentists nationally.

Dental Educational Costs

A 1965 study of dental educational costs indicated that the average cost of dental education per student per year ranged from \$2,919 to \$4,578, depending on the specific program costs included in the analysis.⁴⁶ More recently, Terkla reported that the annual cost of dental education may range from \$11,000 to \$15,000, and that, in addition, construction costs for a new school might be \$200,000 to \$250,000 per student in the initial year of operation.⁴⁷

In order to gain additional insight into the nature and magnitude of dental educational costs, an analysis of the costs of dental

⁴⁶American Association of Dental Schools, Cost Study of Dental Education, Chapel Hill, N. C., 1965, 83 pp.

⁴⁷Terkla, L. G., presentation to the 1970 Conference of Dental School Deans, Palm Springs, California, November 1970.

education at the Medical College of Georgia School of Dentistry was undertaken as a part of the present study.* The purpose of the analysis was to ascertain the annual cost of dental education per dental student for fiscal years 1969 through 1974, at which time the School of Dentistry would attain its full undergraduate enrollment of 224 students. The detailed methods and results of the analysis are presented in Appendix A.

Traditionally, the initial cost of facilities and equipment has been considered a one-time cost which is apportioned among only the first entering class. The approach used in the present analysis differed somewhat from the traditional approach in that it allowed the initial cost of facilities and equipment to be amortized over the useful life of these assets. Using an estimate of the time value of money, the amortized cost was converted to an equivalent annual cost and apportioned among projected yearly enrollments. This approach more realistically represents the time costs of money incurred by both private and public funding agencies.

For example, if a new dental school is constructed for \$10,000,000 and will have a 160-student per year total enrollment, the facilities cost would traditionally be apportioned among the first entering class of 40 students at \$250,000 per student. Assuming a 40-year life and a nominal 5% interest rate, the approach used in the present analysis would compute an amortized total facility cost of \$23,312,000 at an

*Conducted in collaboration with Russell G. Overton, Systems Engineer, Division of Health Systems Engineering, Medical College of Georgia, as an intramurally-funded service and research activity of the institution.

equivalent annual cost of \$582,800. One could then apportion this annual cost among each year's enrollment to ascertain the average facilities cost per student per year. Thus, although these cost estimates are substantially greater than the initial cost alone, they appear to be more representative of actual financial arrangements required for dental educational facilities construction.

In the present analysis, it was estimated that the stabilized total annual cost per dental student, including consideration of the fees and income he generates, is in the \$15,000 to \$20,000 range. The net cost per dental graduate of \$60,000 to \$80,000 is, of course, typically borne by state and Federal agencies through public taxation for most of the nation's dental schools.

Current methods of analyzing educational costs involve the use of a variety of simplifying assumptions, administrative judgments, and techniques for apportioning costs among educational service, and research programs. Until some standardized method for ascertaining costs of education is adopted by all dental schools, comparisons of the results of cost analyses among schools can be misleading. Nevertheless, given the methods and assumptions of the present study, there seems to be no reason to consider the estimated educational costs of the Medical College of Georgia School of Dentistry atypical of costs that would be encountered at other U. S. dental schools.

Paradental Manpower and Educational Costs

Although the principal emphasis in the dental educational field is upon preparation of dentists, in 1968 there were 67 public and

private college and university programs in dental hygiene and 101 programs in dental assisting. Total enrollment in the dental hygiene programs in 1968 was 4,309; in the dental assisting program, enrollment was 3,819. The hygienist and assistant programs were producing 1,739 and 1,593 graduates, respectively, in 1967.⁴⁸

Most dental hygienist training programs range from two to four academic years and award associate and baccalaureate degrees in dental hygiene, with emphasis upon providing limited prophylactic services within the dentist's practice. Dental assistant training programs are of one to two years' duration and yield certified graduates whose principal duties involve supporting the dentist at the chairside.

It has been estimated that the mean annual educational cost per hygienist student was about 1,300 dollars in 1964, yielding a mean cost per graduate of from 2,600 to 5,200 dollars, depending upon course duration.⁴⁹ Cost data for dental assisting programs are not currently available. However, it appears that because of the relatively small scale of assisting programs throughout the United States (total enrollments ranging from 12 to 43 students for most programs), dental assisting programs are conducted principally as adjuncts to and for the benefit of dentist educational programs, and thus require the consumption of few additional educational resources, beyond those required for dentist programs.

⁴⁸Division of Educational Measurements, Council on Dental Education, Annual Report on Dental Auxiliary Education, American Dental Association, Chicago, 1968, pp. 5-23.

⁴⁹American Association of Dental Schools, Cost Study of Dental Education, op. cit., p. 36.

Although cost data are not now available in respect to the one-year training programs used to prepare expanded-function auxiliaries in the experimental Louisville studies,⁵⁰ it is presumed that such training would require approximately the same order-of-magnitude of investment per student as the dental hygiene programs discussed above. Allowing for some additional investment in a wider range of technique training and in associated equipment, it seems reasonable that the cost per graduate expanded-function auxiliary should be on the order of 3,500 dollars for the one year of training. Of course the scale of such training programs might affect that estimate substantially.

The Production of Dental Services

One of the most popular premises put forth in defense of traditional approaches to dental health and manpower planning is that increasing dentist productivity -- arising principally from the use of larger numbers of ancillary personnel in solo practice and economies of scale of dentist group practice -- will offset a substantial portion of projected increases in the need and demand for dental services. Such assertions are commonly based upon the observation that solo dentists who hire ancillary personnel and dentists in group practice have higher gross and net incomes than unassisted dentists without working longer hours and without increasing fees substantially.

In the first case, the higher ratio of ancillary personnel to dentists is accepted widely as prima facie evidence that a greater division of labor must be taking place, requiring decreasing amounts of

⁵⁰ Lotzkar, S., op. cit.

the dentist's time per unit of service and, thus, yielding greater dentist productivity. In the second case, it is argued that group practice, because of the indivisibility of personnel and equipment resources and an even greater propensity to use parodontal manpower, yields even greater productivity and higher dentist incomes, and thus confirms the existence and benefits of economies of scale of group practice. The nature of potential productivity changes and economies of scale will be examined conceptually in this section in an attempt to ascertain whether or not and where such gains might exist and how significant they might be in increasing the availability and economy of dental services.

Productivity is a rate concept which describes, often in ratios of dissimilar units, the quantity of output of a specified type which can be produced by a specified number of units of various inputs. The inputs typically considered important in the dentist's practice are dentist man-hours, capital equipment, and number of operatories. Less frequently identified or used in traditional "productivity" estimates are parodontal personnel man-hours and costs.

The output measures used most widely include the annual number of office visits and price-index-deflated gross income of the dentist's practice. Data concerning the effects of dental practice on individuals' oral health status as an output measure are nonexistent. Data relating the quantities of specific dental services delivered over several different periods of time are, at best, incomplete or incompatible and are inadequately measured at infrequent intervals. Thus, no useful direct measurements of either input or output of the dentist's practice

exist to support empirical studies of alleged productivity changes.

The conventional view of the production of dental services implies that the "final product" of the dentist's practice (patient visits, income, etc.) can be produced in a number of different ways, depending upon the number of kinds of inputs at the dentist's disposal.* In general, there has been widespread neglect of the fact that the dentist's general practice and multispecialty group practices are multiproduct firms. Failure to recognize differences in output (service) mixes has led to implications that all the products of dental practice are similar and that only the input mixes vary. This approach thus encompasses the notion of a production function of the following form:

$$f(K_1 \dots K_m ; L_1 \dots L_n) = y$$

where K_1 might be the number of operatories, K_2 is x-ray equipment; etc.; L_1 is dentist hours, L_2 is hygienist hours, L_3 is dental assistant hours, etc.; and y is the output of the dental firm in numbers of patient visits or deflated gross income or some other one-dimensional conventional measure.

This traditional perspective implies that considerable substitutability of inputs can be exploited in the production of "dentist services." Thus, since the dentist's time is thought to be the most

*This discussion follows the observations of Bailey, R. M., "Philosophy, Faith, Fact, and Fiction in the Production of Medical Services," Inquiry VII:37, March 1970.

expensive and the least available input, the extent to which either capital (K_i) or labor of parodontal personnel (L_i) can replace dentist manhours, dentist productivity is said to increase. However, this construct does not appear to portray accurately the nature of the production function for either individual or group dental practice. The conclusions about changes in productivity and potential economies of scale drawn from such a concept are likely to be somewhat misleading.

An Improved Conceptual Production Function

A better representation of the dental services production process would describe clearly the fact that the dental practice -- both solo and group -- produces a variety of different, distinct services. These services could be denoted conceptually as (S_1, S_2, \dots, S_n) where S_1 might be a one-surface amalgam restoration, S_2 could be a two-surface amalgam restoration, S_3 might be an acrylic jacket crown, S_4 polishing the patient's teeth, and so on. Of course the number of components in such an output vector would be dependent upon the size and degree of specialization of the practice.

If each of these services were treated as having a separate production function, then one should be able to label and classify them into sets such as, for example, "dentist services" (for which the dominant input is dentist time), "ancillary services" (produced largely by auxiliary personnel), and "laboratory services" (produced largely by a dental laboratory technician or commercial dental laboratory). Thus, using a unique production function for each service, production in the dental firm might be characterized as:

$$\begin{array}{rcl}
& S_{1,1} = f_{1,1} (K_1 \dots K_m; L_1 \dots L_n) \\
& S_{1,2} = f_{1,2} (K_1 \dots K_m; L_1 \dots L_n) \\
\text{"Dentist"} & \vdots & \\
\text{Services"} & & \\
& S_{1,D} = f_{1,D} (K_1 \dots K_m; L_1 \dots L_n) \\
& \\
& S_{2,1} = g_{2,1} (K_{m+1} \dots K_r; L_{n+1} \dots L_t) \\
& S_{2,2} = g_{2,2} (K_{m+1} \dots K_r; L_{n+1} \dots L_t) \\
\text{"Auxiliary"} & \vdots & \\
\text{Services"} & & \\
& S_{2,A} = g_{2,A} (K_{m+1} \dots K_r; L_{n+1} \dots L_t) \\
& \vdots & \\
& \text{etc.} &
\end{array}$$

where the $S_{1,1}$ through $S_{1,D}$ denote the services currently performed primarily by the dentist, such as amalgam restorations, complete oral examination, consultation, and the like. Each $f_{i,j}$ denotes a different technical relationship in terms of varying amounts of dentist and para-dental time inputs, and various levels of utilization of certain capital resources. $S_{2,1}$ through $S_{2,A}$ represent services produced principally by para-dental personnel. The $g_{i,j}$ denote different technical relationships among input factors. Such descriptions theoretically could be repeated for each set of services offered by the dental practice. Using these conceptual descriptions of production functions for various services offered by the dental practice, the notions of productivity and economies of scale will be examined in more detail.

Unassisted Solo Practice

In the unassisted solo practice of dentistry, the dentist can offer a wide range of labor-intensive preventive, restorative, and prosthetic "dentist services." The mix of services he offers can vary from a heterogeneous blend of the many possible services to specialization in a particular set of services as a result of formal training or experience or through selective scheduling of patients. The unassisted solo dentist can increase his production of any or all the services he offers, by increasing the number of hours he spends in practice. However, there was little change in the mean annual number of working hours of dentists from 1962 hours in 1949 to 2039 hours in 1965.⁵¹ The unassisted dentist who adopts certain improvements in equipment, office arrangement, and methods could, theoretically, change the production function of the services he offers by substituting capital for his own labor. Although supporting data are not available, it is presumed that adoption of high-speed cutting equipment by dentists, beginning in the early 1950's, ⁵² has reduced, to some degree, the dentist man-hour requirements for most restorative and prosthetic services. It is presumed also that the effect of high-speed equipment on the productivity of the dentist has now stabilized. Of course, to the extent that similar improvements in equipment, procedures, and materials are developed and adopted, the dentist can potentially produce a larger number of specific kinds of services per hour of his own time.

⁵¹1950 and 1965 Surveys of Dental Practice, op. cit.

⁵²Hillinshead, Survey of Dentistry, op. cit., p. 478.

The unassisted solo dentist also can produce a larger number of services per hour if he can purchase portions of certain time-consuming services from sources outside the practice. The most predominant example of this phenomenon is prosthetic dentistry. It is estimated that about 90 per cent of all dentists in the United States send fabrication specifications for prosthetic appliances to technicians employed by commercial dental laboratories.⁵³ Thus, the shift in input factor use from dentists to technicians has changes dramatically the production functions for prosthetic services and created a new set of "technician services" provided outside the dental practice. As a result, dentists can produce a larger number of the "dentist" portions of prosthetic or other services within the dental practice. The impact of the commercial dental laboratory on the dental practice appears to have stabilized from the point of view of the dental profession;* it is suspected that the potential contribution of the purchased-service mode of further increasing the availability of dental services is now marginal. Moreover, solo dentists are not now able to compete with commercial dental laboratories for the employment of laboratory technicians.

Assisted Solo Practice

The unassisted solo dentist also can attempt to substitute more readily available kinds of manpower for his own input within the dental

⁵³Ibid, p. 237.

*Professional and legal issues related to this provision of all services associated with the prescription, fabrication, and fitting of complete dentures by commercial dental laboratories and individual technicians ("denturists") continue to be debated and are beyond the scope of this study.

practice. A traditional first step in this direction is the dentist's hiring a receptionist-secretary whom he may train also to assist him with chairside procedures. Although formal training programs for "dental assistants" produced about 2,700 graduates in 1969,⁵⁴ approximately 12,000 assistants continue to be trained on the job each year by their dentist-employers.^{54A} Typical duties performed by the dental assistant/receptionist and the proportions of time spent on each category are shown in Table 2.

Clearly, the assistant's performing routine secretarial and bookkeeping duties relieves the dentist of those duties and makes available additional dentist time, potentially for the production of greater quantities of dentist-intensive services. Moreover, to the extent that the assistant can substitute for the dentist in performing chairside procedures, the production functions for certain specific oral health services could be changed. Limited data indicate that a dentist-and-chairside-assistant team, practicing "four-handed" dentistry, can in some instances reduce the dentist's chairside time per service.** In nearly every case, whether or not the dentist's time per service is reduced, the use of an assistant lessens the dentist's fatigue and discomfort. For some services, however, the dentist's

⁵⁴Castaldi, C. R., "Dental Auxiliaries: Dental Auxiliaries: Dentistry's Dilemma," *Journal of the American Dental Association*, 84:1082, May 1972.

^{54A}*Ibid*, p. 1080.

**For example, see Klein, Dollar, and Bagdonas, "Dentist-Time Required to Perform Dental Operations," *J.A.D.A.*, Vol. 35, No. 3, 1 August 1947, pp. 153-160, and Korber, E. in *Deutsch Zahnaerztl*, (Ger.), March 1966.

Table 2. Percent of Dental Assistants' Time Spent Performing Various Duties.

Duties	Number of Assistants, by Percent of Time Spent								
	Less Than 10	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80 or Over
Appointments and reception	306	568	410	126	74	79	24	12	7
Business procedures	391	506	295	98	43	39	--	5	6
Chairside assisting	128	233	303	178	191	288	125	108	78
Taking X-rays	598	210	44	10	2	1	1	1	--
Processing X-rays	992	369	36	2	1	1	--	--	--
Laboratory assisting	594	413	114	22	9	12	2	4	1
Ordering supplies	1,179	139	6	1	--	--	--	--	--
Maintaining inventory	974	93	2	1	--	1	--	--	--
Patient education	822	211	25	2	2	--	--	--	--
Housekeeping and maintenance	706	604	170	27	10	4	2	2	--
Other	78	35	14	5	2	3	2	2	3

^{54B}Hillinshead, op. cit., p. 217.

chairside time may be increased by utilization of an assistant.^{54C} Nevertheless, the net effect of the dentist's training or hiring the first dental assistant seems to be positive in that: (1) some house-keeping and clerical services formerly done by the dentist become auxiliary services done nearly entirely by the assistant and (2) the production functions for some oral health services may be changed, allowing the dentist-assistant team to produce a greater number of those specific services per team hour.

As the dentist employs additional dental assistants and invests capital in additional operatories, there is clearly a rapid rate of decrease in returns to scale, unless the chairside assistants could be assigned substantial chairside functions, formerly done by the dentist, that can be done without his participation. The dentist can work with only one dental assist and patient at any one time, although having more than one assistant may allow the dentist to develop some empirical improvements in scheduling patients and sequencing services. Of course, to the extent that substantial portions of certain services are delegated to be performed independently by auxiliary personnel, the production functions for those services are again changed. The extent to which this kind of delegation can take place is currently restricted by state dental practice acts.

The Distribution of Dental Services

An important criterion for evaluating the supply of dental services to the public is the extent to which those services are available

^{54C} Klein, et al, op. cit.

geographically. Geographic considerations can, of course, be translated into economic terms if one considers patients' travel costs, lost income opportunities, and similar expenses. Focusing as they have upon gross measures of the supply of dentists vis-a-vis the total population of states and national regions, dental manpower studies have historically avoided the matter of the distribution of dentists' practices and, thus, of dental services, in smaller geographic areas in which proximity of dentists' practices is of more practical significance to the consumer.

In order to gain additional insight into the way in which dentists tend to distribute themselves within a given state, data from a survey of Georgia dentists in 1966^{54D} were analyzed descriptively and, to a limited degree, statistically in the present study. Table 3 contains the results of the simple descriptive analysis of the distribution of dentists in Georgia by county. Thirty-five (22 per cent) of the 159 counties in Georgia had no dentists to serve their approximately 247,000 residents. Moreover, about 30 per cent of the dentists in the 87 counties with one to four dentists in 1966 were age 55 or older; only about 50 per cent of these older dentists were expected to be practicing in 1975 and only 10 percent in 1985.⁵⁵ It was observed further that eight (five per cent) of the 159 counties in Georgia had 62.5 per cent of the number of dentists in the state and 43.3 per cent of the population.

^{54D}Board of Dental Examiners in Georgia and American Association of Dental Examiners, "1966 Survey of Dentists Licensed in Georgia," August 1968, 15 pp.

⁵⁵Ibid.

Table 3. Distribution of Georgia Dentists and Population by County Groupings, 1966.

Number of Dentists in County	Number of Counties	Percent Counties in Class	Total Class Population	Percent Population in Class	Total Resident Dentists	Percent Georgia Dentists in Class	Population Per Dentist
0	35	22.0	247,520	5.5	0	0.0	---
1 - 4	87	55.0	1,131,520	25.3	177	14.5	6,393
5 - 9	17	10.5	514,040	11.8	113	9.0	4,549
10 - 24	12	7.5	603,600	14.1	173	14.0	3,489
25 or more	8	5.0	1,914,000	43.3	777	62.5	2,463

Thus, while the state's persons-per-dentist ratio was expected to decrease to the projected U. S. average of 2,500 by about 1980, the ratio within the state varied widely, from near 1,400 persons per dentist in metropolitan Fulton County to 23,400 in one rural county to "indeterminately large" in the 35 rural counties with no dentists. Thus, it is clear that the state or national population: dentist ratio used so frequently in manpower planning as a measure of the availability of dental services does not portray adequately the manner in which those services are distributed in dentist practices in specific locations.

On the presumption that dentists might be attracted more strongly to areas that would afford them greater economic opportunity, two basic relationships across 159 Georgia counties were examined: (1) number of persons per dentist versus personal income per person; and (2) total personal income versus total number of dentists. Simple linear bivariate regression analyses were conducted for each of these relationships.

Analysis of the relationship between income-per-person and persons-per-dentist ratios for Georgia counties in 1966 yielded a negative correlation between these variables as expected. Also expected was the relative weakness of the relationship indicated by a correlation coefficient of -0.25 and a standard error of the estimate of 3,106 persons per dentist. The nature of this result can be appreciated in part by observing that, while the persons-per-dentist ratio varied from 1,396 to 23,400 to "indeterminately large," the income-per-person ratio ranged only from \$1,029 to \$3,401, with most of the 159 counties in the \$1,500 to \$2,000 range, despite large differences in the population-dentist

ratio. Thus, per capita personal income alone appears to reveal little information about the persons-per-dentist ratio likely to be found in a Georgia county. Similarly, the per capita income figure would reveal little about the number of dentists likely to locate in a particular Georgia county.

An analysis of the relationship between the total number of dentists and the total personal income for each of 159 Georgia counties revealed a positive correlation coefficient of 0.91, with a standard error of the estimate of 14.06 dentists. Thus, it appears that the number of dentists attracted to a particular Georgia county is influenced rather strongly by total personal income, ("a measure that reflects all the income-producing activities of all the people and is usually conceded to be the most comprehensive measure of the economic well-being of an area.")⁵⁶

Although the foregoing results "prove" nothing about the manner in which dentists tend to distribute themselves, the data do support generally the private contentions of dentists that economic attractiveness is a principal concern in selecting a practice location. Of course the observation that a particular county has no dentists in residence does not mean that dental services are unavailable to residents of the county. Rather, it appears that dentists distribute themselves to serve larger (and perhaps more distant) populations in areas of low population density and lower incomes. Moreover, had a different geographic

⁵⁶Drewry, L. A., "Personal Income in Georgia Counties in 1970," College of Business Administration, University of Georgia, Athens, January 1964, p. 1.

base been adopted for analysis, a somewhat different pattern of dentist "coverage" might have emerged. In any case, the location of dental services, in the form of professional practices, is dependent entirely upon the preferences of individual dentists, influenced substantially, it appears, by factors affecting the dentist's economic well-being.

It is clear that, while oral health programs and proposals often are treated as public policy and are considered to be in the public and political domains, the nature, physical operation, and distribution of those programs lie principally in the entrepreneurial domain of the individual dentist. Thus, new programs, such as those providing ancillary manpower to assist the dentist, are constrained in that they could be utilized only in locations in which dentists would have practices.

Programs designed to redistribute primary health manpower through mechanisms such as financial educational aid to students who guarantee to serve in manpower-deficient areas are theoretically marginal at best; however, most have failed further by allowing students to repay their financial obligations without keeping their practice location commitments. It appears, therefore, that the supply of dental services that continues to be offered solely through private professional practice will continue to be distributed among the population according to the practice location preferences of the individual dentist.

Fees for Dental Services

Fees for specific dental services vary widely, both within geographic regions and across geographic areas of the United States.⁵⁷

⁵⁷Bureau of Economic Research and Statistics, "National Dental Fee Survey, 1970," Journal of the American Dental Association, 83:57, July 1971.

Method used by dentists to set fees for service also vary considerably as is indicated generally by the data in Table 4.

Kesel observed in 1961 that

The soundest method of determining fees is one based on the value of the service to the patient, the time required to perform the service, and the overhead costs of maintaining the dental establishment. The value of the service ... concerns the opinion of the patient and the judgment of the dentist.

The time and cost factors are tangible and measurable.... The dentist must then consider other factors (including) the difficulty of the operation ... his experience and skill; his investment in education; the cost of equipping an office and ... purchasing new equipment ... support for an adequate retirement program; the dentist's standard of living; and the patient's ability to pay.⁵⁸

The circumstantial evidence is that dentists, as physicians, tend first to set certain personal goals of net income (before taxes) commensurate with a desired standard of living and a desired annual level of productive working hours; then to estimate total annual operating costs and numbers of various dental procedures to be performed; and thus to derive a schedule of "in-line" fees that will produce the desired net income level.

The pressure of potential governmental and private prepaid and insurance programs led to American Dental Association to develop a method "of setting fees yielding a consistent relationship between fees for different services and yet preserving the integrity of the usual process of fee determination by the individual dentists."⁵⁹ The authors

⁵⁸Kesel, R. G., "Dental Practice," in Hollinshead, B.S., The Survey of Dentistry, op. cit., pp. 132-135.

⁵⁹Council on Dental Health, Bureau of Economic Research and Statistics, American Dental Association, "Study of Relative Values of Dental Services," Journal of the American Dental Association, 76:117, January 1968.

Table 4. Percentage of Dentists Replying as Indicated to the Question "How Did You Arrive at the Fees You are Now Charging?" By Age of Dentist, 1959^{59A}.

Method	Age									All Dentists
	29 or under	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65 or over	
By charging what other dentists, of similar ability, in the community charge	59.2	58.6	50.1	42.8	42.9	35.2	38.4	38.0	31.9	45.9
By charging what patients seemed to be willing to pay	4.1	4.1	6.6	7.1	8.8	9.5	11.5	13.0	14.3	8.2
By analyzing expenses and time required for each service	33.7	43.8	49.9	52.7	49.6	57.6	53.7	56.4	57.1	48.4
By following published fee schedule(s)	15.5	14.2	15.5	13.6	12.5	10.5	11.5	9.7	11.5	14.5
Other	6.7	2.7	1.9	3.1	2.8	2.9	3.2	2.9	2.6	3.3

^{59A}Bureau of Economic Research and Statistics, American Dental Association, "Survey of Dentist Opinion: II: Dental Health Education; Dental Fees," Journal of the American Dental Association, LIX: 340, August 1959.

of the method rated the "intrinsic values" of 133 dental services. These values were derived from "attributes dentists had acquired through long periods of professional education, training, and experience."⁶⁰ They then assumed that

...services that rate high on factors (will) have high fees... the dental market is generally orderly and relatively few services are "out-of-line"... (thus)... the correlation between relative values and fees should be high.⁶¹

To use the method, the dentist is advised to select a low-fee service and a high-fee service whose relative value scores are given in the listing of 133 dental services rated. Having plotted these two points on the conversion graph shown in Figure 1, the dentist is then advised to connect the points to produce a straight "conversion line" to be used to convert relative value points into fees for listed services. Thus, as the authors suggested, the dentist can judge whether or not his other fees are "out-of-line", and can set all his fee levels in a "rational" manner.

It is observed that the relative value method is indeed systematic, in that it is a step-by-step approach that can be explained. Yet its basis remains arbitrary; it assumes linearity among the measures of relative worth of services, based upon the intrinsic values of dentist inputs; the relative contributions of the various services in establishing and maintaining oral health were not examined; and the extent to which the use of ancillary manpower should affect the fee structure was not addressed. In summary, it appears that the development of the

⁶⁰Ibid.

⁶¹Ibid.

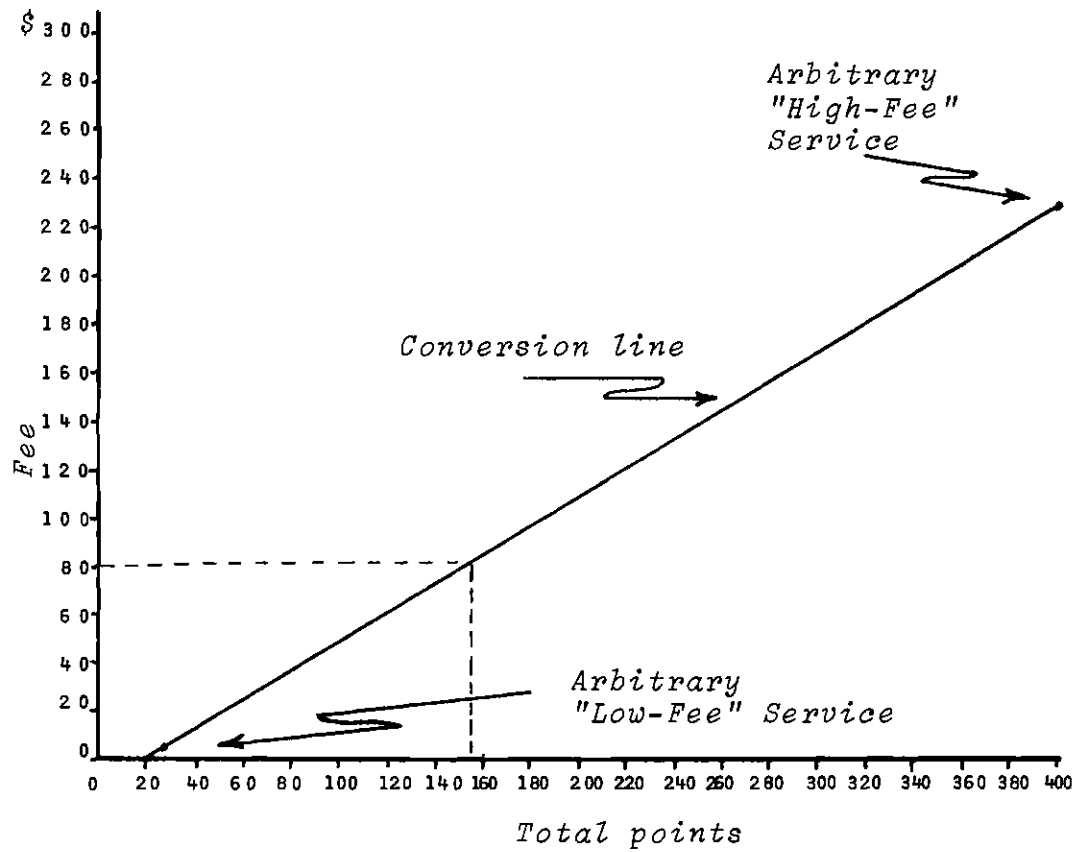


Figure 1. Conversion Graph to Convert Relative Values of Services into Fees for Those Services.⁶²

dentist's fee structure remains largely a function of the desires and judgment of the individual dentist, related only indirectly to either the contributions of services to oral health or to the actual costs of delivering dental services.

The dental profession seems to recognize the need for improvement of the means used to determine fees for services. The perspective for "improvement" is, of course, important. Kesel, for example, observed that:

The construction of a single upper denture takes about five times as much of the dentist's productive time as the administration of a prophylaxis. Yet, based on fees reported in 1956, denture procedures produced a financial return 20 to 30 times greater.... However, the dentist who renders a service that prevents the occurrence or arrests the progression of a disease, thus obviating the need for extensive repair, is entitled to at least a comparable fee.⁶³

Kesel's argument seems to imply that fees for relatively inexpensive disease-preventive dental services should be increased. Indeed, he proposes further, "extensive public education will be necessary to develop the appreciation of healthy teeth in a healthy mouth that is needed to ensure fees that are commensurate with the services rendered."⁶⁴ Kesel's point of view appears to be popular within the dental profession, especially in respect to fees for services in the disease-preventive category. As was noted earlier, the principal source of disease-preventive services in the dental practice is the dental hygienist (or other ancillary with similar skills). Dental hygienists are predominantly salaried employees of dentists, although some also

⁶³Kesel, op. cit., p. 135.

⁶⁴Ibid.

receive commissions on services they provide. Yet, Kesel proposes that relatively high dentist fees be charged for the relatively low-cost disease-preventive services provided essentially independently by ancillary personnel. In his argument, Kesel discussed neither the view that many disease-preventive services are ancillary, requiring neither the dentist's time nor his skills, nor the effect his proposals might have on making such services economically available to the public. Nevertheless, dentists continue to charge substantial professional fees-for-service for this category of dental health care, to some extent in keeping with Kesel's basic philosophy. The "usual, reasonable, or customary" professional fee-for-service structure remains virtually unchallenged as the mode of payment and compensation for all services performed within the private dental practice.

The "supply philosophy" underlying the traditional derivation of fee schedules from dentists' attributes (e.g., disutilities of "long periods of professional training") appears to be accepted widely not only by the dental profession, but also by the public. As is true of most other health services, it is far easier to describe and attach values to inputs of the dental services system than to define and evaluate the worth to the consumer of the outputs of the system. Adoption of a "demand philosophy" of the worth of system outputs as a basis for pricing clearly would require extensive public education concerning the nature and magnitude of opportunity costs of alternative preventive-therapeutic treatment combinations. That such an educational task would be formidable is borne out by historical and current public attitudes toward even the most elementary and inexpensive dental self-care,

dietary, and supplementary fluoridation efforts. The task would, of course, be complicated further by the fact that the dental care services that probably would make the greatest contributions to improved oral health also are the services that could be performed most economically and would require the lowest professional skill levels. Thus, not only might the public resent paying more for relatively low-cost services, despite their relatively high "worth," but also the impact upon the dental profession could be so traumatic that a strictly rational "demand philosophy" of pricing might be intolerable to the profession.

It is concluded, therefore, that the present supply philosophy will continue to be dominant as a basis for fee determination within the dental profession. Moreover, until different state and national governmental controls and programs are initiated, the dental profession will continue to operate with an exclusive legal franchise as the supplier of all dental health services, but without the price controls typically present for government-sponsored natural monopolies (public utilities). Within geographic regions, collusive quasi-oligopolistic pricing of dental services probably will continue, with the supply philosophy as its principal justification.

Summary of Trends in the Supply of Dental Services

An attempt has been made in this chapter to describe the nature and some of the characteristics of dental practice that affect its current and projected status as the principal source of dental services in the United States. The dental practice has been characterized as an independent professional enterprise in respect to which the dentist-owner may select its location, determine its service mix, set the prices

for services, establish its staffing levels, decide -- to some degree -- the services a patient will receive and which patients he will serve, and determine the schedule and total hours of operation. The private dental practice is, simultaneously, virtually the sole planned source of oral health services for the civilian, non-institutional population of the United States.

Dentists appear to offer a service mix directed principally at intervention ex post facto in oral disease processes. Preventive oral health services, including prophylaxes and topical fluoride application, account for about 16 percent of dental services provided in the private practice; restorations, extractions, prostheses, and oral surgery account for most of the remainder of services typically provided.⁶⁵ Because of the relatively short durations of most preventive procedures, they account for an even smaller proportion of total personnel time devoted to all dental services within the dentist's practice.

Dentists' practices typically are located in urban or suburban high-density population areas whose economic health is good. Dentists do not distribute themselves uniformly among the population or in areas of low total personal income. Thus, persons seeking dental services in dentist-deficient areas must either incur additional costs in traveling to areas of greater dentist availability or forego dental treatment. Prospects for improving the distribution of dentists' practices among the population through voluntary incentive programs seem dim. Long-term economic and cultural disadvantages seem to outweigh short-term financial incentives.

⁶⁵Douglas, et al, op. cit., p. 365.

It appears that the total supply of dentists will increase marginally over the next ten to fifteen years, roughly in proportion to projected population growth. Even substantial changes in dental school enrollments would have only marginal effects on the total dentist supply and would not be expected to affect the distribution of dentists appreciably. Moreover, the costs of producing dentists -- estimated at near \$67,500,000 (exclusive of facilities costs) to produce 3,200 graduates in 1963 - 64,^{66,67} -- borne directly or indirectly by the public already are increasing at an accelerating rate, due principally to annual salary increases of faculty and staff. Further, even if increasing the dentist supply substantially were feasible and desirable, that supply is inelastic. A seven-year lead time to establish a new or greatly-expanded dental program does not appear to be unusual.

Increased use of ancillary dental personnel within the dental practice is proposed by numerous health professionals and health agencies as the principal means by which the supply of dental services will be increased to keep pace with expected increases in demand for such services. Although, hypothetically, less expensive and more elastic supplies of specific kinds of ancillary personnel can be substituted for the more expensive, less elastic supply of dentists, there are a number of practical difficulties associated with implementation of

⁶⁶U. S. Department of Health, Education, and Welfare, Health Manpower Source Book, op. cit., p. 72.

⁶⁷American Association of Dental Schools, Cost Study of Dental Education, op. cit., p. 10.

such a theory. First, a large number of dentists do not now employ traditional dental assistants or hygienists -- ancillary personnel who have been shown to contribute positively to the dentist's practice for many years. Many of the same dentists had no plans to hire such ancillary personnel, even if they were readily available. Secondly, the kinds of ancillary personnel that could potentially make the greatest contribution to production of services in the dental practice appear also to pose the greatest threat to the dental profession, from the profession's point of view. Fear of independent licensure of and competition from expanded-function auxiliaries probably will delay their becoming a significant factor in the production of dental services. At best, the roles of such ancillaries are likely to be limited severely by states' dental practice acts, representing the views of state dental societies. And, thirdly, it seems unlikely that the economies inherent in the production and use of expanded-function ancillaries will be passed on to the consumer-patient. Indeed, some dentists indicate that there is a tendency to want to increase fees at a more rapid rate than previously because of "increased practice expenses" associated with hiring ancillary personnel, despite potential economies to the dentist under existing fee structures.

Dentist group practice, for reasons discussed earlier in this chapter, may offer certain convenience and economic advantages to dentists who affiliate in such practices. It seems unlikely, however, that the supply of dental services could be increased significantly through increased emphasis on group practice. Production functions for dental services would be largely unaffected by such arrangements. And,

indeed, it would not be unreasonable to expect that the supply of services might be reduced somewhat by group practice affiliations in which dentists agree to "cover" for each other to allow individual dentists more free time.

It is concluded from the observations and analyses of this chapter that the nature, magnitude, and distribution of dental services produced virtually entirely through the private dental practice will change only marginally in the next one to two decades. Proposals to modify the nature of dental practice through use of new kinds of ancillary personnel or group practice organizations and to increase the supply of dentists seem to offer few significant advantages. It is important, therefore, to examine the projected requirements for oral health services in order to design and evaluate alternative dental manpower and dental services strategies in respect to their costs and effects on those requirements. In the next chapter, the nature and magnitude of oral health services requirements will be examined.

CHAPTER IV

REQUIREMENTS FOR DENTAL SERVICES

It is important to define and to distinguish between the need and the demand for dental services for several reasons. First, it is toward alleviation of need or accommodation of demand that most dental manpower programs are said to be directed. Secondly, there is a substantial difference between the magnitudes of the problems represented by estimates of need and demand. Thirdly, there is wide diversity of opinion and there appears to be some confusion in the literature concerning means of measuring or estimating need and demand and of converting such estimates into requirements for manpower programs. The following discussion is addressed to clarification of these issues.

Need for Dental Services

Need, in the context of dental health, has come to mean something more than strict necessity of treatment for survival. It has become, in a sense, a normative assessment -- usually by dental professionals -- of the manner in which the consumer should behave vis-a-vis the increasing availability of technically- and economically-feasible dental care services. This view of need is not inconsistent with the increasingly popular notion that health care programs should be designed to improve not only morbidity and mortality rates but also the "quality of life" for all citizens. For example, the orthodontist might define as a legitimate need the opportunity to have one's teeth straightened

for aesthetic purposes. Certain consumers would agree; however, a number might be perfectly satisfied with misaligned teeth. Most dental professionals now identify maintenance of the natural teeth as a health need without question. Yet there are a large number of consumers who apparently prefer systematic extraction of their teeth in the belief that the eventual purchase of dentures would be more economical and quite adequate for their purposes; they do not "need" their natural teeth (or the services associated with their maintenance) for survival or for social purposes, from their point of view.

Thus, it appears that the dental professional would judge that virtually all services currently offered by licensed dentists (and their auxiliaries) are designed to eliminate or alleviate some legitimate dental "need." The consumer's view appears to be somewhat differently oriented. If, however, the consumer were "educated" to share the dental profession's views, he might redefine his perceived needs. To some extent, then, the nature of dental "need" is determined by a set of expectations derived through indoctrination of the professional and the consumer through formal dental education and public health education.

Of course there are a number of kinds of dental disorders that can cause severe pain or physical discomfort, that can lead to disfigurement and emotional discomfort, and that can affect one's physical and mental health directly and indirectly by contributing to infectious disease, poor eating habits, or malnutrition. Some of the most common oral disorders are discussed in the following paragraphs.

The Nature of Dental Disease

The major dental disorders which form part of the need for dental care may be classified generally as dental caries, periodontal disease, orthodontic problems, oral clefts, and oral carcinoma. Another component of need which is interrelated with these categories of dental disorders is preventive dental care, which can preclude the occurrence or intensity of certain disorders, and is therefore judged to be a need of somewhat different character than are the other categories.

The first component of the (dental) problem, the high attack rate of dental diseases affecting almost the entire population, would be enough to present a formidable obstacle, since these diseases begin early in life...and become progressively more severe with age. This factor is complicated by the irreversible and cumulative nature of most dental diseases, which do not heal spontaneously and cannot be cured by advice or prescription. The widespread failure to seek adequate treatment, the second aspect of the problem, therefore results in the accumulation of a staggering backlog of untreated dental disease existing in the population at any one time.⁶⁸

Dental caries, the most frequently-occurring oral disorder, is said to occur in about 95 percent of the population. It was estimated that, in 1960, the 180 million persons in the United States had accumulated at least 700 million unfilled cavities. Armed Forces recruits were said to have shown an average of over thirteen caries each.⁶⁹

⁶⁸Young, W. O., op. cit., p. 5.

⁶⁹Ibid, pp. 5, 6, 14.

The twenty primary teeth which begin to appear during the first year of life and which are all present usually by age three, are subject to decay even before all twenty teeth have appeared. The rate of decay in the primary teeth usually increases until the number of primary teeth is reduced through exfoliation, beginning at about age six. During this period of development, the average number of teeth decayed, indicated for extraction, or filled appears to be between three and eight, depending primarily upon the level of fluoridation in the water supply.⁷⁰

Some of the implications of high levels of caries are most dramatic in children from ages five to twelve. During this period, both the primary and the permanent teeth are present and are subject to caries. The loss of primary molars prior to natural exfoliation, can result in a shifting and malpositioning of the erupting permanent teeth. Such malformations can then result in a number of more serious dental disorders.

Although the consequences of early untreated caries attacks in children are clearly serious, and are substantiated in a number of publications, the permanent teeth are subject to caries attack as long as they are in the mouth. Figure 2 illustrates the persistent nature of dental caries and their effects. The measure of oral condition used in the illustration is the number of decayed, missing, or filled teeth per person (DMF rate) for two schools and three adult populations in fluoridated and nonfluoridated areas. Although the results displayed in the figure are not conclusive, they do seem to depict rather well the continuing problems associated with dental caries and the apparent

⁷⁰Ibid, p. 14.

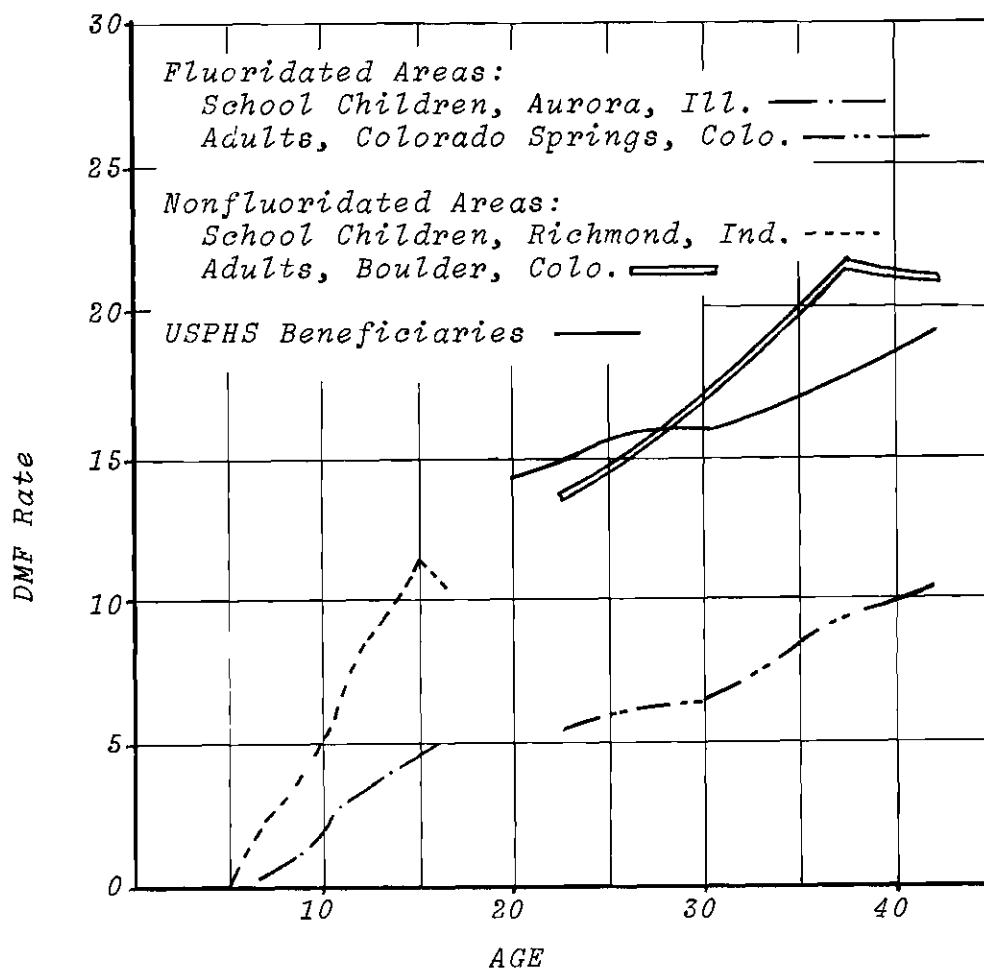


Figure 2. Number of Decayed, Missing, and Filled Teeth per Person (DMF Rate) for Two Child and Three Adult Populations in Fluoridated and Nonfluoridated Areas.*

*Adapted from Young, W. O., op. cit., p. 15.

dramatic effects of fluoridation as a preventive measure. That fluoridation can apparently reduce the DMF rate by fifty percent is of itself significant, and is supported by a number of other studies to be discussed later.

Teeth which survive attacks by caries are subject to subsequent indirect attack through disorders of the supporting tissue, ranging from mild inflammation of the gum around the upper part of the tooth (gingivitis) to severe destruction of the supportive tissues, the periodontal membranes tissues which support the teeth itself, and the alveolar bone in which the teeth are set. Available data indicate that about half the population is affected by serious periodontal disease by age fifty and almost all the population is affected by age sixty-five.⁷¹

A survey of periodontal disease and its effects on tooth mortality was conducted by Pelton, Pennell, and Druzina in 1954 among beneficiaries of the U. S. Public Health Service. Figure 3 illustrates the relative proportion of teeth indicated for extraction for various age groups by the reason for extraction. Periodontal disease is seen to account for about half the extractions over all ages, while above age forty-five, about eighty percent of extractions were apparently the result of periodontal disease.⁷²

⁷¹Marshall-Day, C. D., "The Prevalence of Periodontal Disease," Journal of the American College of Dentists, Vol. XXI, September 1954, pp. 312-314, in Young, W. O., op. cit., p. 16.

⁷²Pennell et al, op. cit., p. 441.

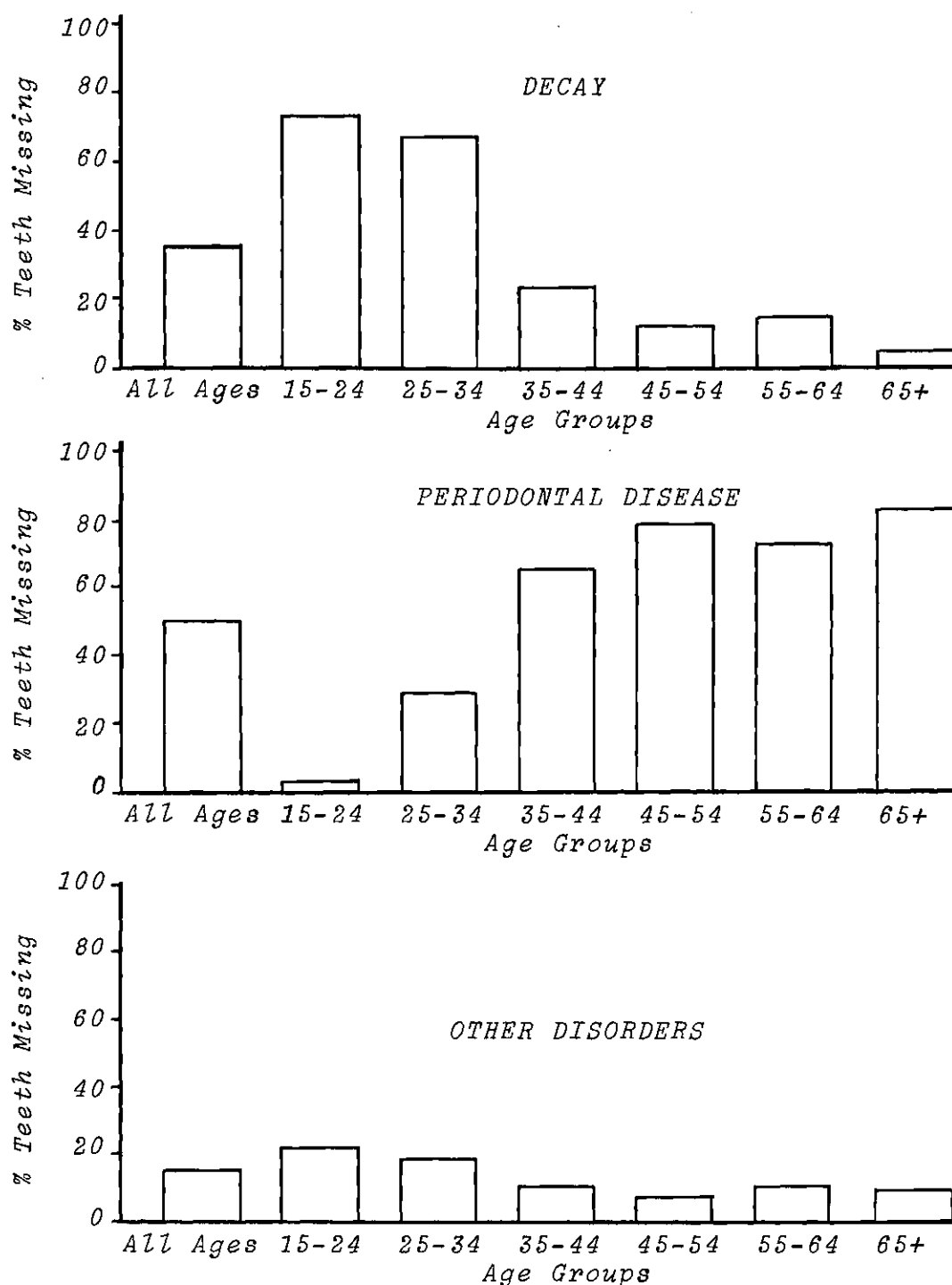


Figure 3. Per Cent of Teeth Indicated for Extraction for Reasons of Decay, Periodontal Disease, and Other Oral Disorders.*

*Source: Pelton, W. J., E. H. Pennel, and A. Druzina, "Tooth Morbidity Experience of Adults," *Journal of the American Dental Association*, Vol. XLIX, October 1954, p. 441, in Young, W. O., op. cit., p. 17.

Difficulties associated with the configuration and alignment of the teeth can range from simple deviations which are merely unpleasant aesthetically to severe deformities and malocclusions. Although few epidemiological data are available regarding the prevalence of orthodontic disorders, Young indicates that estimates range from twenty to eighty percent in children. Young judged that approximately half the school-age population need some kind of orthodontic treatment and about one child in five probably has a severe orthodontic problem.⁷³ It appears that a great deal of the concern about orthodontic disorders centers around the reasonable conjecture that the psychological impact of disfiguring malformations can be extremely serious, especially during childhood.

Cleft lips and palates account for about thirteen percent of birth defects in the United States. Treatment of these disorders generally requires the involvement of a number of dental and medical specialists and professionals in the social and behavioral sciences.⁷⁴

In 1954, about one of every forty deaths caused by carcinoma was attributable to oral cancer. The incidence of oral cancer as estimated by Dorn and Cutler ranges from about five new cases per year per 100,000 persons in females and twenty-two per 100,000 in males.⁷⁵ Martin

⁷³Young, op. cit., p. 16.

⁷⁴Hagan, T. L., "The Prevalence of Oral Disease," The Practice of Dental Public Health: Proceedings of the Fourth Workshop on Dental Public Health, Objectives, and Evaluation of a State's Dental Program, Ann Arbor: University of Michigan, 1956, p. 88.

⁷⁵Dorn, H. F. and Cutler, S. J., Morbidity from Cancer in the United States: Part I: Variation in Incidence by Age, Sex, Race, Marital Status, and Geography, Public Health Monograph No. 29, U. S. Government Printing Office, Washington, 1954, 121 pp.

reported in 1949 that in cases in which a dentist detected a suspicious lesion, an average of only three weeks elapsed before the patient received treatment from a physician. In those instances in which the lesion was not detected first by a dentist, an average delay of seven months occurred before treatment was initiated.⁷⁶ The relative ease of oral examination makes the role of the dentist a significant one in respect to the early detection of oral carcinomas. Apparently about thirty percent of cancerous oral lesions are curable if they are detected and treated early, while only one-fourth of all patients who have oral cancer detected survive for as long as three years.⁷⁷

Caries, Periodontal Disease, and Edentulousness

The most predominant oral diseases, as was indicated in the previous section, are caries and periodontal disease. These two categories of oral disease and edentulousness, the principal result of these diseases, also account for virtually all the services provided by the general dentist and his ancillary personnel. Both these categories of oral disease are more or less irreversible, cumulative, eventually affect virtually the entire population, do not heal spontaneously, and cannot be cured through advice or prescription. Public apathy, lack of information and misinformation about oral disease control, slow rates of adoption of available passive preventive measures such as water fluoridation, and failure or inability to seek adequate treatment have resulted

⁷⁶Hayes, M., Mouth Cancer and the Dentist: A Monograph for the Practicing Dentist, American Cancer Society, Chicago, 1949, p. 10.

⁷⁷"Early Recognition of Intraoral and Facial Cancer," Cancer Bulletin, September-October 1955, pp. 82-84.

in accumulation of a large and growing national backlog of untreated dental disease.

Although the precise etiologies of caries and periodontal disease are not fully understood at the present time, the most widely-accepted explanations involve the accumulation of matter on and around the teeth that allows the growth and concentration of certain forms of pathogenic bacteria to actuate and sustain the disease processes. The formation of carious lesions also involves the susceptibility of the tooth surfaces to attack by these bacteria, a factor that is affected significantly by diet and the ingestion or topical application of fluoride compounds.⁷⁸

It appears that the incidence of both new caries and new periodontal disease could, theoretically, be reduced to a negligible level through either neutralization of the proper pathogenic bacteria or effective mechanical or chemical removal of plaque, the growth medium, before harmful concentrations of the pathogens could form to attack the teeth. Although research to develop anti-pathogen vaccines is reported to be widespread, effective passive anti-pathogen measures are not yet available.

There are available, however, effective personal means of removing plaque daily that are said to be efficacious in preventing both caries and periodontal disease. These newly-developed teeth brushing and flossing techniques in conjunction with use of fluoridated dentifrices and periodic professional cleaning of the teeth and topical

⁷⁸National Center for Health Statistics, "Decayed, Missing, and Filled Teeth in Adults," Series 11, No. 23, U. S. Dept. of HEW, Washington, 1962, p. 22.

applications of fluoride compounds are said to prevent effectively the formation of both carious lesions and periodontal disease. Unfortunately, however, this approach requires unusually conscientious, active, and proficient use of these techniques by the individual. Moreover, one is not likely to be instructed properly in the use of these somewhat inconvenient and difficult techniques, nor is he likely to apply them regularly, unless he already is a participant in a program of regular professional dental care.

The prevalence and recurrent nature of both caries and periodontal disease tend to cause even the most modern and expensive dental services techniques to be little more than palliative measures. Without means to prevent effectively the recurrence of dental disease either through passive measures or effective promotion of personal oral disease control measures, it seems likely that levels of oral disease will continue to rise. Examples of this phenomenon are illustrated in Chapter VI.

Demand for Dental Services

Consumer expenditures for dental services rose from about 962 million dollars in 1950 to 4.4 billion dollars in 1970, accounting for about 10 percent of all health expenditures in the United States throughout that 20-year period. Dental services expenditures represented about 0.51 percent of total consumer expenditures in 1950, 0.60 to 0.68 percent through 1969, and 0.71 percent in 1970.⁷⁹

⁷⁹Bureau of Economic Research and Statistics, "Expenditures and Prices for Dental and Other Health Care, 1935 to 1970," Journal of the American Dental Association, 83:1334, December 1971.

Despite this history of substantial national expenditures on dental care services -- and in other health services areas -- the theory and empirical analysis of demand for specific health services are not yet well-developed. Clearly, however, appreciation of the factors affecting demand for dental services is requisite to formulation of national dental health policies. It is known that a very large backlog of dental disease is accumulating among the population.* Yet, calculation of dental "need" is, to some degree, academic if the consumer is unable or unwilling to purchase dental services to alleviate his "need." Account should be taken of existing patterns of payment for dental services and their impacts on utilization of dental services. Even if there were a large quantity of dental services available, many consumers might be deterred from using dental services by a relative shortage of money or by traditions, habits, customs, and education. Thus, questions related to determining "required" numbers of dentists and ancillary personnel are (or should be) quite sensitive to considerations affecting demand for specific services provided by dental personnel. It is recognized further that projections of income and price effects will continue to be implied, if not carried out explicitly, in dental health planning efforts.

A number of authors have conducted empirical studies that give some insight into the demand for dental services that can be useful in examining alternative health and manpower policies. To the extent that empirical studies yield direct or circumstantial evidence concerning the effects of prices, income, and other factors on the quantities of

*See pp. 110, 172, 173.

dental services demanded, projections of the general effects of these factors can be prepared and evaluated with improved confidence.

The purpose of this section of this chapter is to attempt to describe some empirical findings and points of view about demand for dental services that are relevant to dental health planning and policy formulation.

Determinants and Measures of Demand

One of the principal problems confronting the health services researcher in analyses of consumer demand for dental services is development of adequate measures and identification of relevant determinants of demand. The predominant demand measure adopted throughout the literature is expenditures for dental services. Although the monetary unit provides a common measure for comparison of dental services expenditures among families and individuals, it has a number of shortcomings as a measure of use of dental services. The most critical inadequacy of expenditures as a measure of use is its sensitivity to variations in the price of each dental service.

Charges for a particular dental service can vary considerably for a number of reasons. Approximately eight percent of the dentists responding to a 1959 dentist opinion questionnaire admitted charging "what patients seemed to be willing to pay."⁸⁰ A "sliding fee scale" is not unusual, a number of dentists admit privately. Thus, as Andersen

⁸⁰ Bureau of Economic Research and Statistics, American Dental Association, "Survey of Dentist Opinion: II: Dental Health Education; Dental Fees," Journal of the American Dental Association, LIX: 340, August 1959.

has pointed out, "expenditures as indicators of use are positively biased for high income families and negatively biased for low income families."⁸¹

Dental care prices also vary substantially among and within geographic regions.⁸² If dollar expenditures were used as measures of the quantities of dental care services demanded, persons in high-fee areas would appear to use greater quantities of services -- and in low-fee areas, smaller quantities of services -- than they actually consume.

Because of limitations on the kinds of data currently available, continued emphasis upon total expenditures tends further to divert attention from the health services mix that is demanded. Nevertheless, expenditure data used as surrogate demand measures throughout the current literature are aggregate data. Thus, little is known, even on an expenditure basis, about quantities of specific health services utilized by the public.

Despite the shortcomings of expenditures as a measure of the use of dental services, some useful insights about the nature of that demand were obtained through review of research that incorporates the expenditure approach. Additional information about the character of demand for dental services was found in reports of research based upon survey approaches. The most useful findings of several of these studies are summarized in the following paragraphs.

⁸¹ Andersen, R., op. cit., p. 22.

⁸² Bureau of Economic Research and Statistics, American Dental Association, "National Dental Fee Survey, 1970," Journal of the American Dental Association, 83:57, July 1971.

Using cross-sectional data from the July 1958 health services survey of the Health Information Foundation and the National Opinion Research Center, University of Chicago, Feldstein⁸³ conducted multivariate analysis studies of health care expenditures among groups of similar families. He examined the effects on dental services expenditures of mean family income, mean age of family head, percent of families with one or more members age 65 or older, percent of families with one or more members under five years of age, mean family size, percent of families living in urban areas, and dollar value of free or reduced care. These explanatory variables yielded a multiple correlation coefficient of 0.71, accounting for about 50 percent of the variation in family dental expenditures. When the data were transformed into logarithms to account for nonlinearities, the multiple correlation coefficient increased to 0.76, and the independent variables were shown to account for 57 percent of the variations in expenditures. In both cases, most of the explained variation in dental care expenditures was accounted for by family income.⁸⁴ Table 5 depicts clearly not only the strong effects of income on dental expenditures, but also the marked difference in income effects on dental services expenditures vis-a-vis expenditures on other health services.

The income effects derived from the arithmetic and logarithmic versions, respectively, of both the simple and multiple regression

⁸³Feldstein, P., "Demand for Medical Care," in The Cost of Medical Care, Vol. 1, American Medical Association, 1964, pp. 69-72.

⁸⁴Ibid, p. 69.

Table 5. Family Income Effects on Selected Health Care Expenditures,
Derived from Simple and Multiple Regression Analyses.*

	SIMPLE REGRESSION		MULTIPLE REGRESSION	
	Arithmetic(\$)	Logarithmic(%)	Arithmetic(\$)	Logarithmic(%)
DENTAL EXPENDITURES	0.0104	1.4030	0.0080	1.1657
Drug Expenditures	0.0008	0.2173	0.0007	0.1661
Physician Expenditures	0.0080	0.4826	0.0081	0.5582
Hospital Expenditures	0.0036	0.1135	0.0079	0.5082
Health Insurance Expenditures	0.0082	0.7680	0.0092	0.7284

*Adapted from Feldstein, P., op. cit., p. 75.

approaches are of a similar order of magnitude. In the arithmetic models, the simple and multiple analyses yielded coefficients of approximately 0.008 and 0.010 (actually lower limits of the income coefficients). Thus, in the arithmetic case, an increase in family income of 1,000 dollars would be expected to yield an increase of at least 8 dollars in family dental expenditures. In the logarithmic models, the analyses yielded lower limit coefficients of about 1.4 and 1.2, respectively. Thus, in the logarithmic case, an increase in family income of about 10 percent would be expected to yield an increase in dental services expenditures of at least 12 percent.

Unfortunately, Feldstein was not able to include a price variable in his analyses because of unavailability of appropriate data. As a result, his explanatory models are not "true" demand functions in the usual sense, since it was necessarily assumed that unit prices of services were the same for all families. And, of course, Feldstein's cross-sectional data ostensibly yield measures of expenditure differences among families with different characteristics -- not changes in expenditures of families whose characteristics change. Nevertheless, despite these shortcomings, Feldstein's findings lend substantial support to the assertions that the demand for dental services is highly income-elastic; that income is a much more predominant determinant of dental services demand than any other factor except, perhaps, prices of dental services; and that these large income effects on expenditures are relatively unique among U. S. health services.

Implicit in Feldstein's findings is the suggestion that levels of dental care for low income families are substantially lower than

for middle and high income families. That implication is supported by White, who directed a 1964 National Center for Health Statistics survey of 42,000 households and 135,000 persons.⁸⁵ White observed that

Behavior with respect to dental care exhibits a clearer pattern of correlation with income levels than for medical services, largely because it is less affected by health insurance and welfare programs.

...Children in the highest income group received dental care at a rate three to four times that received by those in the lowest income families. Substantial differences in the rate of dental visits by family income level continue throughout the age span.⁸⁶

White's findings are summarized in Figure 4, which displays annual numbers of dental visits per person by family income and age. White's survey data also contained some information about the general nature of the service mix at the income extremes. He found that the most frequently used dental services among higher income families were restorative, prophylactic, and orthodontic procedures. Among lower income families, extractions and periodontal treatment were sought with the greatest frequency.⁸⁷

Another major quantitative research effort involving demand for dental services was the 1968 study by Andersen.⁸⁸ He hypothesized a

⁸⁵White, E. L., "A Graphic Presentation on Age and Income Differentials in Selected Aspects of Morbidity, Disability, and Utilization of Health Services," Inquiry, V:18, March 1968.

⁸⁶Ibid, p. 23.

⁸⁷White, op. cit., p. 25.

⁸⁸Andersen R., "A Behavioral Model of Families' Use of Health Services," Center for Health Administration Studies, The University of Chicago, Research Series 25, 1968, 111 pp.

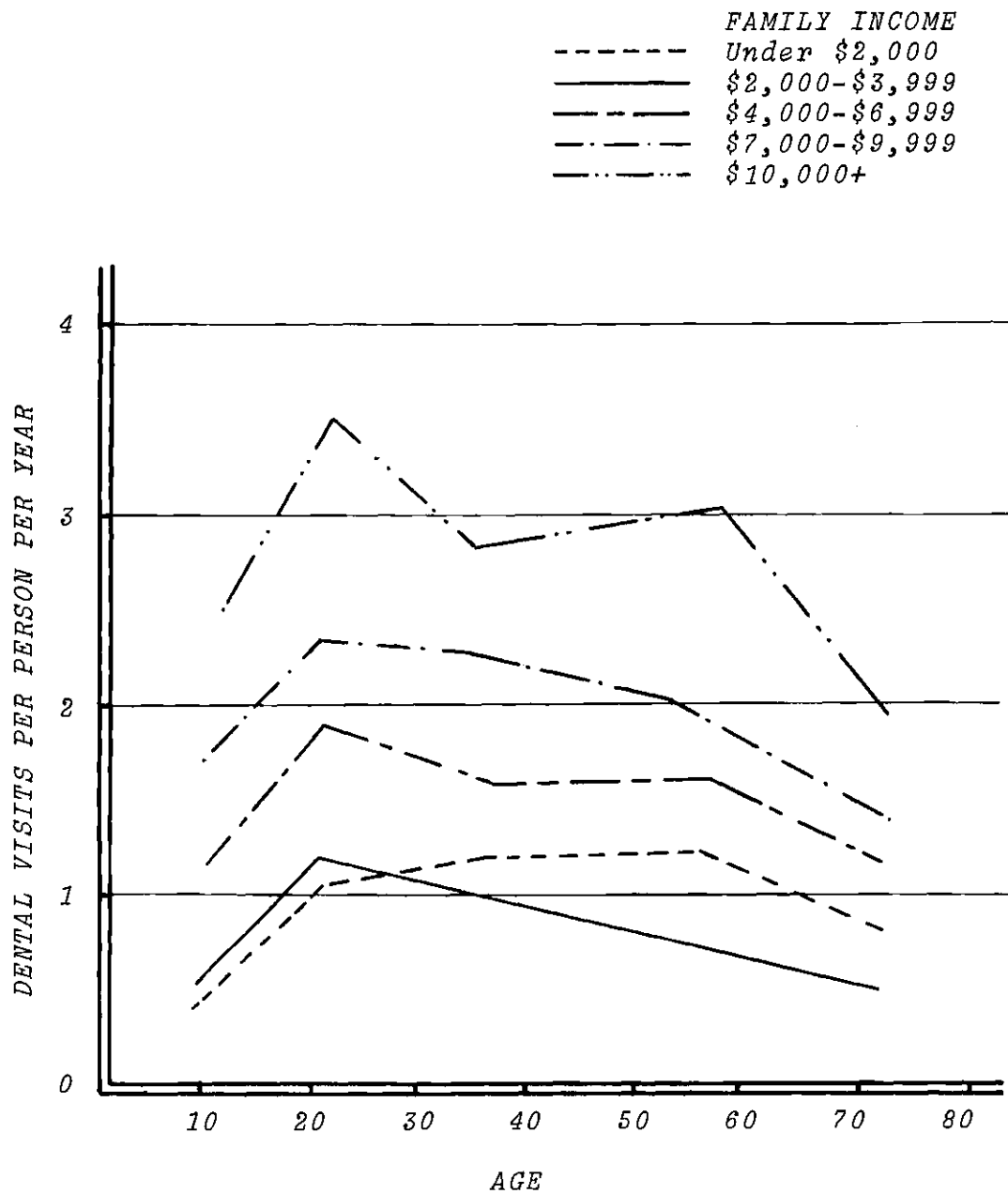


Figure 4. Dental Visits per Person per Year by Family Income and Age, Fiscal Year 1964*.

*Adapted from White, op. cit., p. 23.

three-stage behavioral model of health services utilization, consisting of predisposing, enabling, and need components. He hypothesized further that the contribution of the predisposing and enabling components would be greatest for dental services, since these services may be deemed "least urgent or necessary" and the family has most discretion in choosing alternative actions. Andersen developed relative value measures for certain of the health services in his study; however, because of data limitations, he chose to use actual dollar expenditures as a surrogate measure of dental services utilization by families. The data for the study were derived from a 1964 national social survey of 2,367 families conducted by the Health Information Foundation and the National Opinion Research Center of the University of Chicago.

Andersen found that, while physician services were used by 90 percent of the families, dental services were used by about 59 percent of the families.⁸⁹ He also found no significant correlation between families' use of dental services and utilization of any other category of health services.⁹⁰ Using an approach developed by Sonquist and Morgan called "automatic interaction detector,"⁹¹ Andersen divided the sample of families into a mutually exclusive series of subgroups through a series of dichotomous splits. At each stage, the splits were made for those independent variables accounting for the greatest differences

⁸⁹Andersen, op. cit., p. 28.

⁹⁰Ibid, p. 29.

⁹¹Sonquist, J. and Morgan, J., "The Detection of Interaction Effects," University of Michigan, Ann Arbor, Monograph 35, 1964.

in dental expenditures. Analyses of variance at each split then were used to determine remaining splits until no further differences in expenditures could be accounted for. The general structure of the analysis and proportions of explained variance at each stage are summarized in Figure 5. It is seen that the "predisposing" variables accounted for about 16 percent of the variation in families' expenditures, the "enabling" variables about two percent, and the "need" components none. Andersen indicated that, if the effects of income (an "enabling" variable) are partialled out, much of the explanatory effect of the predisposing variables is eliminated. Thus, although Andersen's work provided some useful insights into the general nature of families' use of dental services, the analysis method he chose seems to have yielded little new information about the specific nature of dental services demand. He did confirm, in an indirect way, Feldstein's finding that income is an important determinant of dental services expenditures.

In a 1970 follow-on study of the same data, Andersen and Benham⁹² examined more closely the relationship between family income and health care expenditures. Although this study emphasized physician services, the authors' findings corroborated those of Feldstein in respect to income effects on expenditures for dental services. Their simple and multiple regression analyses produced dental expenditure "income elasticities" of 0.83 and 1.24. They found, moreover, that the income elasticities of dental expenditures were reduced to about

⁹²Andersen, R. and Benham, R., "Factors Affecting the Relationship Between Family Income and Medical Care Consumption," University of Chicago, 1970, 27 pp.

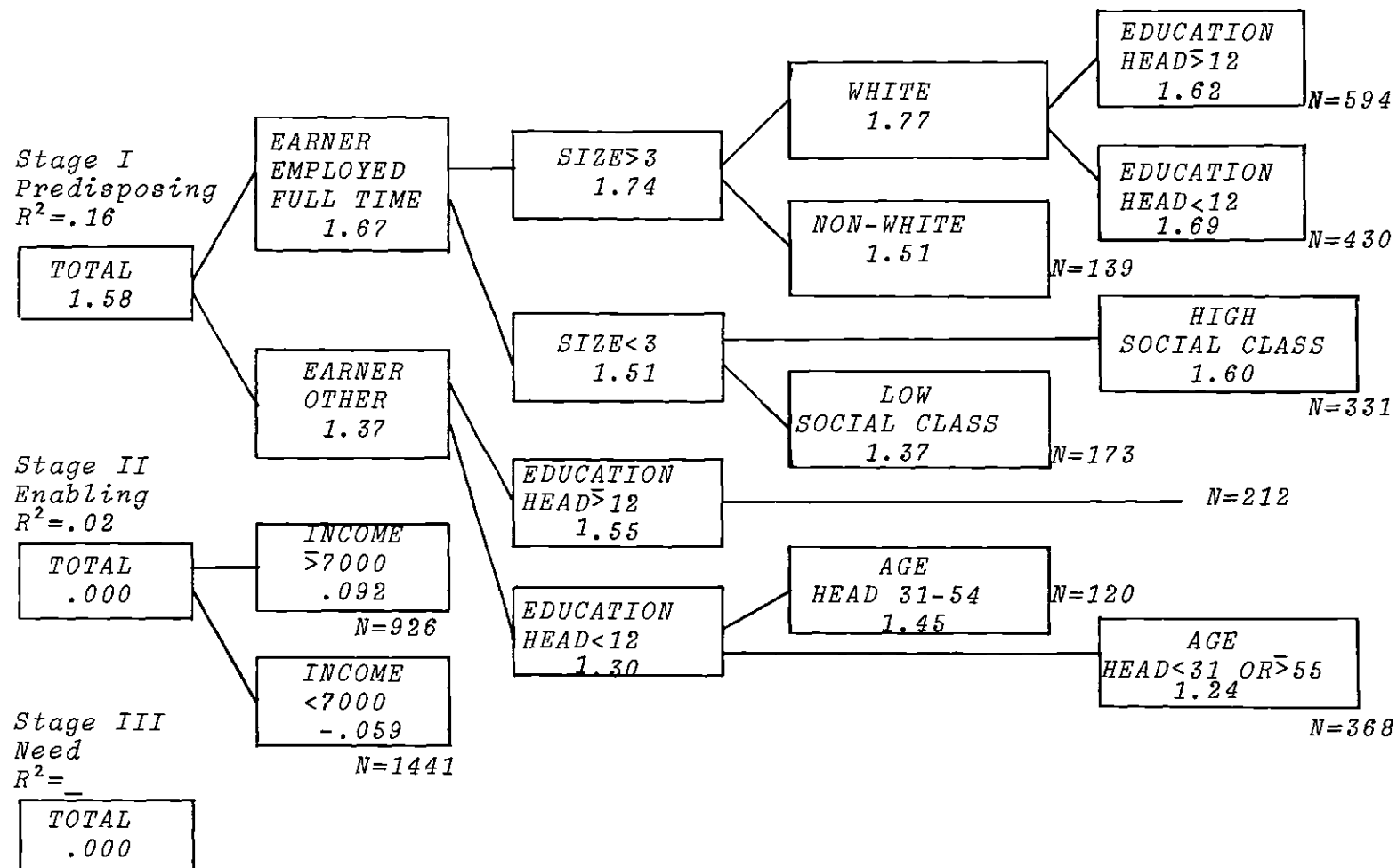


Figure 5. Predictor Trees for Analysis of Dental Expenditures*.

*Adapted from Andersen, op. cit., p. 77.

0.61 and 0.99 when urban-rural location, race, family structure and size, and similar sociodemographic variables were taken into account. An important implication of this finding is that simply making available additional dollars for certain depressed areas would not necessarily assure that consumption of dental health services would increase proportionately. Again, however, Andersen and Benham were not able to take into account the effects of prices of dental services.

The Andersen, Benham, and Feldstein studies emphasized the effects of income differences among families on families' dental expenditures within specific study years. Changes in specific families' expenditures from year to year were not examined. Thus, these authors' findings indicate simply that families whose incomes were relatively high seemed to spend proportionately slightly more on dental services than low income families in the study years. These studies provided no information about the kinds of dental services purchased or at what prices they were purchased by which families.

Qualitative Determinants of Demand

Exemplary of qualitative survey approaches to analysis of dental services utilization was the 1960 report of Friesberg and Treiman.⁹³ Using data from a 1959 National Opinion Research Center survey of public attitudes and practices concerning dental care, the authors summarized interview information obtained from 1,862 families. Their principal findings are summarized as follows:

⁹³Kriesberg, L. and Trieman, B., "Socio-economic Status and the Utilization of Dentists' Services," Journal of the American College of Dentists, September 1960, pp. 147-64.

-- 66 percent of the respondents who had gone to the dentist had done so because they believed they needed treatment for some active oral disease process; 30 percent who went to the dentist went for diagnostic or prophylactic services.

-- 23 percent of all respondents who thought they needed dental care during the previous year had not visited the dentist.

-- 34 percent of persons with incomes less than \$2,000, 48 percent with incomes of \$2,000 to \$5,000, 62 percent of persons with incomes of \$5,000 to \$7,500, and 69 percent with incomes over \$7,500 had visited the dentist the previous year, excluding edentulous persons.

-- Public knowledge about oral disease processes and efficacy of dental treatment did not help explain the relationship between socioeconomic position and going (or not going) to the dentist.

-- Persons with incomes under \$5,000 are more likely to live in smaller rural areas and are less likely to go to the dentist when they perceive that they need dental care.

-- Early dental training and care in childhood affect significantly the tendency of adults to visit the dentist preventively and for treatment of disease.

The implications of some of these general qualitative findings for health planning and policy formulation will be discussed later in

the context of alternative dental manpower strategies.

Effects of Dental Prices

Knowing the effects on consumer demand for various kinds of dental services of changes in the prices of those services could be useful in projecting the effects of dental health policies that change the prices of specific dental services. Research to generate such information probably would have to be based upon data reflecting different levels of utilization of specific dental services by similar individuals who are charged different prices for the same services. Such data are not now available and may be difficult to obtain for several years.

Although the studies already cited suggest that the demand for dental services may be more income-elastic than is the demand for any other category of health services, during the period of rising consumer income from 1935 to 1970, expenditures for hospital and physician's services rose at a greater rate than did expenditures for dentists' services.⁹⁴ It is possible that a part of this apparent inconsistency is explained by the very small role played by insurance and prepaid health plans for dental services vis-a-vis other health services. Since the consumer is not "insulated" from direct payment for dental services, it appears that the more direct effect of dental services prices could tend to depress somewhat the effect of high income elasticity derived irrespective of price. Thus, since the proportion of

⁹⁴ Bureau of Economic Research and Statistics, American Dental Association, "Expenditures and Prices for Dental and Other Health Care, 1935 to 1970," Journal of the American Dental Association, 83:1334, December 1971.

total consumer expenditures allocated to dental services varied irregularly from 1956 - 1969 between 0.62 and 0.68 percent,⁹⁵ perhaps some other factor -- possibly rising dental prices -- kept the "net income elasticity" of dental expenditures near unity.

From a somewhat different perspective, it seems reasonable to suspect that dental services demand may be largely unaffected by nominal year-to-year dental services price changes. The general unavailability of dental services price information, except through word of mouth or at the time of a dental visit, may yield relative insensitivity to changes such as the three to nine percent annual dental price increases of the last decade.⁹⁶ Moreover, almost all dental visits appear to be accounted for by individual recognition of oral conditions that need urgent treatment or pre-scheduled diagnostic-prophylactic visits. Both of these circumstances are characterized by the consumer's referral to or selection of a single dental practice with a "good reputation" as the source of treatment. Thus, there is little apparent "shopping around" for sources of treatment on the basis of price. It appears, therefore, that, although the consumer may be aware of the relatively "high" prices of dental services,⁹⁷ (in view of relatively low consumer priority for those services) he may, at the same time, be insensitive to short-term changes of the magnitude described earlier.

⁹⁵Ibid, p. 1335.

⁹⁶Ibid, p. 1337.

⁹⁷Friedson, E. and Feldman, J., The Public Looks at Dental Care, Health Information Foundation Research Series 6, New York, 1958, p. 12.

Dramatic changes in dental prices would, of course, be expected to generate substantial changes in dental services demand. The large national backlog of dental disease that consumers recognize as "existent, but not urgent" at current prices and income levels⁹⁸ could be converted into demand if effective prices were lowered enough.

Examples of substantial increases in demand resulting from large reductions in effective prices of dental services are found in the experiences of an employer-union welfare program⁹⁹ and a state Medicaid program that included dental services benefits.¹⁰⁰ In the union-employer program, demand for prosthodontic services -- typically highly-priced services -- was seen to account for about 40 percent of the participating dentists' chairside time, compared with about 13 percent of chairside time in the typical dentist's practice during the same period.¹⁰¹ Although chairside time is not an entirely adequate surrogate measure of utilization, the dramatic increase is indicative of the dentist's inclination to give high priority and to allocate his time to patients who seek relatively high fee-per-hour services. Thus, the effective reduction in price of prosthodontic services appears to

⁹⁸Ibid, p. 12.

⁹⁹Friedman, J. W., "The Dental Care Program of the Los Angeles Hotel-Restaurant Employer-Union Welfare Fund," Regents of the University of California, Los Angeles, 1970.

¹⁰⁰Fisher, M. A., "New Directions for Dentistry," American Journal of Public Health, 60:848, May 1970.

¹⁰¹Biodental Engineering Research Project, Tufts Survey of Dental Practice, Monograph 1, Tufts University, Medford, Mass., 1970, p. 13.

have resulted in a substantial increase in demand for denture prosthetics, reflected in participating dentists' time allocations.

Title XIX of Public Law 89-97 (Medicaid), enacted by the 89th Congress in 1965, was to be implemented for the federal assistance groups (the aged, dependent children, the blind, and the totally and permanently disabled) throughout the United States in 1970 and for all the medically indigent by 1975. Title XIX would require the provision of five basic health services categories uniformly throughout a state receiving Title XIX funds. Dental services were not listed specifically as required services. In 1966, New York State adopted Title XIX and immediately included the medically indigent (\$6,000 net income for a family of four) and comprehensive dental services. Because of excessive program costs, the level of indigency was reduced to \$5,300 in 1968 and to \$5,000 in 1969 and, by 1969, excluded members of indigent families between 21 and 64 years of age and dental prostheses not required for employment or to alleviate serious health problems.¹⁰² The remainder of this discussion will deal with the New York City experience only from 1966 to 1969.

Initially, the New York City program included 2.5 million persons eligible for dental benefits -- a number nearly equal to the total national enrollment in all nongovernmental prepaid dental programs.¹⁰³ During the period 1966 - 1968, the number of invoices for completed services was over 6,000 per day. The 1968 reduction in

¹⁰²Fisher, M., op. cit, p. 849.

¹⁰³Ibid, p. 850.

indigency level reduced the invoice frequency by 58 percent to about 2,500 per day. In 1968 alone, some 440,000 of the eligible New York City residents received dental services. The cost of those services exceeded 82.5 million dollars in 1968 -- more than the total 1968 expenditure for all other private sector health services combined.

Although the data describing the New York Medicaid program are not detailed and are incomplete, some implications of the program are clear. Reductions in the prices of dental services to a level consisting only of transportation costs -- and possibly a small lost-working-time cost -- increased the cumulative proportion of persons receiving dental services in public assistance categories from 39 percent in 1967 to 56 percent in 1968. The surge in demand for highly-priced prosthetic services in 1966 - 1968 was so great that denture prosthetics as a general benefit was removed in 1969.

The prospects for national comprehensive dental care programs for all U. S. citizens under Title XIX or similar programs were described succinctly by Fisher:

About \$3 billion was spent nationally in 1966 for adequate dental care to only 20 percent of the population of the United States ... Care for the total population of the country ... would have approached \$15 billion or two percent of the country's gross national product ... probably more than the country is willing to pay for dental care ...¹⁰⁴

Indeed, the 1958 study by Freidson and Feldman found that, among 2,400 families, only 40 percent of family heads thought comprehensive dental insurance was a "good idea", while 65 percent thought medical insurance would be a "good idea." Thus, it appears that,

¹⁰⁴Ibid, p. 853.

while the indigent -- who would receive essentially "free" care -- would utilize comprehensive dental services programs heavily, there would be general public reluctance to support such ambitious dental services programs through either payment of insurance premiums or taxation. Clearly, under such programs the effective prices of dental services to certain population segments are reduced dramatically, yielding substantial demand increases; for the remainder of the population who would not receive program benefits, the effective prices of dental services may increase because of the increased demand from the indigent sector, possibly yielding reduced demand among the non-indigent population. Although there is increasing national political pressure for development of comprehensive health services programs, it seems likely that inclusion of comprehensive dental services may be delayed for some time.

Summary of Trends in Dental Services Requirements

It appears that the national backlog of dental disease will continue to accumulate. General price levels of dental services and the relatively low priority of dental services among individuals cause demands for various dental services to be far below the levels required to reduce the rate of accumulation of recurring dental problems. Population growth and rising personal incomes should yield larger total and per capita dental expenditures on the order of magnitude of 0.70 to 0.75 percent of all consumer expenditures and about 0.50 percent of per capita personal income, respectively, during the next several years. Dental prices probably will continue to increase at the rate of

about nine percent per year and should depress per capita expenditures to yield a slowly-increasing level of "real" per capita expenditures for dental services. Several of these trends for the period 1960 - 1970 are summarized in Table 6.

Thus, based on the past ten years' experiences, it appears that rates of population and personal income growth will be the principal determinants of near-future changes in total dental services demand. Circumstantial evidence cited earlier and the data in Table 6 imply slightly greater than unit income elasticity of dental services demand, while price-elasticity remains essentially unexamined. There are few useful data and no reported analytical studies that have yielded information about dental services demand mixes -- a potentially significant factor in dental services planning. The implications for alternative dental health strategies of the dental services requirements described in this chapter will be discussed in Chapter V.

Table 6. Some Trends in Total and Per Capita Dental Services Expenditures, 1960 - 1970.

Year	a,b Estimated Civilian Population (X10 ³)	c Estimated Total Personal Income (X10 ⁹)	b Total Expenditures for Dental Services (X10 ⁶)	b Per Cent of Total Consumer Expenditures, Dental Services	c Estimated Per Capita Personal Income	Per Capita Dental Services Expenditures	Per Cent of Per Capita Personal Income, Dental Services	b Dental Services Price Index (1958=100)	Deflated Per Capita Dental Services Expenditures
1970	201,647	*	4,383	0.71	*	21.74	*	152.2	14.28
1969	199,067	747.2	3,921	0.68	2,974	19.70	0.52	143.9	13.69
1968	197,026	687.9	3,461	0.65	2,884	17.57	0.50	134.5	13.06
1967	195,181	629.4	3,306	0.67	2,763	16.94	0.52	127.5	13.29
1966	193,345	587.2	2,970	0.65	2,674	15.36	0.51	121.4	12.65
1965	*	538.9	*	*	2,545	*	*	*	*
1964	189,085	*	2,623	0.65	*	13.87	*	114.0	12.17
1963	*	*	*	*	*	*	*	*	*
1962	183,644	*	2,265	0.64	*	12.33	*	108.0	11.42
1961	*	*	*	*	*	*	*	*	*
1960	178,136	401.0	2,007	0.62	2,157	11.27	0.50	104.7	10.76

^aBureau of the Census, U. S. Department of Commerce, Current Population Reports, P-25, 1970.

^bBureau of Economic Research and Statistics, American Dental Association "Expenditures and Prices for Dental and Other Health Care, 1935-1970," Journal of the American Dental Association, 83:1334, December 1971.

^cBureau of the Census, U. S. Department of Commerce, Statistical Abstract of the United States:1970, (91st Edition), 1970.

* Data not available.

CHAPTER V

DENTAL MANPOWER PLANNING
CRITERIA AND STRATEGIES

The notion that universal shortages of health manpower exist at all levels has become a truism in the health literature and in the public policy statements of private, health professional, and governmental groups alike. The precise nature of those shortages is elusive, however. Few have attempted either to define or to document the characteristics and the effects of alleged health manpower shortages in any useful way.

Every assertion that a manpower shortage exists rests upon the criteria employed to assess both the intensity of the demand for a particular category of workers and the characteristics of the available supply. Judgments about the scale and seriousness of a given manpower shortage, as well as about the steps necessary to correct it, frequently differ. Lack of agreement can be traced not only to incomplete or conflicting data, but also to the fact that different criteria are invoked in determining whether the relationship between demand and supply is such as to constitute a shortage situation.¹⁰⁵

Sugg observed that

Manpower studies tend to begin under the influence of a sort of enthusiasm which expresses itself in the conviction that a shortage exists or is to be feared. Investigators, therefore, tend to work from an unexamined premise.

¹⁰⁵ National Manpower Council, Womanpower, Columbia University Press, New York, 1957, p. 257.

A manpower shortage must be understood as a function of the criteria used in determining it. In asserting the existence of a manpower shortage ... as well as in anticipating one in the future ... one is presenting a logically developed conclusion derived from assumptions. Alter the assumptions and you arrive at a different conclusion. And how well the conclusion squares or will square with reality is still another matter.¹⁰⁶

The principal purpose of this chapter is to describe a number of traditional and proposed criteria for assessing dental manpower, dental services, and dental health "shortages" and "crises", and to examine their utility in the formulation of dental manpower planning strategies. The categories of planning criteria to be discussed include manpower-population ratios, internal rates of return and dentist incomes, demand-supply-price projections, and epidemiological indices. Within each category, the most commonly recommended dental manpower strategies are examined vis-a-vis implicit and explicit health and manpower goals.

Manpower-Population Ratios

The most popular criterion for assessment of dental manpower shortages and adequacy of projected manpower supplies is the manpower-population ratio. This approach is also the most frequently used method of setting dental manpower goals. The literature search of Chapter II summarized the historical use of the manpower-population ratio approach to set health manpower goals in the United States. This traditional approach to dental manpower planning requires the assumption that existence of a specified number of dentists will assure the delivery

¹⁰⁶Sugg, R. S., Jr., "Manpower Policy and Educational Planning," a working paper, Atlanta Regional Metropolitan Planning Commission, December 1963, pp. 30-31.

and consumption of adequate quantities of the proper dental services, in the required locations, for a predetermined number of people. It is a relatively passive and simplistic approach to dental health planning. It is passive in the sense that no changes in dental services delivery mechanisms are suggested (nor would they be enforceable in the current system); thus, it is implied that the dentist will locate himself and deliver dental services in the interest of the consumer's dental and economic health. It is simplistic in the sense that it is easily described and understood by health planners, the dental profession, political bodies, and the public. Once there is conviction that some manpower-population target is desirable, policies that move toward that status are defined to be desirable. A common approach to setting "desirable" dental manpower targets is to select regions with the highest dentist-population ratios or to select a regional or national average as the goal. This approach yields desirability by comparison; no one likes to be "below average" or "below standard" once it is pointed out in public. Thus, programs designed to achieve relief from such comparisons (or justified by existence of such goals) may be supported enthusiastically -- in terms of both political promotion and financial aid.

Typical of the significant policy recommendations which flow from the manpower-population ratio approach was a 1962 statement of the Bureau of Economic Research of the American Dental Association:

The population of the United States was 180,670,000 as of July 1, 1960. Dividing this figure by the then 93,079 active dentists, indicated the population per dentist was 1,941. The population growth of July 1, 1960 to July 1, 1961 was 2,980,000. This figure

divided by 1,941 indicates that an increase of 1,535 dentists would have been required to maintain the 1960 ratio. Since the number of graduates in 1961 was 3,265 and the number of dentists lost through death and retirement was 2,427, the net gain was only 838, rather than the 1,535 needed to maintain the existing ratio. If the population continues to grow as projected, between two and three new schools will be needed per year in order to restore the 1960 population-dentist ratio in 1980.¹⁰⁷

Similar conclusions were reached by the Commission on the Survey of Dentistry in the United States in 1960¹⁰⁸ and in a number of other similar reports cited in Chapter II.

If such policy recommendations were mere expressions of concern, shortcomings of the manpower-population ratio approach might be disregarded; however, when multimillion-dollar public construction projects and operating and research budgets for increasing numbers of dental schools result from such convictions, possibly at the expense of more rational dental health policies, the shortcomings of this approach become important.

The manpower-population approach leaves unexamined practically every aspect of dental services need, demand, supply, and distribution. Moreover, it appears that dentist-population ratio goals are set without regard to or followup concerning the dental health status or health behavior of the public. The consequences of not meeting -- or of meeting -- dentist-population ratio objectives have not been assessed. Indeed, it is not clear that this approach has yielded even

¹⁰⁷Bureau of Economic Research and Statistics, American Dental Association, "Population per Dentist 1960-1980," J.A.D.A., May 1962.

¹⁰⁸Hollinshead, B. S., "Dentistry in the United States: Status, Needs, and Recommendations," Summary Report, 1960, pp. 4, 10, 11, 41.

improved supplies of dentists in the specific locations for which the increased supplies were intended.

The costs of expanding or initiating educational programs to produce more dentists can be substantial, as was indicated by the dental educational cost study of Chapter III. Thus, to continue to subscribe to the unexamined premises underlying the dentist-population approach to dental health planning appears to be an irrational course from a public health policy point of view. While construction of new or expanded dental schools does provide honorable and interesting employment for a large number of dental and parodontal professionals and for an increased number of dentist graduates, there is little evidence that the simple production of relatively small additional numbers of dentists alleviates any specific dental health problem. Indeed, although this too is an unexamined assertion, the dentist manpower produced by a number of programs may be substantially offset by the large number of dentists required to operate the programs and the increasing emphasis on post-graduate studies and specialization that such programs seem to inspire. Fein, too, concluded that:

Medical manpower policy ... should move beyond the maintenance of historically-derived manpower-population ratios. It must ask whether goals can be reached in alternative less costly ways with fewer resources (or, putting it differently, whether higher goals can be reached)...¹⁰⁹

Dentist Incomes and Internal Rates of Return

In an attempt to develop an improved analytical basis for measuring the existence of shortages or surpluses of health manpower,

¹⁰⁹Fein, R., op. cit., p. 21.

several authors have proposed adoption of comparative-income and internal-rate-of-return methodologies. Rayack¹¹⁰ proposed that a manpower shortage exists when the quantity of services supplied increases less rapidly than the quantity demanded at incomes received by physicians in the recent past. Under such conditions, he asserted, the incomes of physicians relative to the incomes of others will tend to rise. As the relative incomes of physicians rise, there will be attempts to substitute less costly services for those offered by physicians.¹¹¹ Thus, Rayack attempted to measure whether there was an excess of demand for physicians over supply of physicians. He found that physicians improved their relative income position during the period 1929 to 1959, compared with lawyers, managers, and other technical and professional groups. He asserted further that there was a search for less costly substitutes for physicians during the same period. And he concluded subsequently that the evidence supported the existence of a physician shortage.

Rayack's relative income approach has several shortcomings that limit its usefulness as a measure of dental and medical services shortages and as a basis for policy formulation. Principal among these shortcomings is the fact that his method does not provide any means for estimating the magnitudes of alleged shortages or surpluses. The observed rate of change in the relative income position of dentists as a group cannot indicate the extent of the excess of demand over supply,

¹¹⁰Rayack, E., "The Supply of Physicians' Services," Industrial and Labor Relations Review, 17:221, January 1964.

¹¹¹Ibid, p. 223.

nor can it indicate whether or not an alleged shortage is being eliminated. If the prices of dentists' services are very responsive to increases in demand, or if the dentist productivity improved, yielding higher relative incomes, these observed changes might denote a reduction in excess demand rather than an increase in the shortage condition. Rayack's approach also emphasizes demands for and supplies of specific kinds of health manpower. Of course demands typically are for services, which can be provided by a number of different kinds of health manpower.

Hansen¹¹² proposed what he considered to be an improvement in the relative income approach. He attempted to incorporate both the economic returns to health professionals and the costs of training into an internal-rate-of-return figure. Hansen defined the internal rate of return to be "the rate of discount which equates the present value of the expected earnings stream to the present value of the expected outlay or cost stream."¹¹³ Hansen's arguments in favor of his approach center around an assertion similar to that made by Rayack; namely, that a shortage of physicians or dentists occurs when the number of professionals increases less rapidly than the number demanded at recent rates of return, thus yielding a rising rate of return.¹¹⁴ Recognizing that

¹¹²Hansen, W. L., "Shortages and Investments in Health Manpower," in The Economics of Health and Medical Care, Proceedings of the Conference on the Economics of Health and Medical Care, University of Michigan, Ann Arbor, 1954, pp. 75-91.

¹¹³Ibid, p. 81.

¹¹⁴Ibid, p. 82.

his approach had some of the same shortcomings as the relative income methodology, Hansen proposed adoption of a "standard alternative rate-of-return level" with which rates of return for specific health professions could be compared. He chose as his standard the prevailing rate earned by male college graduates in specific study years. He then termed deviations of four to eight percent from the standard as "mild" shortages or surpluses and larger deviations as "sizeable" shortages or surpluses.¹¹⁵ According to Hansen's data, there was a "sizeable" surplus of dentists in 1939, a "sizeable" shortage in 1956 -- conclusions that differed substantially from those based upon manpower-population ratios described in Chapter II. Hansen's approach is, of course, dependent upon selection of the "standard" rate and, thus, suffers from some of the same problems or arbitrariness that characterize the manpower-population ratio approach. Moreover, neither Hansen's nor Rayack's approach provides information that would be helpful in developing dental health policies to overcome alleged shortages or surpluses of indeterminate size. And, again, both approaches focus upon demands for and supplies of dental manpower without regard to specific dental services or health goals. Neither approach appears to be very useful for the development of improved criteria to be used as the basis for formulation of rational dental health and manpower policies.

¹¹⁵Ibid, p. 86.

Projections of Economic Demand

Young¹¹⁶ probably was the first to develop quantitative estimates of required numbers of dentists by attempting to project the total economic demand for dentists' services. Using a linear extrapolation of the trend in deflated per capita dental expenditures from 1946 to 1958, Young estimated that there would be a 43 percent increase in deflated per capita dental expenditures between 1958 and 1975. He calculated that, together with projected population growth, there would be an increase of about 93 percent in total national demand for dental care between 1958 and 1975.¹¹⁷ Young then asserted that these projections yielded a requirement in 1975 for 190,000 dentists (93 percent or 72,000 dentists more than the projected 1975 supply of about 118,000). Young adopted the premises of the Bane committee (maintain the 1959 dentist-population ratio) as the base to which he added consideration of rising per capita dental expenditures. He assumed that any percentage increase in per capita dental expenditures would require the same percentage increase in the number of dentists available to meet that demand.

Using a somewhat different basis for estimation, the Division of Dental Resources of the U. S. Public Health Service also studied the trend toward increasing per capita dental expenditures.¹¹⁸ The authors assumed that per capita dental expenditures would increase in direct

¹¹⁶Young, W. O., "Dental Health," in The Survey of Dentistry, Final Report of the Commission on the Survey of Dentistry in the United States, American Council on Education, Washington, 1962, pp. 5-94.

¹¹⁷Ibid, p. 80.

¹¹⁸Division of Dental Resources, U. S. Public Health Service, "1975, Supply of Non-Federal Practitioners vs. Alternate Estimates of Need," Washington, 1959.

proportion to increases in per capita personal income. Their data indicated that, to offset the increase in demand for dental services arising from projected increases in personal income and population growth, 136,500 dentists would be required by 1975. These results are based upon assumptions similar to the dental expenditures findings of Chapter IV; namely, that increases in total expenditures for dental services for the next several years are likely to arise principally from population and per capita personal income growth.

Manpower policies derived from maintaining previous-year ratios between numbers of dentists and total dental expenditures would appear to retain some of the characteristics of dentist-population ratio approaches. In the aggregate, however, the expenditure approach does attempt to accommodate some degree of growth in dental services utilization, assuming approximately unit income elasticity of dental services expenditures. Nevertheless, as a base for development of health-directed dental manpower policies, this approach retains most of the disadvantages of the dentist-population ratio approach. It does not allow for supervised or complete transfer of dental services production to persons other than dentists, nor does it attempt to address problems of maldistribution of dental services. And, of course, the expected expenditure approach is not an approach that lends itself to development of manpower policies to alleviate specific dental health problems.

Moreover, as Young observed:

Should the prediction of the level of future demand (expenditures) be overstated by half, the problem of assuring adequate dental manpower in 1975 still would represent a Herculean task. In fact, to train in the brief period of fifteen years

the number of dentists needed to meet even part of the tremendous increase in demand is an almost impossible undertaking.¹¹⁹

Thus, it appears that the extrapolation of present proportionalities into the future may be, in large part, an academic exercise. Young recognized that, since projected demands probably could not be met through producing additional large numbers of dentists alone, "it will also be necessary to reduce the incidence of dental need and to increase, as much as possible, the productivity of practicing dentists."¹²⁰

The Louisville Studies

A recently-published five-year laboratory study of the effects of having the dentist direct a team of dental assistants performing an expanded set of dental procedures, formerly done by dentists, concluded:

As heads of dental teams with four assistants performing expanded functions, dentists were able to increase their productivity over their base-line (one dentist, one "traditional" assistant) performance by 110% to 133% depending on the method used for measurement.¹²¹

These findings, as interpreted widely by dental health officials, are said to imply that the dentist can more than double the number of

¹¹⁹Young, W. O., op. cit., p. 83.

¹²⁰Ibid.

¹²¹Lotzkar, S., Johnson, D. W., and Thompson, M. B., "Experimental Program in Expanded Functions for Dental Assistants: Phase 3 Experiment with Dental Teams," Journal of the American Dental Association, 82:1075, May 1971.

services he produces by employing four expanded-function assistants to whom he has delegated a number of "dentist" duties. Of course one might suspect that a team of five persons performing similar work could produce a substantially greater quantity of work than could two persons, one of whom is not allowed to perform "delegated" tasks. Indeed, in the study, procedures accounting for 43 percent of the dentist's chairside procedure time were delegated to each of the four ancillary personnel. Thus, assuming complete homogeneity of procedure mix, no scheduling problems, and adequate demand, one might suspect that this team of 2.72 "effective dentists" could indeed produce over twice the "dentist" output of a single "assisted" dentist. Of course there are problems of supervision, scheduling, and interdependence of procedures; but there are concomitant opportunities for the ancillary personnel to produce greater quantities of relatively independent services such as x-rays, prophylaxes, oral health instruction, etc. Unfortunately the study results do not indicate the specific areas in which the so-called "productivity" increases occurred. The only clearly-supported conclusion of the study seems to be that the dentist and four "partial-dentists" can produce a greater quantity of some kinds of services than can the solo dentist with a traditional assistant.

It is clear that the production functions for a number of "dentist" services are changed by the delegation of tasks to assistants. It is not clear, however, that the dentist himself can produce appreciably greater quantities of those services requiring his "superior skills," principally because of his apparently increased supervisory responsibilities. To the extent that the new ancillary personnel

could operate independently, of course, the dentist's potential "productivity" could be improved. Nevertheless, assessment of the productivity of the five-man team should consider the worth of the ancillary inputs as well as the dentist input. If, roughly speaking, the new ancillaries each can produce 43 percent of the services the dentist formerly performed, then the new production level of 233 percent of the solo level, divided by 2.72 "effective dentists" would give a "productivity" index of about .86 compared to 1.00 for the solo dentist. Thus, in this sense, productivity of the dentist practice has declined, although production has increased. This conjecture is supported in part by the fact that the new ancillary personnel typically took longer to perform most tasks than dentists did in the baseline experiments.

The implications of the Louisville (Kentucky) studies discussed here are powerful in several respects. The study found that dental assistants trained for one year could perform chairside procedures accounting for at least 43 percent of the dentist's procedure time as well as experienced dentists could perform the same tasks. The nature and need for dentist supervision of such tasks were not clear in the study, leaving the implication that the assistants actually could perform as quasi-dentists in several respects. It was not clear, moreover, that the dentists were producing greater quantities of services calling for their higher skill levels; a principal source of the increase in team output could have been increased emphasis upon certain ancillary components of the "product line," yielding a substantially different service mix.

The study results suggest further that a high-school graduate trained for one year can produce certain dental services -- accounting for 43 percent of individual procedure time -- as well as the experienced dentist with at least six years of post-high-school education. Although, by definition and legally, all those tasks could not now be performed independently of the dentist-employer, the implication as cited above is that many such tasks could indeed be performed independently by such personnel. This factor lends support to potential proposals for the independent practice of parodontal personnel such as has been adopted in New Zealand.¹²²

However, the experimental results of the Louisville study -- widely touted as the principal means of making greater quantities of dental services available to the public -- may not be a feasible means of accomplishing that objective in the short or intermediate term. In 1971:

Forty percent of the nation's dentists still answer their own telephones, send out their own statements, clean and sterilize their own instruments, and perhaps even sweep their own floors. They employ no full-time dental auxiliary. Forty-eight percent of the nation's dentists employ one full-time auxiliary.¹²³

Thus, although the potential benefits of the use of ancillaries have been promoted for some time, a relatively large proportion of dentists have not exploited the claimed advantages of the in-practice

¹²²Fulton, John T., "Experiment in Dental Care: Results of New Zealand's Use of School Dental Nurses," Bulletin of the World Health Organization, 4:1, 1951.

¹²³Gilman, C. W., "The Interface of Dental Assisting and Dentistry," Dental Assistant, 41:11, April 1972.

auxiliary beyond the first dental assistant. Moreover, surveys of dental practice since 1953 indicate that 15 to 20 percent of U. S. dentists have felt that they did not have as many patients as they would have liked; an additional 30 to 40 percent of U. S. dentists have indicated that they met all their demand, but did not feel "over-worked."¹²⁴ This attitude is reflected in employment of paradental personnel. In the 1964 survey of dentist opinion, 40 to 45 percent of all respondents indicated that they would not hire additional ancillary personnel because of insufficient demand to keep such personnel busy. Of respondents employing either no auxiliaries at all or only a receptionist-secretary, more than half indicated that demand was too low to justify their hiring additional personnel.¹²⁵

It seems unreasonable, therefore, to expect widespread employment of large teams of expanded-function paradental personnel among dentists currently in practice. However, since the opportunity for substantially increased financial production and productivity with dental ancillaries is clear, rapid rises in demand for dental services could yield subsequently increased demands for paradental personnel. Moreover, as new dental graduates are indoctrinated with the advantages of ancillary team practice, marginal increases in the utilization of such teams in the dental profession would be expected. The tendency

¹²⁴ADA Surveys of Dental Practice, 1953, 1956, 1959, 1962, 1965, 1968, 1971.

¹²⁵Bureau of Economic Research and Statistics, American Dental Association, "Survey of Dentist Opinion," 1964, pp. 20-24.

of several states to modify their dental practice acts to allow delegation of tasks to paradental personnel also may further encourage some increase in the utilization of such personnel.¹²⁶

Health-Directed Dental Manpower Programs

As has been discussed previously, projected consumer demand for dental services presents potential challenges that the dental profession would have extreme difficulty meeting. Yet, the U. S. National Health Survey of 1957 - 1959 found that only about 40 percent of the population had visited the dentist during the previous year, that 10 percent of the population accounted for two-thirds of all dental visits, and 33 percent of all persons surveyed had not visited the dentist in the previous five years.¹²⁷ Moreover, as was indicated in Chapter IV, dental disease affects virtually the entire population. About half the population is completely edentulous by age 65, and two-thirds is edentulous by age 75; the typical 16 year-old is missing 1.3 permanent teeth, has received 1.6 fillings, and has 10 untreated carious teeth; and twenty percent of the population has a complete upper denture by age 35.¹²⁸ Thus, it is clear

¹²⁶Johnson, D. W. and Bernstein, S., "Classification of States Regarding Expanding Duties for Dental Auxiliaries and Selected Aspects of Dental Licensure," American Journal of Public Health, 62:208, February 1972.

¹²⁷U. S. Department of Health, Education, and Welfare, Public Health Service, Health Statistics from the U. S. National Health Survey: Dental Care, Interval and Frequency of Visits, July 1957 - June 1959, Publication No. 584-B14 Washington, U. S. Government Printing Office, 1960.

¹²⁸U. S. Department of Health, Education, and Welfare, Public Health Service, Health Statistics from the U. S. National Health Survey: Loss of Teeth, Publication No. 585-B22, Washington, U. S. Government Printing Office, 1967.

that projections of dentist manpower requirements based upon extrapolations of current dental expenditure patterns would yield manpower policies that would have little effect upon the general dental health status of the U. S. population. That point becomes clearer when one considers that, despite effective therapeutic intervention, most oral disease processes can recur at their previous rates subsequent to treatment.

Fluoridation and Dental Manpower

Although it is not a dental manpower matter per se, the presence of natural and supplementary fluoridation of community water supplies has been shown to have a substantial effect upon the incidence of carious lesions. Decreases in the incidence of caries of from 35 percent to 80 percent have been reported for fluoridated communities.¹²⁹ It is, of course, intuitively clear that fluoridation of water supplies could reduce dramatically not only the incidence of caries, but also of subsequent edentulousness and resulting malocclusion. It seems clear also that the cost and frequency of necessary dental care for individuals would be significantly smaller in communities with fluoridated water supplies, and that per capita demands for dentists' services would be reduced within such communities. Until recently, assertions such as these could be argued logically, but little experiential

¹²⁹For example, see: Blayney, J. R., and Hill, I. N., "Fluorine and Dental Caries," Journal of the American Dental Association, 74:233, January 1967. Englander, H. R., and Wallace, D. A., "Effects of Naturally Fluoridated Water on Dental Care in Adults," Public Health Reports, 77:887, October 1962. Russell, A. L., and Elvove, E., "Domestic Water and Dental Caries," Public Health Reports, 66:1389, October 1951.

evidence existed to support them. Ast and others¹³⁰ reported in 1965 that child patients in Newburgh, N.Y., where the water is fluoridated, had about half the incidence of decayed, missing, and filled teeth displayed by children in Kingston, N.Y., where the water was not fluoridated. They found also that the mean time and cost per child of both initial and followup comprehensive dental care for the Newburgh children was less than half that required for the Kingston children. These findings were corroborated by similar studies in other locations.¹³¹ Thus, there is a clear reduction in individual dental costs and dentist manhours required for treatment in communities whose water supplies are fluoridated.

Effects of fluoridation on dental manpower requirements and dental practice were reported by Terhune and Muhler¹³² in 1967 and by Douglas and others¹³³ in 1972. Terhune and Muhler found that, in

¹³⁰Ast, D., Naham, C., Carlos, J., and Maiwald, A., "Time and Cost Factors to Provide Regular, Periodic Dental Care for Children in a Fluoridated and Nonfluoridated Area," American Journal of Public Health, 55:811, June 1965.

¹³¹Denby, G. and Hollis, M., "Effect of Fluoridation on a Dental Health Public Programme," New Zealand Dental Journal, 62:32, January 1966; Blayney, J., "Economy of Water Fluoridation," Journal of the American Dental Association, 65:595, November 1962; Mitchell, G. E., "The False Economy of Dental Neglect," U. S. Public Health Service, Publication No. 1178, U. S. Government Printing Office, Washington, 1967, p. 18.

¹³²Terhune, R. C. and Muhler, J. C., "Influence of Communal Fluoridation on Dental Practice," Journal of Dentistry for Children, 34:228, July 1967.

¹³³Douglas, B. L., Wallace, D. A., Lerner, M. and Coppersmith, S. B., "Impact of Water Fluoridation on Dental Practice and Dental Manpower," Journal of the American Dental Association, 84:355, February 1972.

fluoride-deficient community "A" and naturally-fluoridated community "B": each dentist served an average of 2,060 population in B and 1,550 in A; per capita dental expenditures were \$22.95 in A and \$15.72 in B; mean gross annual dentist income in A was \$29,900 and in B was \$32,900; and mean net dentist income was \$11,285 in A and \$17,746 in B.

Douglas and his associates reported similar findings for seven matched pairs of fluoridated and nonfluoridated communities. Dentists in the fluoridated communities apparently located and distributed themselves so that they each served from 14.5 to 30 percent more residents than did dentists in the non-fluoridated communities. Although dentists in the non-fluoridated communities were apparently "busier" (54 percent either felt overworked or turned away patients, compared with 37.5 percent in the fluoridated areas) and employed far greater numbers of auxiliary personnel, median gross and net annual dentist incomes were higher in the fluoridated areas. The mixes of dental services provided in fluoridated and non-fluoridated communities were essentially identical in every category, as shown in Table 7.

A strong implication of these findings, aside from the clear cost and disease reduction benefits of fluoridation to individuals, is that dentists appear to distribute themselves "naturally" to maintain similar practices and incomes in the face of substantial differences in the dental requirements of the populations they serve. If this observation is accurate, then it appears that two significant factors emerge. First, programs that are directed toward maintenance of the natural teeth of children (ingestion of fluorides prior to age 14 and similar programs) can substantially reduce the general level of dental care

Table 7. Nature of Dental Treatment Provided in Fluoridated and Fluoride-Deficient Communities, 1966.¹³⁴

Dental Treatment (Services)	Fluoridated Communities		Fluoride-deficient Communities	
	No	%	No	%
All treatments	10,953	100.0	10,370	100.0
Restorations	4,512	41.2	4,367	42.4
Deciduous teeth**	624	5.7	449	4.4
Permanent teeth**	3,402	31.1	3,454	33.3
Gold inlays, gold crowns, and porcelain and acrylic jackets	316	2.9	314	3.0
Other restorations	170	1.5	150	1.5
Extractions	1,641	14.9	1,570	15.1
Deciduous teeth	255	2.3	251	2.4
Permanent teeth	999	9.1	977	9.4
First permanent molars	196	1.8	205	2.0
Third permanent molars and supernumerary teeth	191	1.7	137	1.3
Prophylaxes	1,624	14.8	1,581	15.2
Radiographs	1,269	11.5	1,137	10.9
Prostheses	488	4.5	483	4.7
Fixed bridges	83	0.8	70	0.7
Partial dentures	174	1.6	126	1.2
Complete dentures	231	2.1	287	2.8
Specialty treatment	401	3.7	215	2.0
Topical fluoride application	163	1.5	107	1.0
Surgery sittings including impactions	117	1.1	82	0.8
Other and ill-defined treatment	738	6.8	828	8.0

*Week of Oct. 17 to 22, 1966.

**Amalgam, cement, and plastic.

¹³⁴Ibid.

need and demand among the population. Secondly, the dental profession is not affected adversely by such programs, since dentists can maintain or improve their economic well-being while serving larger populations.

Yet, despite overwhelming evidence of the dental health and economic benefits of fluoridation of community water supplies, this relatively passive and inexpensive measure has not been widely adopted in the United States. By 1956, only 1,526 communities, representing 32 million people, or 18 percent of the U. S. population at that time, had fluoridated their water supplies. From 1956 to 1959, only 4.22 million persons were added to that figure.¹³⁵ Young estimated that, by 1970, only about 30.5 million persons would have been exposed to fluoridation by their fourteenth birthday. Of course there are alternative means of gaining some of the caries-inhibiting benefits of fluoride compounds. Fluoridation of school water systems, fluoride-compound dentifrices, home auto-fluoride kits, fluoride tablets, and the like have been shown effective; yet none of these measures is so economical or widely effective as fluoridation of community water supplies. Nevertheless, the benefits nationally of this simple, passive health measure have not yet been exploited.

The New Zealand Experience¹³⁶

In 1912, medical and dental examinations of New Zealand school children revealed such rampant dental disease that the then president

¹³⁵Young, W. O., op. cit., p. 84.

¹³⁶Fulton, J. T., "Experiment in Dental Care: Results of New Zealand's Use of School Dental Nurses," Bulletin of the World Health Organization, 4:1, 1951.

of the New Zealand Dental Association proposed development of a system of state dentistry for complete dental care of all school children. Under the aegis of the New Zealand Department of Health, the School Dental Service began in 1921 with two-year programs of training for school dental nurses. Upon completion of the training program, dental nurses were employed by the Department of Health whose dental officers periodically inspected the work and records of each nurse. The dental nurses were assigned to operate elementary school dental clinics under the general daily supervision of school officials. Under strict guidelines, the dental nurse performed prophylaxes, oral examinations, fillings, extractions, gum treatments, and dental health education for pre-school children and for elementary school students ages 6-14 years. All other services were provided through referral to private dentists, under a free-choice arrangement. The state paid all fees associated with referrals under a special benefits contract with the dentists. Enrollment in the school programs and referrals to contracting dentists were both voluntary, requiring written parental consent.

After initial resistance in 1912-1920, New Zealand dentists have come to accept and to participate in the school dental nurse program enthusiastically, according to Fulton.¹³⁷ But the most significant result of the program appears to have been improvement in the oral health status of New Zealand children. Fulton's examinations of 4,000 children in 1950 revealed that: by age seven, more than five deciduous molars per child had been carious, but 95 percent were filled;

¹³⁷Ibid, p. 49.

two permanent teeth also had been attached by caries by age seven, but 75 percent had been filled; and, by age 14, although 10 teeth per child had been carious, 86 percent were filled and only 0.4 permanent teeth per child were missing.¹³⁸ These findings become especially significant when compared with the previously cited findings of the U. S. National Health Survey of 1967, in which the typical U. S. 16-year-old had 10 untreated carious teeth, 1.6 fillings, and 1.3 permanent teeth missing.¹³⁹

Clearly, the New Zealand school dental nurse program was developed as a health-directed dental manpower strategy. Moreover, like fluoridation, the program was directed toward, and has been effective in, maintaining the natural teeth of children. And, interestingly, although the number of dental school nurses and annual number of nurse graduates more than doubled during the period 1939 - 1949, the number of dentists and annual number of dentist graduates remained essentially static during the same period.

It appears unlikely that programs similar to the New Zealand approach will be initiated in the United States without considerable resistance from the dental profession. In 1949, the Massachusetts legislature passed a bill that allowed a five-year research project to be initiated to train dental hygienists to perform prophylaxes and to prepare and fill simple cavities in children's teeth. Dentists were to evaluate the results of the program during its final three years.

¹³⁸Ibid, pp. 7-17.

¹³⁹U. S. Department of H.E.W., op. cit.

In 1950, however, under pressure from the dental profession, the legislature repealed the bill and the project was cancelled.¹⁴⁰ In Alabama in 1958 a proposal was made to modify the state's dental practice act to allow licensure of dental nurses who would perform prophylaxes, take X-rays, make examinations of teeth, administer local anesthetics, apply rubber dams, and take impressions for study models only. The proposal was not supported by the state dental society and was not passed by the legislature.¹⁴¹

Nevertheless, programs similar to the New Zealand dental nurse concept appear to offer strong economic and health advantages over traditional U. S. dental manpower planning approaches.

Alternative Conceptual Approaches to Delivery of Dental Services

If dental health planners and policy makers are to make rational allocations of limited resources to achieve a high level of satisfaction of some public dental health goal, it is important that they be made aware of the costs and degrees of achievement of that goal under alternative dental health strategies. In this section, some general conceptual relationships¹⁴² which are important in comparing alternative strategies will be discussed. An attempt will be made in Chapter VI to illustrate these concepts in examining strategies for delivery of specific dental health services.

¹⁴⁰Kesel, R. G., "Dental Practice," in The Survey of Dentistry, op. cit., pp. 205-206.

¹⁴¹Ibid, p. 206.

¹⁴²After Forrester, p. 318.

Let it be assumed that an overall index of quality-quantity-equity (QQE) can be formulated to represent the characteristics of a strategy (efficacy, price, availability, quality, distribution, etc.) required to satisfy various proportions of some health goal. In Figure 6, it is observed that a relatively low QQE (representing, perhaps, a strategy of relative inaction) has little effect upon meeting the stated goal or requirement. Until some reasonable level of QQE is achieved, little progress toward the established goal is possible. Through the midrange of QQE values, it appears that relatively rapid movement toward the goal is possible. Finally, despite rather sophisticated and substantial improvements in QQE, it might be difficult to satisfy the remaining portion of the goal.

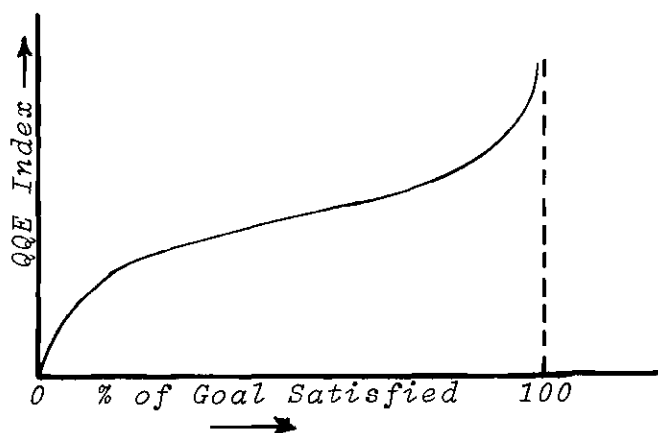


Figure 6. QQE Versus Percentage of Health Goal Satisfied.

The curves in Figure 7 describe the achievement of QQE as a function of cost (developmental, educational, research, and operating costs, including noneconomic disutilities such as elapsed time). Choices among different health strategies usually are available, and

may involve substantially different QOE-cost relationships as represented by approaches A and B in Figure 2.

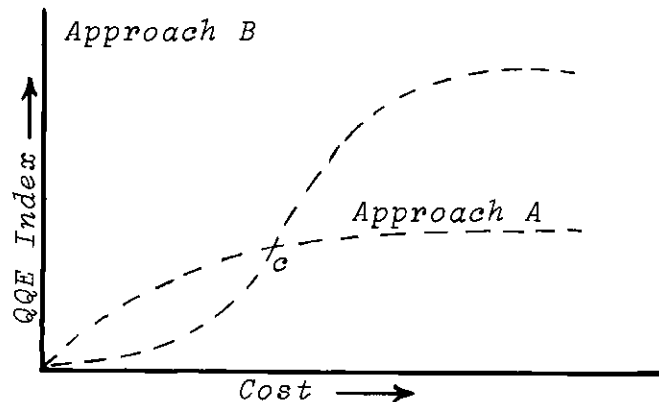


Figure 7. QOE Versus Cost for Alternative Health Services Strategies.

Approach A in Figure 7 might represent a well-known traditional approach to health problems that can be exploited to produce highly-visible short-term gains in QOE. Approach A has a lower potential QOE than is shown for Approach B. Approach B is not so far along in terms of realizable QOE when the choice of health strategies is to be made, and will require additional developmental and set-up resources before it can produce an acceptable level of QOE. However, Approach B has potential for a far greater ultimate level of QOE than does Approach A, and, beyond point c, at comparable cost.

The effects of the two strategies become clearer when Figure 7 is superimposed upon Figure 6, as shown in Figure 8.

Although the horizontal scales are different in Figure 8 for cost and percentage satisfaction of the health goal, horizontal

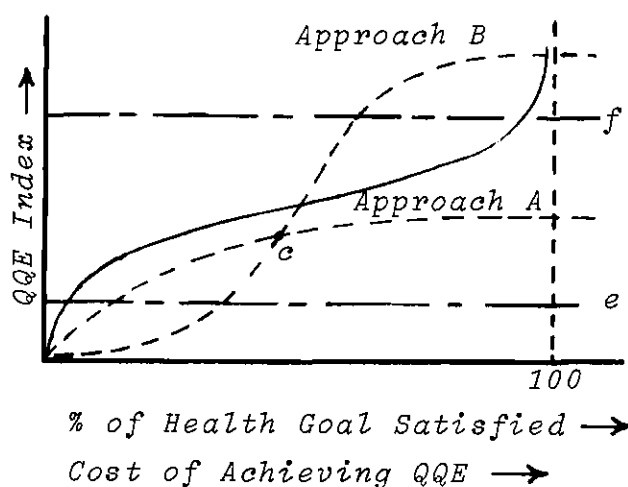


Figure 8. Costs and Achievements of Alternative Health Strategies.

positioning between the curves is of little interest here. A horizontal line at e intersects both the approach curves. For the QQE level at e , Approach A is less expensive than Approach B; however, the percentage of the health goal satisfied by that level of QQE is very small.

At point c in Figure 8, the costs and QQE values are the same for Approaches A and B. But at costs higher than those at point c , Approach B is clearly more effective. At the QQE level at f , only Approach B is technologically feasible.

By transferring pairs of cost and percentage-of-goal-satisfaction points for Approaches A and B from Figure 8, Figure 9 is obtained. In Figure 9, the horizontal cost scale is the same as before; the percentage goal satisfaction scale is now vertical.

In Figure 9 it is observed that, in the lower cost-satisfaction regions, the "traditional" Approach A yields increases in goal

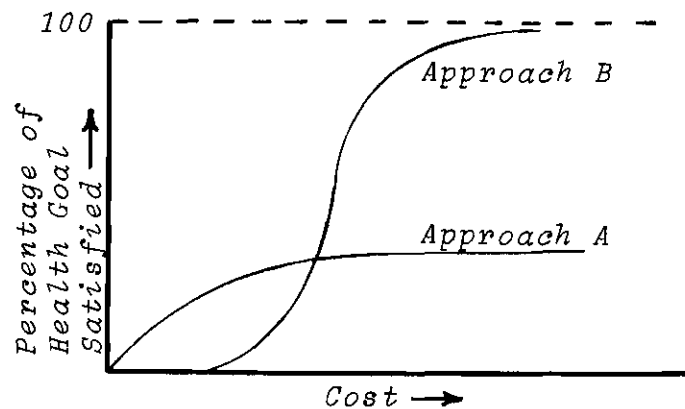


Figure 9. Health Goal Satisfaction Versus Cost for Two Different Health Strategies.

satisfaction approximately proportional to expenditures. Approach A reaches a point of diminishing contributions to goal satisfaction rather rapidly, however. (Slightly more rapidly than was apparent in Figure 8.) Above point c in Figure 8, Approach B, on the other hand, yields rapid increases in QGE as expenditures increase. Since these increases occur in a region in which QGE increases make their most rapid contributions to goal satisfaction, an abrupt rise in degree of health goal satisfaction versus development cost is seen in Figure 9.

The short-term "obvious" advantage of Approach A may lead health planners to recommend and policy makers to adopt and defend a strategy which is relatively simple to propose, understand, and implement, but which lacks adequate potential for satisfying the stated health goal. Although the general analyses portrayed in the above figures are static, steady-state representations of eventual outcomes for the strategies portrayed, the relationships appear to be typical of those that would be used to describe the general characteristics of a service-goal

satisfaction system. The appropriateness of these conceptualizations to analysis of dental health services strategies was highlighted by Forrester:

We often see comparative situations (such as those above) in new, rapidly evolving technological areas. (Approach A) ...illustrates the approach which is initially easier and which people attempt to exploit beyond its inherent capabilities. Programs become committed to such improvement and can involve large expenditures. An entirely different approach aimed at much higher goals can often be the least costly in the long run because it requires embarking upon an approach of much greater potential.¹⁴³

It is asserted here that the character of traditional dental manpower strategies, in respect to the goal of improved dental health, is essentially that of the conceptual type "A" approach. The characteristics of private dental practice, dental manpower production, and production consumer demand for dental services appear to limit severely the potential of traditional strategies. It is asserted further that the steady-state status of traditional strategies currently in effect is represented approximately by point t in Figure 10. It does not appear that even substantial additional expenditures of public or private funds to prepare increasing numbers of dentist-entrepreneurs or their ancillary employees would yield significant gains in reducing the general prevalence of dental disease.

Yet, probably in no other general area of public health -- except perhaps in the control of certain communicable diseases through immunization -- is the level of existing technology for prevention, control, and treatment of disease so well-developed as in the area of dental health. Indeed, the technology for near-eradication of certain kinds of oral disorders appears to exist; moreover, a great deal of the

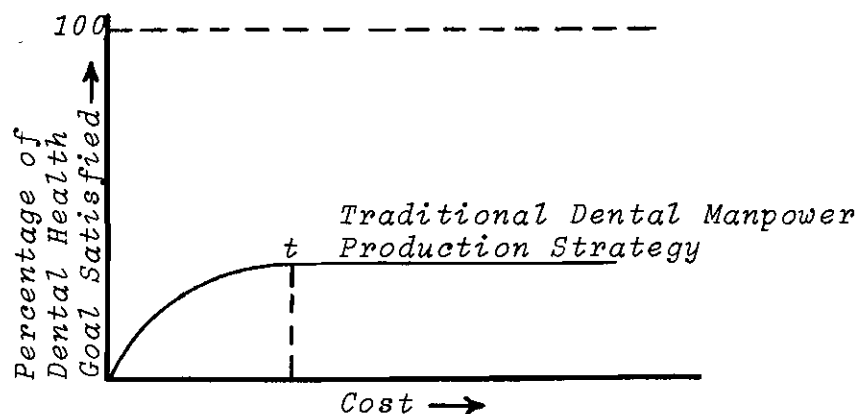


Figure 10. Current Status of Manpower Production as a Dental Health Policy.

initial research and development related to this technology already have been accomplished. Although certain of these technologies have existed for a number of years, they are yet to be implemented in an organized fashion as a health strategy. It appears that a health planning strategy involving health-directed application of these technologies (through programs such as fluoridation and public dental nurse programs) is similar in character to the conceptual "Approach B" discussed previously. It is assumed that the steady state status of directed dental health improvement strategies is represented approximately by point t in Figure 11. (Point t denotes also the asserted current status of the manpower production strategy described in Figure 10.)

Conceptually, then, it appears that the allocation of substantial additional funds and dental health planning efforts -- if the public health interest is to be served -- must be to strategies and programs of directed health improvement instead of toward currently-

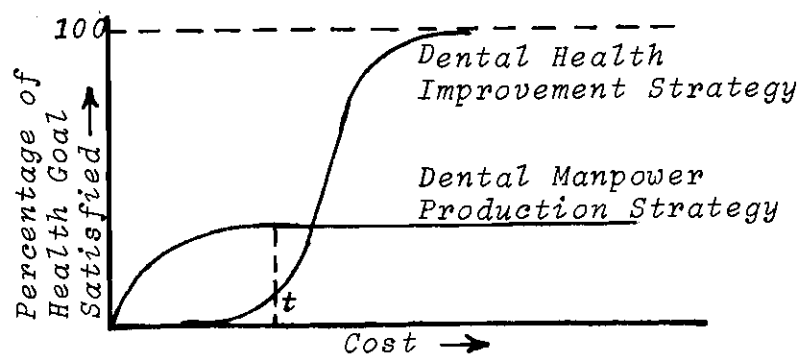


Figure 11. Current Status of Directed Dental Health Improvement as a Dental Health Policy.

proposed expansions of traditional profession-oriented manpower production programs. This assertion presumes, of course, that alleviation of well-documented, widely-prevalent dental disease is preferable to symptomatic treatment of alleged professional manpower crises, and that the success of the former practically insures resolution of the latter.

CHAPTER VI

PROSTHODONTIC SERVICES: A CASE STUDY
OF NEED AND AVAILABILITY IN THE UNITED STATES*

In attempting to plan for the growth of health professions education, manpower planners and policy makers commonly utilize population projections and fixed manpower-to-population ratios to establish levels of manpower which will be "needed" at some future time. This traditional approach to health manpower planning seems to be based upon the critical assumption that existence of a specific number of health professionals will assure the delivery of adequate health services for a predetermined number of people. However, little attention has been given to either the types and quantities of services that will be required by the public or the ability of projected numbers of health professionals to deliver those services.

This case study was an attempt to deal more directly with the nature and magnitude of requirements for specific dental health services and the capacity and propensity of projected numbers of dentists to provide those services. The general purpose of the study was to develop a framework within which proposed programs related to dental manpower and the provision of prosthodontic services could be examined more

*Developed in part with Russel G. Overton as an intramurally-supported project of the Division of Health Systems Engineering, in collaboration with Louis J. Boucher, Associate Dean, School of Dentistry, at the Medical College of Georgia. Presented in part to the Academy of Denture Prosthetics, Detroit, Michigan, in 1971; published in part in the Journal of Prosthetic Dentistry, 27:329, March 1972.

systematically in respect to their effects on the requirement for such services. Specific objectives of the study were to:

- (1) obtain estimates of the prevalence of various kinds of complete and partial edentulousness requiring specific prosthetic treatment in the U.S. civilian population through 1985;
- (2) project the availability of prosthodontic services offered by active non-Federal dentists through 1985;
- (3) estimate the resulting level of untreated prosthodontic service requirements through 1985.
- (4) ascertain the effects on levels of untreated edentulousness of alternative dental health strategies.

The Dental Health Services "System"

The relationships between the requirements for and the supply of a "typical" dental service are complex and time-varying (Fig. 12). The actual level of dental disease (epidemiological need) is shown to be dependent primarily upon population growth and dental disease prevalence rates. Demand for the service is dependent upon not only the existence of epidemiological need, but also individual awareness of the desirability of treatment, personal financial resources, and prices of various forms of the service. The supply of services ordinarily is directed by the dentist toward satisfaction of visible demand for the service, and results in subsequent alleviation of only a portion of the accumulated epidemiological need.*

*Of course, only a part of the need is ever realized as demand for services. Even if dental care were "free", there would probably be a significant number of persons who, for various reasons, would not seek treatment.

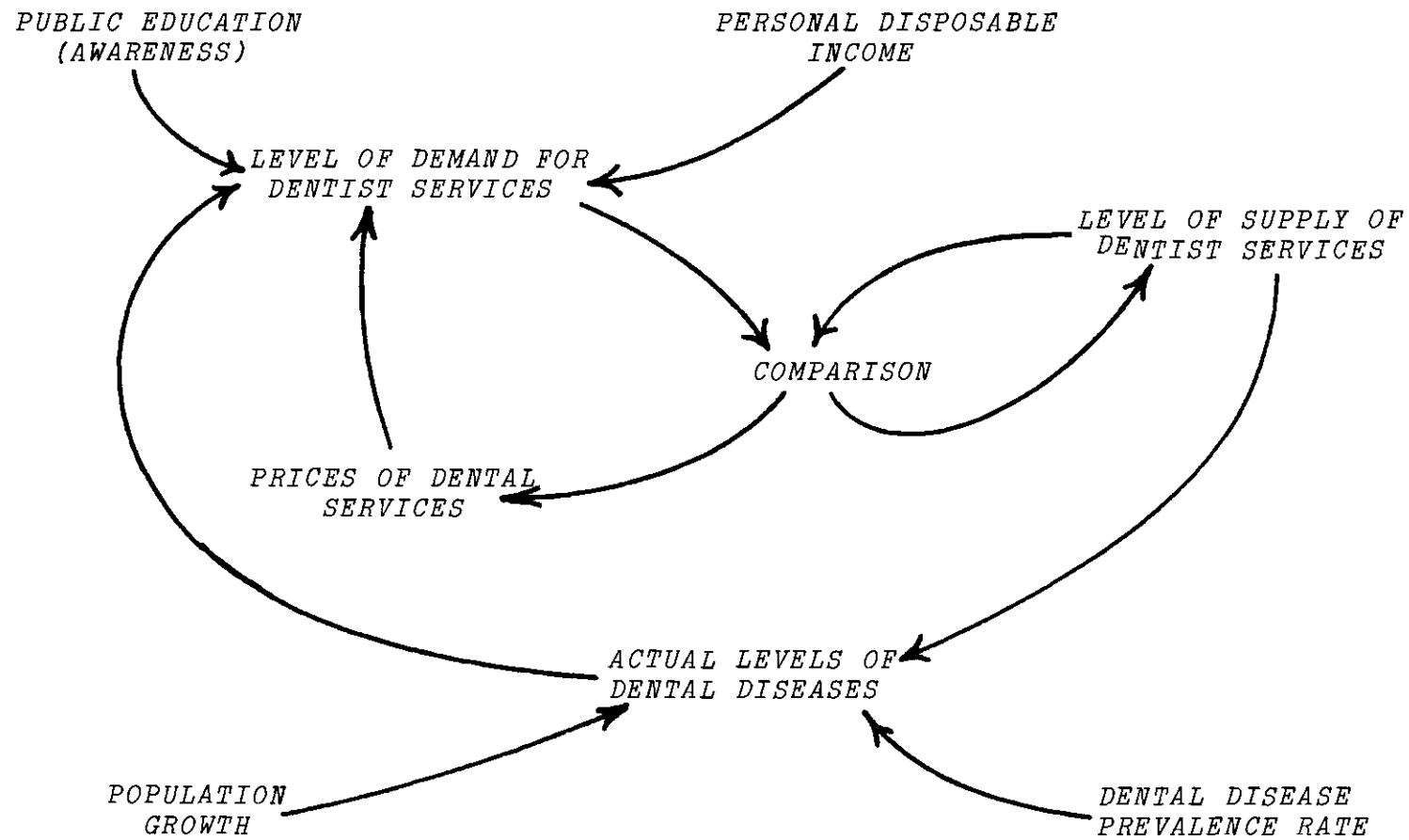


Figure 12. General Relationships Among Elements of the Dental Health Services System.

The study of the need for and availability of prosthodontic services was conducted within the framework of this "system" concept. The elements of the system were represented in the study by projected trends in (a) population growth, (b) prevalence of edentulousness, and (c) dentist time allocated to prosthodontia. A common unit -- dentist chairside hours -- was adopted as a measure of both the requirements for and the supply of services.

Premises of the Study

Most of the projections of the case study were based upon quantitative analyses of historical data related to dental disease and dental practice. Certain assumptions were adopted as reasonable conjecture in the absence of adequate data. All the essential premises of the study are described briefly in the following paragraphs.

- (1) Population Estimates - The population projections of this report are the 1970 Series B projections of the U. S. Bureau of the Census for the 18-79 year-old civilian population.¹⁴⁴
- (2) Prevalence Rates - It was assumed that the prevalence rates for various forms of edentulousness reported in the National

¹⁴⁴U. S. Department of Commerce, Bureau of the Census, Projections of the Population of the United States by Age and Sex (Interim Revisions): 1970 to 1985, Population Estimates and Projections, Series P-25, No. 448: 8-11, 1970.

Health Survey of 1961-62¹⁴⁵⁻¹⁴⁷ would be adequate for the purpose of examining trends in levels of untreated edentulousness beyond 1962. These rates, for persons in the 18-79 age civilian population, were estimated to be approximately:

- a. Full edentulousness: 4.0 percent
- b. One arch missing: 2.0 percent
- c. 1-32 teeth missing or non-functional: 79.0 percent

- (3) Active, Non-Federal Dentists - Projections of the number of active, non-Federal dentists for the years 1970-1985 were based upon expected trends in the U. S. dentist supply published by the American Dental Association^{148,149}

¹⁴⁵National Center for Health Statistics: Total Loss of Teeth in Adults, PHS Publication No. 1000, Series 11, No. 27, Washington, 1967, U. S. Government Printing Office, pp. 11, 14.

¹⁴⁶National Center for Health Statistics: Decayed, Missing, and Filled Teeth in Adults, PHS Publication No. 1000, Series 11, No. 23, Washington, 1967, U. S. Government Printing Office, pp. 15, 38.

¹⁴⁷National Center for Health Statistics: Selected Dental Findings in Adults by Age, Race, and Sex, PHS Publication No. 1000, Series 11, No. 7, Washington, 1965, U. S. Government Printing Office, p. 15.

¹⁴⁸Bureau of Economic Research and Statistics, American Dental Association: Distribution of Dentists in the United States by State, Region, District, and County, Chicago, 1966, American Dental Association, p. 2.

¹⁴⁹Bureau of Economic Research and Statistics, American Dental Association: Distribution of Dentists in the United States by State, Region, District, and County, Chicago, 1969, American Dental Association, p. 2.

and the Department of Health, Education and Welfare.¹⁵⁰

(4) Total Dentist Chairside Time - The average numbers of hours spent annually at the chairside by each active, non-Federal dentist were based upon the chairside times reported in recent American Dental Association surveys of dental practice.¹⁵¹⁻¹⁵⁴

(5) Total Prosthodontic Chairside Time - The average percentages of total annual chairside time spent in providing various prosthodontic services were derived from analysis of the 1950, 1953, and 1959 American Dental Association surveys of

¹⁵⁰U. S. Department of Health, Education, and Welfare: Manpower Supply and Educational Statistics for Selected Health Occupations, PHS Publication No. 263, Section 20, Washington, 1969, U. S. Government Printing Office, pp. 79-86.

¹⁵¹Bureau of Economic Research and Statistics, American Dental Association: The 1959 Survey of Dental Practice, Chicago, 1961, American Dental Association, pp. 40, 41.

¹⁵²Bureau of Economic Research and Statistics, American Dental Association: The 1962 Survey of Dental Practice, Chicago, 1964, American Dental Association, pp. 38-40.

¹⁵³Bureau of Economic Research and Statistics, American Dental Association: 1965 Survey of Dental Practice, J. Amer. Dent. Association 73: 138-140, 1966.

¹⁵⁴Bureau of Economic Research and Statistics, American Dental Association: The 1968 Survey of Dental Practice, Chicago, 1969, American Dental Association, pp. 24,25.

dental practice,¹⁵⁵⁻¹⁵⁷ reports of the Bureau of Economic Research and Statistics¹⁵⁸ and the National Center for Health Statistics,¹⁵⁹ and the Tufts Survey of 1970.¹⁶⁰ These percentages were estimated to be approximately:

- a. 1962-1970: 13 percent of total annual chairside time
- b. 1971-1985: 15 percent of total annual chairside time
- c. Complete denture work: 33 percent of prosthodontic chairside time
- d. Crowns, bridges and partial dentures: 67 percent of prosthodontic chairside time.

(6) Prosthetic Operation Times - The average times required to perform specific prosthetic operations were based upon study results published by Klein, Dollar, and Bagdonas

¹⁵⁵Bureau of Economic Research and Statistics, American Dental Association: The 1950 Survey of the Dental Profession, Chicago, 1951, American Dental Association, pp. 33-38.

¹⁵⁶Bureau of Economic Research and Statistics, American Dental Association: The 1953 Survey of Dental Practice, Chicago, 1954, American Dental Association, p. 24.

¹⁵⁷Bureau of Economic Research and Statistics, American Dental Association: The 1959 Survey of Dental Practice, Chicago, 1961, American Dental Association, pp. 63-72.

¹⁵⁸Bureau of Economic Research and Statistics, American Dental Association: Expenditures and Prices for Dental and Other Health Care, 1935-1968, J. Amer. Dent. Assn. 49: 1447-1450, 1969.

¹⁵⁹National Center for Health Statistics: Volume of Dental Visits, United States, July 1963-June 1964, PHS Publication No. 1000, Series 10, No. 23, Washington, 1965, U.S. Government Printing Office, p. 4.

¹⁶⁰Biodental Engineering Research Project: Tufts Survey of Dental Practice, Monograph 1, Medford, Mass., 1970, Tufts University, p. 13.

in 1947.¹⁶¹ Although these times probably have changed somewhat since 1947, they were considered to be adequate order-of-magnitude estimates for purposes of the present study. The times were estimated to be:

- a. Complete upper and lower dentures: 3.36 hours
- b. Complete upper denture: 2.25 hours
- c. Complete lower denture: 2.35 hours
- d. Crown: 2.88 hours
- e. Bridge: 3.13 hours
- f. Partial denture: 2.02 hours
- g. Denture rebase: one-sixth of the original operation time.*

(It was assumed that rebase of each complete denture would be required after 5 and 10 years of denture wear and that the denture would be remade after 15 years.**)

- (7) Demand and Supply - It was assumed that the demand for prosthodontic services will equal or exceed the available supply of these services through 1985.***

*Estimate from interviews with faculty members of the School of Dentistry, Medical College of Georgia.

**Personal correspondence with Julian B. Woelfel, D.D.S., The Ohio State University College of Dentistry, Columbus, Ohio, May 16, 1971.

***It is clear that the dentist will not allocate more of his time to denture prosthetics than is required to meet patients' demands for these services. In the absence of adequate data on consumer demand behavior and specific dentists' reactions to that behavior, simple projections of dentist time spent in prosthodontics were adopted. The above assumption is thus implied.

A Model for Estimating Prosthodontic Services Requirements

As a result of the limitations imposed by availability of data regarding the prevalence of edentulousness, prosthodontic services were placed into two categories: (1) complete dentures and (2) crowns, bridges (fixed partial dentures) and removable partial dentures. A mathematical model was then developed to estimate annual levels of untreated edentulousness requiring each category of prosthetic services. A conceptual flow diagram of the essential elements of the complete dentures model is presented in Figure 13. Details of the model formulation and computer programs are described in Appendix B. The method of calculation of requirements for the complete dentures service category consists of the following steps for any one year of the period under study:

- A. From each year's projected 18-79 age population are subtracted both the number of untreated edentulous persons from the previous year and the number of persons who previously had received complete upper and lower dentures.* The remaining number of persons thus becomes the current year's "susceptible" population.
- B. To this susceptible population are applied the prevalence rates (P.R.) for full and one-arch edentulousness and the times (T) required to treat these needs. The result is the number of dentist-hours of need for new complete dentures.

*Persons treated previously for one-arch edentulousness are included again in the susceptible population since they may subsequently require a complete denture for the other arch.

To this result are added the time requirements for rebasing dentures made 5 and 10 years previously and for remaking dentures made 15 years previously. The resulting total time represents the number of dentist-hours of additional complete denture need at the beginning of the current year.

- C. At this point, the previous year's balance of dentist-hours of untreated need is added to the current need to obtain the first-of-the-year gross level of need.
- D. To the number of active, non-Federal dentists projected for the current year are applied the average total number of chairside hours per dentist (C.H.) for the year and the expected percentage of chairside time (%) allocated to the complete dentures category. This calculation yields the projected number of dentist-hours devoted to complete denture prosthetics for the year.
- E. The projected number of dentist-hours of complete denture services to be rendered during the year is subtracted from the first-of-the-year gross level of need to obtain the end-of-year balance of untreated complete denture need in dentist-hours.
- F. This sequence of calculations was repeated (with a digital electronic computer) for each of the years in the projection period.

A mathematical model similar to the one described for complete dentures, was used to estimate levels of untreated edentulousness for the category of crowns, bridges, and partial dentures. However, this

second model did not include consideration of a "rebase" or "remake" requirement. Patients who had received a crown, bridge, or partial denture in a previous year were not subtracted from each year's 18-79 age population before the prevalence rates were applied. Since these patients might subsequently require additional crowns, bridges, or partial dentures, they were assumed to remain a part of the susceptible population.

Projected Service Requirements

Using the mathematical models, assumptions, and data described earlier, estimated levels of untreated prosthodontic need were calculated for each service category for each of the years 1962 through 1985. The results of these calculations are presented graphically for the complete dentures category in Figure 14 and for the category of crowns, bridges, and partial dentures in Figure 15.

For both categories, the levels of untreated need (millions of dentist-hours) continue to accumulate through 1985 due to the widespread prevalence of complete and partial edentulousness, the increasing size of the 18-79 age civilian population, and the relatively small marginal increases in numbers of dentists each year. The trend line for complete dentures (Figure 14) indicates a decreasing rate of increase in untreated need through 1976. However, due to the pronounced effects of the newly-introduced "15-year remake" feature of the estimation model, the trend line experiences an upturn in 1977 and continues to increase at a nearly constant rate through 1985.

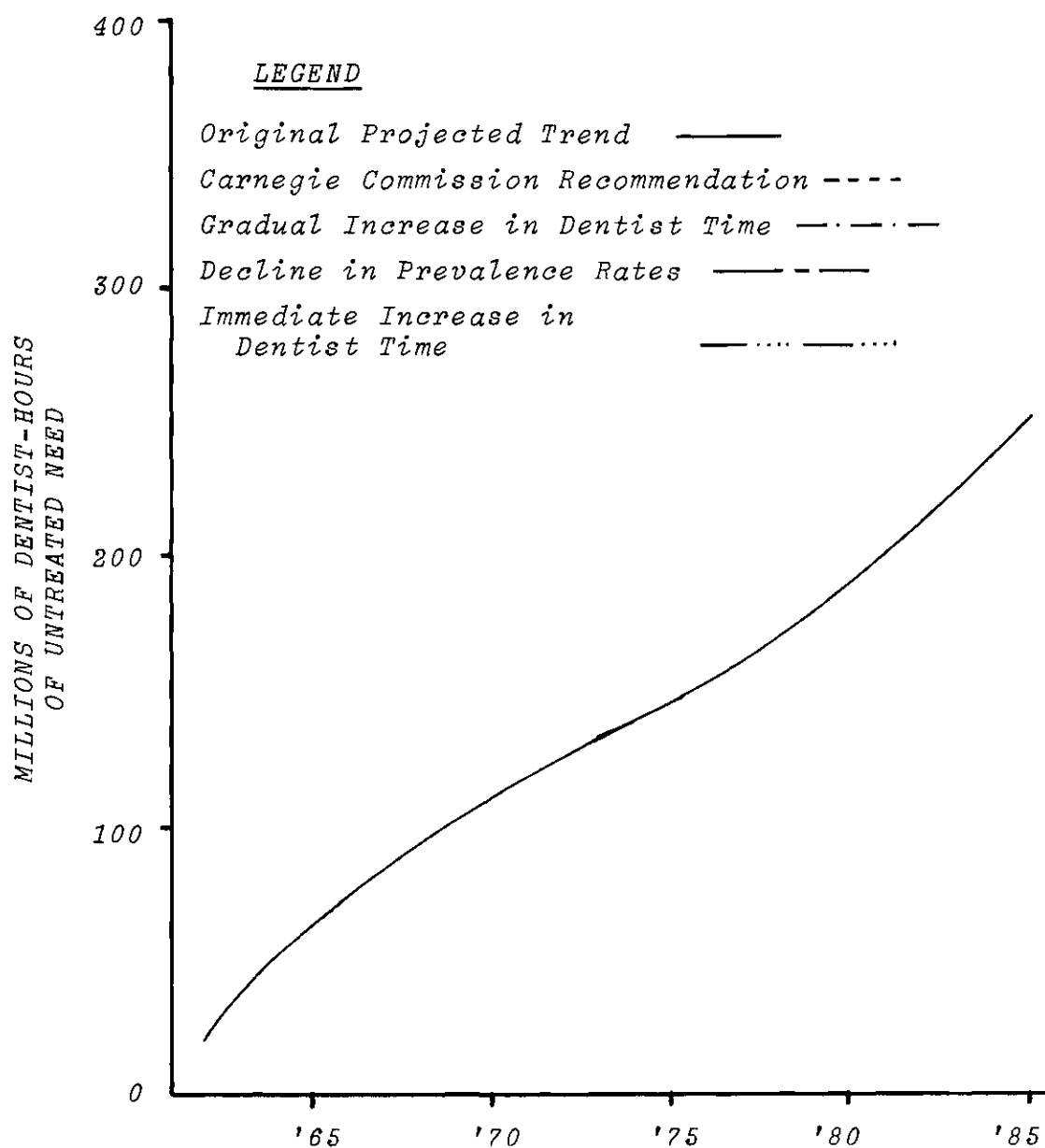


Figure 14. Projected Level of Untreated Need for Complete Dentures through 1985.

The level of untreated need for crowns, bridges, and partial dentures is shown to increase rapidly from 1962 to about 1965 (Figure 15). Beginning in 1965, the gradually increasing number of dentist-hours devoted to these services reduces somewhat this rapid rate of accumulation and the level of untreated need continues to rise through 1985 at a relatively constant rate.

Alternative Strategies

In order to examine the degree to which these projected trends in untreated edentulousness might be affected by various kinds of dental health programs, some of the original assumptions in the projection models were changed to represent the effects of three such programs. Specifically, changes in (a) prevalence rates of edentulousness, (b) percentages of dentist time allocated to prosthodontia, and (c) planned dental school enrollments, respectively, were introduced independently to represent the individual effects of each of three "type" approaches. The effects of these changes on the accumulation of untreated prosthodontic need are discussed in the following paragraphs and are presented graphically in Figures 16 and 17.

Declining Prevalence Rates

To represent the strategy of expanding health-directed programs such as water fluoridation, public school dental nurse programs, and oral disease control training, and placing greater emphasis upon personal preventive dentistry, it was assumed that the prevalence rates for complete and partial edentulousness would be reduced gradually by 50 percent over the period from 1971 to 1985. This change in the model

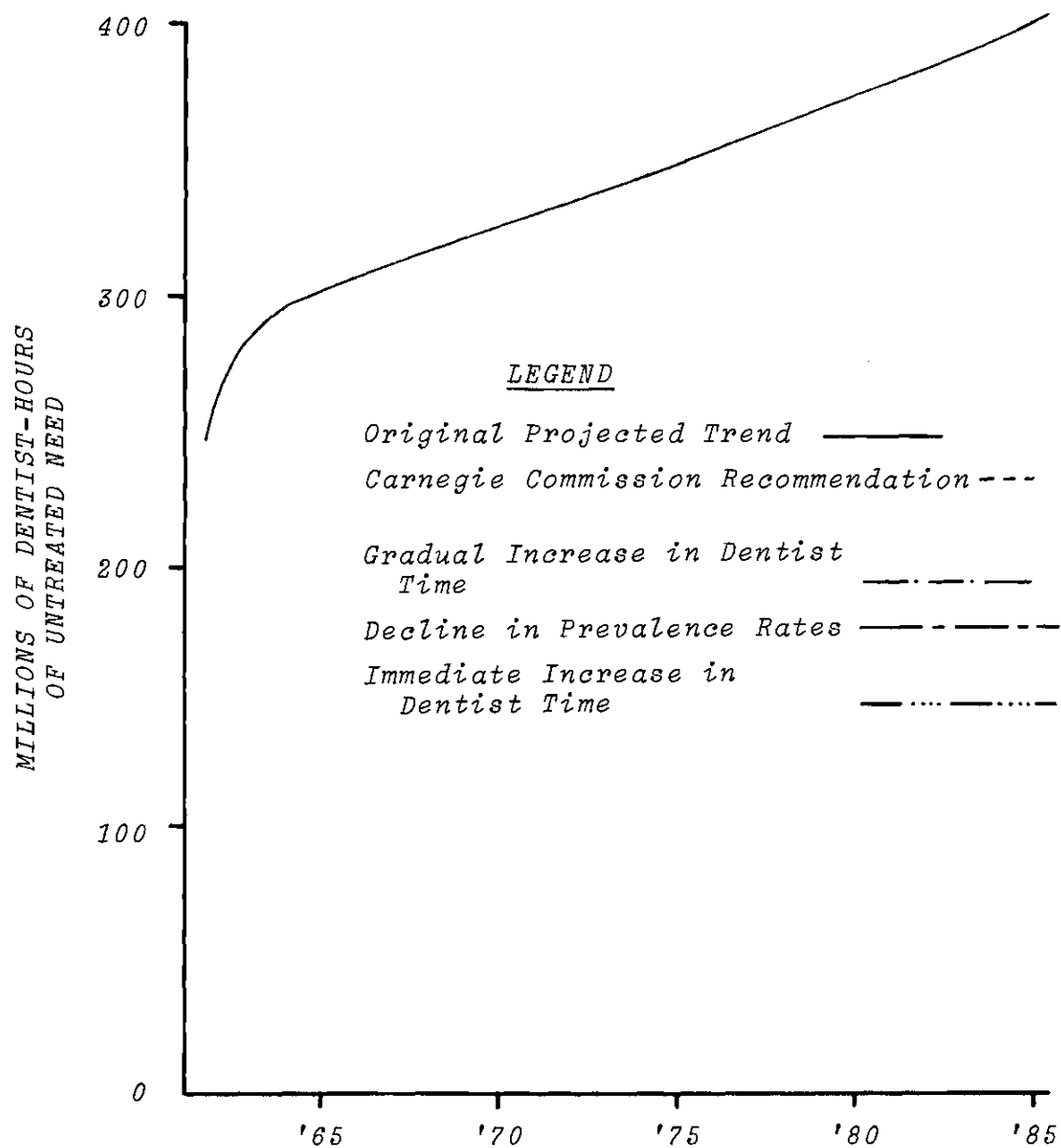


Figure 15. Projected Level of Untreated Need for Crowns, Bridges, and Partial Dentures through 1985.

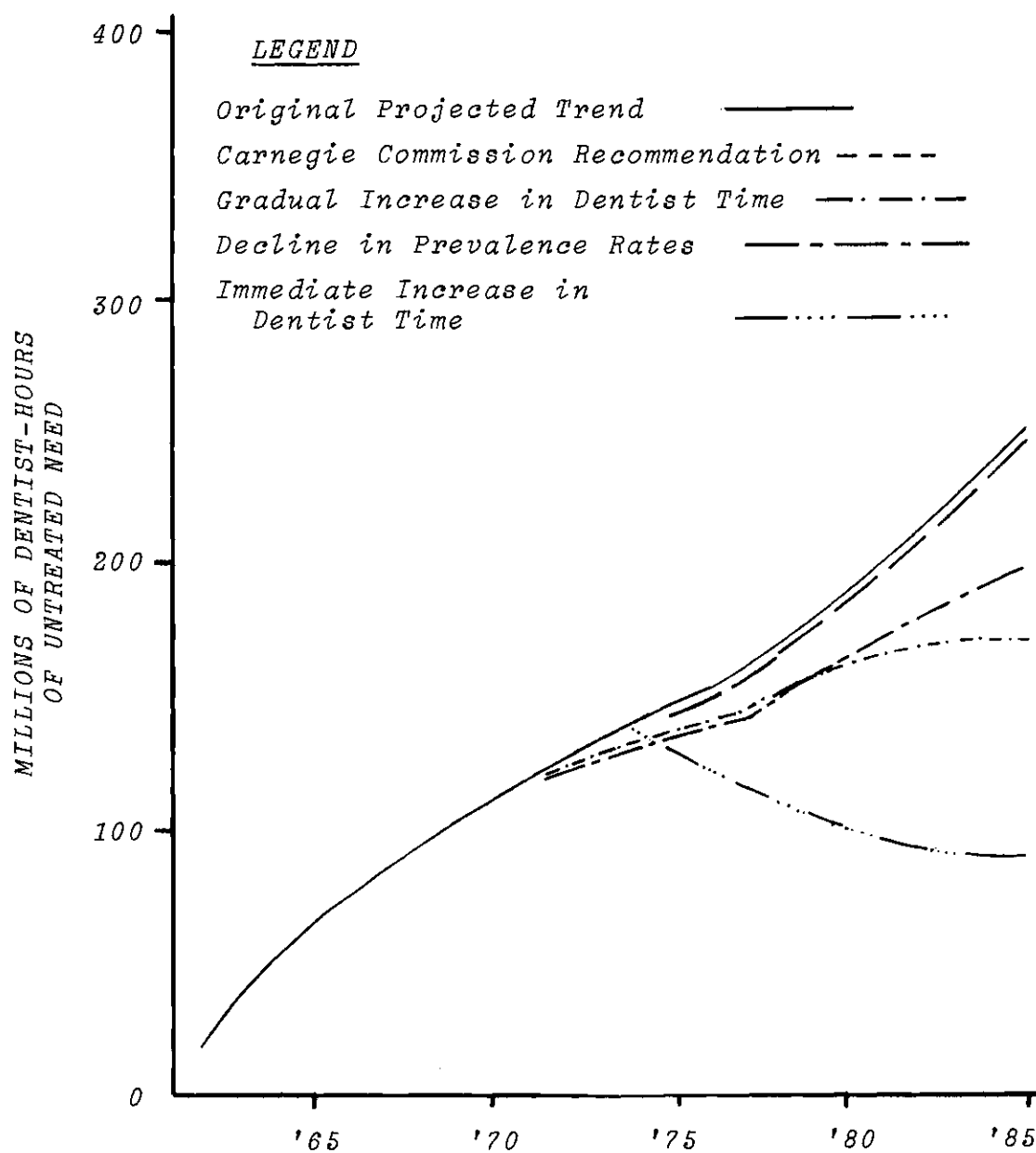


Figure 16. Effects of Alternative Programs on the Level of Untreated Need for Complete Dentures.

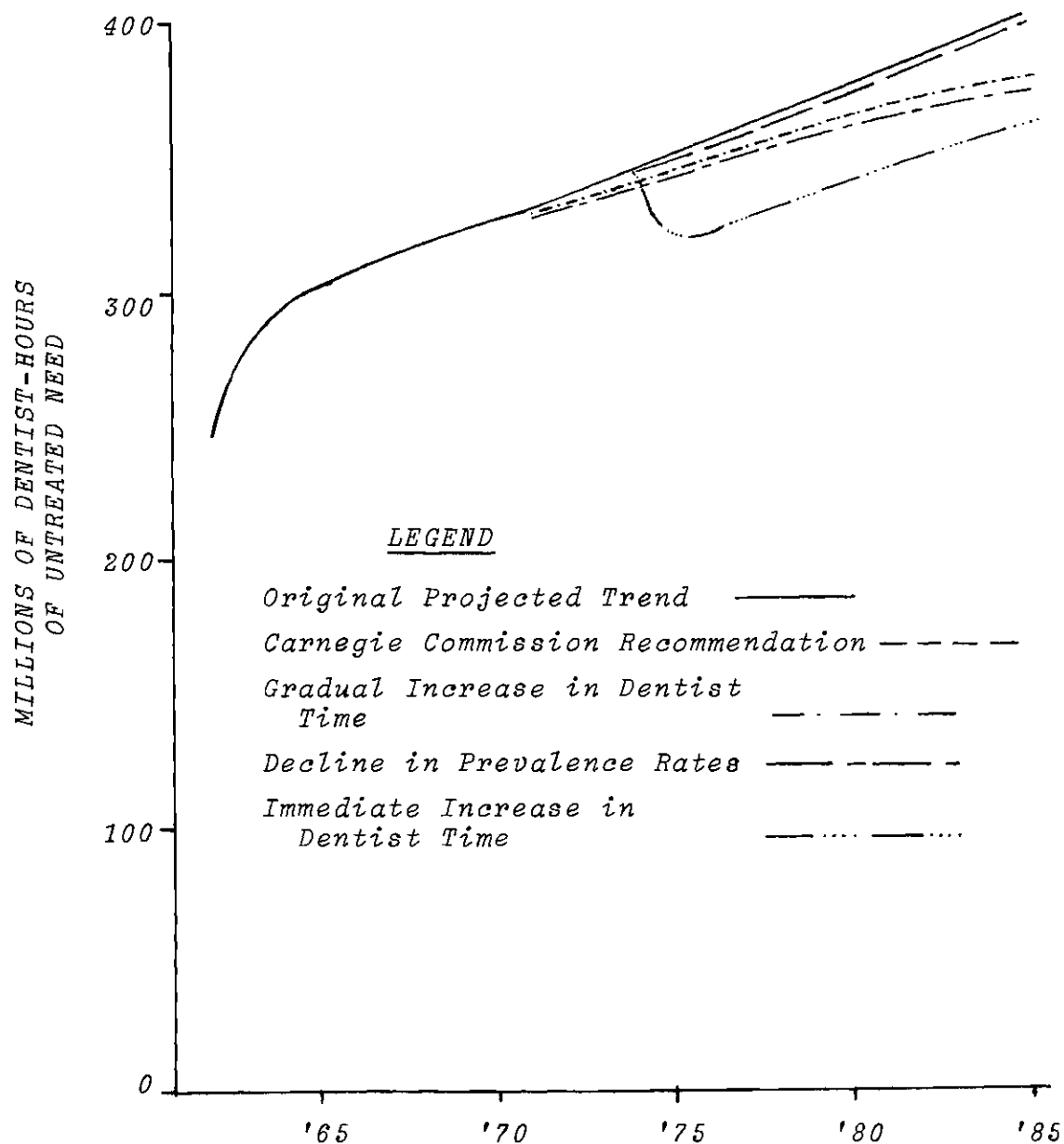


Figure 17. Effects of Alternative Programs on the Level of Untreated Need for Crowns, Bridges, and Partial Dentures.

resulted in new trend lines (Figures 16 and 17) which represent approximately an 18 percent reduction in projected levels of untreated need for the complete dentures category and a 7 percent reduction in untreated need for the crowns, bridges, and partial dentures category by 1985.

Gradual Increases in Time Allocation

To represent an approach that would yield small annual increases in dentist chairside time devoted to prosthodontia, such as could accrue gradually if dentists employed expanded-function auxiliaries on a substantial scale, it was assumed that the percentage of dentist chairside time allocated to prosthetic services would gradually increase from about 15 percent in 1970 to 30 percent in 1985.* The new trend lines (Figures 16 and 17) which represent the effects of these assumed changes reflect approximate reductions of 28 percent and 7 percent, respectively, in levels of untreated need for the categories of complete dentures and crowns, bridges, and partial dentures by 1985.

Immediate Increase in Time Allocation

The advent of programs such as Federally-financed national health plans could accelerate dramatically future demands for prosthodontic services. Dentists' reactions to higher demands for services could result in the immediate allocation of substantially larger quantities of chairside hours to prosthodontics, especially as prices rise in the face of such demand. To represent this phenomenon, a 40 percent

*A gradual increase of this magnitude might result from dentists' responses to gradual changes in consumer demands for prosthetic services arising from improved public education, rising incomes, the advent of more widespread dental insurance, and/or stable prices of prosthodontic services.

allocation of dentist chairside time to prosthodontia was assumed to occur in 1975 and to remain at that level through 1985.*

For the complete dentures category (Figure 16), this assumption yields about a 65 percent decrease in the original projected level of untreated need by 1985. Apparently, an immediate 40 percent allocation of dentist time to an essentially non-recurring problem such as complete edentulousness could alleviate the need at a faster rate than it accumulates.

A somewhat different result (Figure 17) was observed for the category of crowns, bridges and partial dentures. The trend line produced by the immediate 40 percent dentist time allocation assumption reflects a reduction in untreated need of about 7 percent during 1975 to a level which remains fairly constant through 1976. In 1977, the level of untreated need once again begins to rise at approximately the previous rate of accumulation. By 1985, there appears to be about a

*In some third-party payment programs such as the Los Angeles Hotel-Restaurant Employer-Union Welfare Fund Dental Care Program¹⁶² and the Medicaid program in New York City,¹⁶³ considerable increases in utilization of otherwise relatively costly dental services have been observed. In the Los Angeles program, as the effective cost to the patient was reduced, the proportion of dentist chairside time spent in prosthodontia rose to about 40 percent.¹⁶⁴

¹⁶²Friedman, Jay W.: The Dental Care Program of the Los Angeles Hotel-Restaurant Employer-Union Welfare Fund, Summary Report of an Evaluation, Los Angeles, 1970, the Regents of the University of California, pp. 26-27.

¹⁶³Fisher, Morton A.: New Directions for Dentistry, Amer. J. of Public Health, 60: 850, 851, 1970.

¹⁶⁴Friedman, Jay W.: The Dental Care Program of the Los Angeles Hotel-Restaurant Employer-Union Welfare Fund, Summary Report of an Evaluation, Los Angeles, 1970, the Regents of the University of California, p. 31.

10 percent reduction in the original projected level of untreated need. It appears that the extremely high prevalence rate (79 percent of the population) and the recurrent nature of partial edentulousness, in conjunction with a steadily increasing population, tend to produce needs for crown, bridge, and partial denture services at a rate which exceeds dentists' capacities to treat these needs, even with the assumption of a 40 percent time allocation to prosthodontia.*

Increased Dental School Enrollments

The Carnegie Commission on Higher Education¹⁶⁵ has recommended that there be a 20 percent increase in dental school entrant places by 1980.** This recommendation was the basis for the fourth variation of assumptions. The mathematical models were altered to include an 18 percent increase in the annual number of dental school graduates beginning in 1975, as the result of a 20 percent increase in enrollment in 1971 minus a 10 percent academic attrition rate.***

*As stated earlier, it was assumed that the percentage allocations of prosthodontic chairside time to complete denture work and to crown, bridge, and partial denture work would be 33 percent and 67 percent, respectively.

¹⁶⁵The Carnegie Commission on Higher Education: Higher Education and the Nation's Health, Policies for Medical and Dental Education, McGraw-Hill, Hightstown, New Jersey, 1970, p. 45.

**The Carnegie Commission's recommendation was selected as only an illustrative example of proposed programs of marginal increases in the supply of dentists through substantial increases in dental school enrollment. Other recommendations of a similar order-of-magnitude should yield similar results.

***Includes consideration of both failure to complete the curriculum and choice of a dental career other than professional practice.

The new trend lines (Figures 16 and 17) demonstrate clearly that adoption of this strategy would have relatively little effect upon untreated levels of prosthodontic need. Quantitatively, the reduction in untreated need would be approximately 1 percent for each category of services by 1985. Of course, the results of this variation were to be expected, since an 18 percent increase in the number of dental graduates per year results in an increase of only about one percent in the total number of active, non-Federal dentists already in practice.

Summary of Case Study Conclusions

Given the assumed conditions and relationships upon which the study was based, certain general conclusions follow from the foregoing analyses:

1. The untreated need (but not necessarily the unmet economic demand) for prosthodontic services will, if projected trends in patterns of edentulousness and in the dentist supply continue, accumulate to a level of around 650 million dentist chairside hours by 1985.
2. Programs that promote maintenance of the natural teeth can have significant effects upon accumulation of untreated need for prosthodontic dentistry. Gradual reduction of the prevalence rate of edentulousness by 50 percent could yield a reduction in untreated need of about 75 million dentist chairside hours by 1985.
3. Conditions that would encourage the practicing dentist to spend larger portions (30 to 40 percent) of his chairside

time in prosthetics could yield reductions in the level of untreated prosthodontic need of about 95 million to 190 million dentist chairside hours by 1985. (The effects of such allocations on preventive dentistry and, in turn, on prevalence rates of edentulousness, were not examined.)

4. Proposals to increase the annual number of graduating dentists by about twenty percent by 1975 apparently would yield a reduction in projected levels of prosthodontic need of about 4 million dentist chairside hours by 1985.
5. It apparently follows that combinations of efforts such as those in conclusions two (prevention) and three (30 to 40 percent of dentist chairside time in prosthodontia) above could result in a reduction in the unmet need for denture prosthetics of about 170 million to 265 million dentist chairside hours by 1985.

Discussion of Case Study Results

The precision of each of the numerical results presented in this study is, of course, a function of the extent to which certain assumed conditions and relationships in the mathematical models will be realized in the future. If, however, one views the assumptions and data simply as reasonable order-of-magnitude approximations of reality, then the relative values of trends in the findings can be interpreted meaningfully.

First, it is clear that there is an inherent tendency of various forms of edentulousness to accumulate rapidly among the population. It is clear also that successful prosthetic treatment of either complete

or partial edentulousness does not obviate the necessity for additional prosthetic treatment. Thus, even the most rigorous and competently-rendered programs of denture prosthetics alone cannot -- under conditions of limited public resources -- be expected to alleviate completely present and future problems associated with edentulousness. Indeed, concentration of increasing proportions of dental health resources in denture prosthetics, without compensatory increases in preventive dental programs, might eventually increase the intensity of the problem of edentulousness rather than alleviate it. On the other hand, emphasis upon dentist-intensive preventive programs alone might result in a desirable decrease in edentulousness in the long run, but would allow the backlog of edentulousness to accumulate more rapidly in the shorter run.

Thus, it appears that combinations of manpower strategies (e.g., continuing to produce dentist manpower at the present rate and initiating public paradental manpower programs directed toward specific disease entities among specific population groups) would allow the dentist to devote greater quantities of his time to services that require his skill (e.g., prosthetics) while allowing increasing numbers of public paradental personnel to produce greater quantities of services to preserve the natural teeth.

If the types of analyses presented in this study for prosthodontics could be carried out for the various other categories of dental services, the "trade-off" relationships among these services could be examined more directly and systematically. Unfortunately, existing periodic reports of surveys of dental practice do not contain many

direct measurements or estimates of the kinds needed for studies of the sort reported here. Thus, a great deal of interpretive analysis and a number of assertions are required in order to proceed with such studies. Clearly there is a need for more current quantitative data and for improved knowledge about behavioral issues of the kind discussed in the present study. Existing data-collection mechanisms, such as those of the American Dental Association, seem to offer excellent potential means for collecting these kinds of information in a consistent and accurate manner.

This exploratory study of prosthodontic needs and services has shown that:

- More direct study of health services needs and health manpower capabilities to meet those needs is feasible, even under conditions of limited quantitative data,
- Conclusions drawn from studies such as the one presented here may be quite different from the conclusions of traditional fixed manpower-to-population ratio approaches, and could have profound implications for the formulation of health strategies,
- Difficulties of relating health needs and demands to health services resources can be alleviated by using common units (such as dentist chairside hours) to represent both requirements and supplies,
- Explicit delineation of underlying assumptions and methods of estimation facilitates identification and examination of questionable premises that could affect significantly the

findings of health services studies,

- Areas of dynamic behavior to which the health services system is especially sensitive can be identified and subjected to indepth study, and
- Specifications for improved accuracy and consistency of certain kinds of health and health services data become more definitive.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

This was a study of the structure and behavior of the dental health services system and the implications of that structure and of behavior for the formulation of dental manpower strategies. The general purposes of the study were to clarify some of the issues that relate to dental manpower policy formulation, to identify areas in which manpower policy changes are likely to have significant effects on dental health objectives, and to identify opportunities for improvements in health services planning through health systems research and improved availability of data. This exploratory investigation was based upon information acquired through actual experience in dental manpower planning for the State of Georgia, accounts of other health manpower planning studies and proposals in the literature, a variety of dental practice and public health survey publications, and interviews with dentist educators, researchers, and practitioners.

Conclusions related to degrees of accomplishment of each of the five specific study objectives described in Chapter I are presented in the following paragraphs. Specific conclusions of the study are found in the chapters cited. General conclusions and recommendations related to the purposes of the study are then presented as a framework for further developmental dental manpower research and planning.

The Dental Health Services System

The first study objective was to describe and conceptualize the structure and behavior of the dental health services system. The nature and some of the characteristics of professional dental practice that affect its current and projected status as the principal source of dental services in the United States were described in Chapter III. A conceptual model of the production of a heterogeneous dental services mix was presented as a departure from traditional approaches in order to identify and describe more appropriately the input and output factors that relate to dental services production and productivity issues. It is concluded that the first study objective was achieved satisfactorily in Chapter III.

Dental Services Need and Demand

The second study objective was to describe the character of need and demand for dental services. A definition of dental services need, the nature and quantitative estimates of the prevalence of various dental diseases, and some determinants, measures, and quantitative trends in economic demand for dental services were presented and discussed in Chapter IV. The wide disparity between the known incidence of dental disease and the public's desire and ability to purchase dental services was identified and discussed. It is concluded that the second study objective was achieved in Chapter IV.

Alternative Dental Manpower Strategies

The third study objective was to examine alternative dental manpower planning criteria and their utility in formulating rational

dental manpower strategies. Several categories of such criteria, and the manpower strategies that flow from their use, were described in Chapter V in the contexts of the conceptual dental services supply and requirement considerations developed in earlier chapters. Two general conceptual approaches to dental health services planning, representing traditional profession-oriented versus potential health-directed dental manpower strategies, were then compared as to their relative costs and effectiveness in achieving dental health objectives. Thus, it is concluded that the third specific study objective was accomplished in Chapter V.

Illustrative Case Study

The fourth study objective was to develop an illustrative application of quantitative modeling and analysis to a specific set of dental health problems and services to evaluate the effects of some alternative strategies on specific measures of dental health levels. A case study of prosthodontic services and edentulousness in the United States, using available actual data, was the vehicle for demonstration of the applicability of quantitative methods to dental health services planning. The results of the case study of Chapter VI demonstrated the applicability of such methods, even under conditions of limited availability of data, and, thus, constitute achievement of the fourth study objective.

General Conclusions

Health manpower planning continues to be a dominant focus of the national search for means to improved levels of public health. Yet,

this focus appears to be confined to prevailing traditional patterns of manpower organization and practice that are managed by the independent health professional entrepreneur and promulgated by his representative professional organizations. This approach is not unexpected, of course, when one considers that most health manpower planning efforts and resulting policy recommendations are conducted, proposed, and carried out by representatives of the professions that ultimately are affected. It is important to recognize also that health manpower goals are not necessarily coincident with public health goals. Nevertheless, traditional health manpower planning efforts, directed typically toward primary professional manpower targets, have left unexamined both the anticipated and ex post facto public health benefits to be derived from recommended manpower programs.

This exploratory study of the present dental health services system, levels of dental disease, and demand for dental services has produced considerable evidence that traditional approaches to dental health planning in the United States, through specification of dentist manpower targets and production of increasing numbers of dentists alone, may yield negligible effects on levels of dental disease. Moreover, it appears that recently-proposed programs to supplement the dentist's practice with expanded-function dental ancillary personnel share some of the shortcomings of dentist manpower programs and may offer few, if any, economies or dental health benefits to the general public. Of course, to the extent that the dental profession and the public can generate sufficient economic demand and political pressure, increasing numbers of dentists probably will continue to be produced.

That such a trend constitutes a rational policy for the allocation of public resources to dental health objectives is not supported by available information and the analyses of this study.

Health-directed dental manpower programs, such as the state-operated New Zealand school dental nurse program, supplemented by contractual agreements with a stabilized supply of private dentists, appear to offer clear public dental health benefits and economies beyond those available under traditional profession-oriented manpower programs. As with supplementary fluoridation programs, health-directed dental manpower programs, particularly those aimed at the dental health of children, can delay significantly the onset and permanent effects of dental disease and can reduce the general requirement for dentist manpower without affecting adversely the economic or professional status of the dentist.

In summary, this study has shown that traditional approaches to dental health planning through formulation and implementation of expanded profession-oriented manpower programs are relatively ineffective and uneconomical dental health strategies. Conceptually, it was demonstrated that new manpower programs could be formulated and implemented to achieve specific dental health objectives in a relatively economical fashion. The value of the systems-analytic point of view was demonstrated throughout the study as previously-unstructured relevant issues were conceptualized and used as the context of logical argument that yielded the above conclusions.

The principal contributions of the present study were: synthesis of conceptual descriptions of the dental services system and of

dental services requirements; description and evaluation of alternative conceptual dental manpower planning approaches and their effects on dental health; and application of these concepts to a particular set of dental services and dental health problems. The results of this study should enable the dental health systems researcher to select areas of study with improved knowledge of the potential whole-system effects of his research. The findings of this study also should provide an improved framework within which the effects of proposed dental manpower programs can be assessed more systematically and with greater objectivity.

This study has produced considerable evidence that traditional dental manpower strategies, implemented through the current structure and philosophy of private dental practice and involving dependence upon existing public expenditure patterns for dental services, may have negligible marginal effects on levels of dental disease. Public paradental manpower strategies directed toward specific dental disease entities and population groups, were shown to offer significant public health advantages over traditional approaches alone. It was demonstrated further that combinations of private and public manpower programs can be feasible, effective, and more economical alternatives to the present exclusively private enterprise system for the delivery of dental services, without detriment to the dental profession.

This study also has contributed to identification of data and information sources relevant to the study of dental manpower and health issues, has demonstrated the utility and shortcomings of a variety of available data, and has indicated the need for improved information in a number of specific areas.

Recommendations for Further Study

The present study was an attempt to examine a relatively complex, ill-understood area of public health policy from an objective point of view. Virtually all previous studies in this area of inquiry have been confined to intra-professional matters such as improvements in efficiency within the health professional's practice and within other existing health care institutions. Understandably, few attempts had been made previously by industrial and systems engineers to address such problems. Accustomed to working within existing objectives and policy constraints of institutions as staff consultants, industrial and systems engineers ordinarily would not be expected to participate in extensive inquiry or challenge beyond those boundaries. Yet, as has been demonstrated in the present study, the results of such inquiry can lead to reexamination and possible restructuring of institutional policy in the public interest.

Clearly, in the present study the issues addressed have not been resolved. The findings of the study challenge convention, but need themselves to be challenged or corroborated. It is suggested, therefore, that the following areas of inquiry would be appropriate as follow-on and developmental research in the area of dental health and manpower planning:

- Development and cost/benefit evaluation of specific health-directed dental manpower programs and policies, such as state-sponsored school and community dental nurse programs.

- Development and evaluation of intra-professional incentives to promote control of, as opposed to only intervention in, dental disease and the passing on of economies of dental practice to the public.
- Further exploration of the social, economic, health, and political implications of specific dental services and manpower strategies through whole-system modeling, analysis, and design approaches, such as those of Forrester's industrial dynamics methodologies.
- More extensive participation and education of industrial and systems engineers in public health policy matters, to promote development of informed and interested academicians, researchers, and practitioners whose contributions to public health policy formulation and program development can be substantial.

APPENDIX A
DENTAL EDUCATIONAL COST ANALYSIS

DENTAL EDUCATIONAL COST ANALYSIS

In order to analyze the cost of dental education, various component cost factors which contribute to the total cost of dental education at the Medical College of Georgia School of Dentistry were individually analyzed. These cost factors included: the amortized cost of the Dental Clinical Services Building and the Dentistry portion of the Research and Education Building; faculty and non-faculty payroll and fringe benefits; normal operating expenditures; miscellaneous indirect costs; amortized costs of loose office and dental equipment; and intern and resident student stipends.

The total equivalent annual cost associated with each of these factors was computed using conservative estimates of the time value of money (i.e. interest rates) and useful life expectancies of facilities and equipment. Also considered were two revenue factors, tuition and clinic income, which made it possible to estimate net costs of dental education. The detailed methods used in calculating these costs and revenues are outlined in this appendix.

Costs and revenues associated with extramurally - funded research programs were not included in the cost-per-student estimates and projections of this report. The primary difficulty encountered in attempting to incorporate such estimates was that only gross projections of research funding through 1974 were available. Moreover, these projections of research funding were not program-specific and, thus, could not be apportioned easily among research and educational programs.

Bases for Apportioning Costs and Revenues

Since the objective of the analysis was to estimate costs on a per-dental-student basis, guidelines for apportionment of costs among student users of School of Dentistry resources were established. The following assumptions, formulated by the administrative officers of the School of Dentistry, were used for apportioning costs and revenues:

- (1) Costs should be apportioned among dental students, advanced education students (graduate and postgraduate students), dental hygiene students, dental assistant students, and dental technician students.
- (2) Apportionment among these student groups should be based upon the relative amount of use of dental facilities and faculty by each of the groups.
- (3) The Allied Health Sciences (Hygienists, Assistants, and Technicians) students will be considered equal to dental and advanced education students with regard to apportioning facilities and faculty costs, but will participate in all other costs according to their "dental student equivalent" as illustrated in Table .

By using these assumed equivalence relationships, each student group's yearly projected enrollment total (Table A23) was converted to an equivalent number of dental students for each cost and revenue category within each fiscal year (Table A24). By adding together the dental student equivalents for a given cost or revenue category within a given year, the total equivalent number of dental students to be used for calculating the per-dental-student cost or revenue for that particular category and year was derived.

Having derived the foregoing information, the cost or revenue per dental student per year for each category was computed by dividing the total projected equivalent annual cost (EAC) or income associated with each category (factor) by the equivalent dental student enrollment (EDSE). The results of these computations are presented in the various tables throughout Appendix A.

The total cost of dental education per dental student is displayed in the summary table (Table A25). It is important to note that, due to the apportionment guidelines suggested by the administrative officers of the School of Dentistry, the total net cost per dental student is the same for both undergraduate and advanced education students; the total gross cost per dental student differs between the two groups by only the amount of the undergraduate student kit cost. These results do not reflect the cost per student of the Allied Health Sciences educational programs.

The results of this analysis are strongly dependent on the assumptions made through the study. It is for this reason that important assumptions are clearly stated and their sources identified for each component of the analysis.

Table A-1. Dental Clinical Services Building Amortized
Facility Cost Per Dental Student Per Year*

40 YEAR AMORTIZATION		
YEAR	FEDERAL \$	STATE \$
1969-1970	4,351.31	2,143.18
1970-1971	2,353.26	1,159.07
1971-1972	1,226.70	604.19
1972-1973	784.42	386.36
1973-1974	662.70	326.40
1974-1975	613.35	302.10

ASSUMPTIONS:

1. Zero salvage value at end of amortization period.
2. 5% interest rate for amortization.
3. Federal and State funding are 67% and 33% respectively.
4. 40-Year useful life of faculty.

*See Appendix A for methodology.

Table A-2. Research and Education Building Amortized
Facility Cost Per Dental Student Per Year*

40 YEAR AMORTIZATION		
YEAR	FEDERAL \$	STATE \$
1969-1970	1,711.14	842.80
1970-1971	925.41	455.80
1971-1972	482.40	237.60
1972-1973	308.47	151.93
1973-1974	260.60	128.36
1974-1975	241.19	118.80

ASSUMPTIONS:

1. Zero salvage value at end of amortization period.
2. 5% interest rate for amortization.
3. Federal and State funding are 67% and 33% respectively.
4. 40-Year useful life of facility.

*See Appendix B for methodology.

Table A-3. Personnel Expenditures Projected Payroll
Cost Per Dental Student Per Year*

YEAR	FACULTY		NON-FACULTY		TOTAL COST PER STUDENT
	TOTAL PAYROLL	COST PER STUDENT	TOTAL PAYROLL	COST PER STUDENT	
1969-1970	(Faculty + Non-Faculty Payroll = 849,252.21)				20,463.91
1970-1971	1,030,874.00	12,420.17	246,580.00	2,970.84	15,391.01
1971-1972	1,453,532.34	9,469.27	551,136.37	3,590.46	13,059.73
1972-1973	1,793,919.24	7,816.64	720,151.52	3,137.92	10,954.56
1973-1974	2,172,482.20	8,046.23	900,568.43	3,335.44	11,381.67
1974-1975	2,324,555.95	7,800.52	962,694.60	3,230.52	11,031.04

ASSUMPTIONS:

1. 7% increase in faculty salaries per year.
2. 4% increase in non-faculty salaries per year.

*See Appendix C for methodology and personnel projections.

Table A-4. Indirect Cost Projected Fringe Benefit
Cost Per Dental Student Per Year.

YEAR	TOTAL PAYROLL*	TOTAL FRINGE BENEFIT COST	COST PER STUDENT PER YEAR
1969-1970	849,252.21	114,649.05	2,762.63
1970-1971	1,277,454.00	172,456.29	2,077.79
1971-1972	2,004,668.71	270,630.28	1,763.06
1972-1973	2,514,070.76	339,399.55	1,478.87
1973-1974	3,073,050.63	414,861.84	1,536.53
1974-1975	3,287,250.55	443,778.82	1,489.19

SOURCE:

Institutional policy designates the fringe benefit cost to be 13.5% of total payroll.

*Payroll figures are from Appendix D.

Table A-5. Normal Operating Expenditures Projected
Cost Per Dental Student Per Year*

YEAR	OPERATING EXPENSE PER YEAR	COST PER STUDENT PER YEAR
1969-1970	94,361.36	2,273.77
1970-1971	141,939.33	1,710.11
1971-1972	222,740.97	1,451.08
1972-1973	279,341.20	1,217.17
1973-1974	341,450.07	1,264.63
1974-1975	365,250.06	1,225.67

ASSUMPTIONS:

Normal operating expense is assumed to be approximately 10% of total direct cost based upon the 1969 Fiscal Year Financial Report for the Medical College of Georgia.

*See Appendix D for methodology.

Table A-6. Miscellaneous Indirect Cost Projected
Cost Per Dental Student Per Year.

YEAR	TOTAL DIRECT COST*	MISCELLANEOUS INDIRECT COST	COST PER STUDENT PER YEAR
1969-1970	943,613.57	188,722.71	4,547.54
1970-1971	1,419,393.33	283,878.67	3,420.22
1971-1972	2,227,409.68	445,481.94	2,902.16
1972-1973	2,793,411.96	558,682.39	2,434.35
1973-1974	3,414,500.70	682,900.14	2,529.26
1974-1975	3,652,500.61	730,500.12	2,451.34

ASSUMPTIONS:

Miscellaneous indirect cost is assumed to be approximately 20% of total direct cost.

*Direct cost figures are from Appendix D.

Table A-7. Dental Clinical Services Building Estimated
Loose Equipment Cost Per Dental Student Per Year*

YEAR	FEDERAL \$	STATE \$
1969-1970	1,519.70	748.51
1970-1971	821.88	404.81
1971-1972	428.43	211.02
1972-1973	273.96	134.94
1973-1974	231.45	114.00
1974-1975	214.21	105.51

ASSUMPTIONS:

1. Zero salvage value at end of useful life.
2. 5% interest rate for depreciation.
3. Federal and State funding are 67% and 33% respectively.

SOURCE:

Dental Clinical Services Building equipment specification listing and
Dr. Thomas J. Zwemer, Associate Dean, School of Dentistry.

*See Appendix E for methodology.

Table A-8. Research and Education Building Estimated
Loose Equipment Cost Per Dental Student Per Year.*

YEAR	FEDERAL \$	STATE \$
1969-1970	193.32	95.22
1970-1971	104.55	51.49
1971-1972	54.50	26.84
1972-1973	34.85	17.16
1973-1974	29.44	14.50
1974-1975	27.25	13.42

ASSUMPTIONS:

1. Zero salvage value at end of useful life.
2. 5% interest rate for depreciation.
3. Federal and State funding are 67% and 33% respectively.

SOURCE:

Research and Education Building equipment specification listing and
Dr. Louis J. Boucher, Associate Dean, School of Dentistry.

*See Appendix F for methodology.

Table A-9. Oral Surgery Cost of Intern and Resident Stipends.

YEAR	INTERN	STIPEND*	RESIDENTS	STIPENDS**	RESIDENTS	STIPENDS***	YEAR	STIPENDS	COST PER DENTAL STUDENT
1969-70	2	13,000	2	14,000	2	15,000	1969-70	42,000	1,400.00
1970-71	2	13,000	2	14,000	2	15,000	1970-71	42,000	617.65
1971-72	2	13,000	2	14,000	2	15,000	1971-72	42,000	328.13
1972-73	2	13,000	2	14,000	2	15,000	1972-73	42,000	218.75
1973-74	2	13,000	2	14,000	2	15,000	1973-74	42,000	184.21
1974-75	2	13,000	2	14,000	2	15,000	1974-75	42,000	164.06

ASSUMPTIONS:

Intern & resident stipends will remain constant

SOURCE:

Dr. Richard G. Topazian, Oral Surgery, School of Dentistry.

Enrollment Figures (Appendix G).

* Interns receive \$7,500 per year.

** 1st Year Residents receive \$7,000 per year.

*** 2nd Year Residents receive \$7,500 per year.

Table A-10. Revenue - Tuition Per Dental Student Per Year.*

YEAR	TOTAL PROJECTED TUITION	TUITION PER STUDENT
1969-1970	21,450	715.00
1970-1971	52,800	776.47
1971-1972	102,300	799.22
1972-1973	154,500	804.69
1973-1974	183,900	806.58
1974-1975	203,925	796.58

ASSUMPTIONS:

1. Cost of tuition will remain constant at \$825.00 per year for Georgia residents and \$1,650 per year for non-residents.
2. Percentage of non-resident dental students will remain approximately constant at 6.66% of total dental enrollment based upon present enrollment figures.
3. Students enrolled in an advanced education program which requires tuition will pay \$135.00 per quarter if a Georgia resident and \$315.00 per quarter if a non-resident.
4. Percentage of non-resident graduate students paying tuition will remain approximately constant at 50% of total graduate students paying tuition.

SOURCE:

Registrar, Medical College of Georgia.
 Dr. Francis J. Behal, Dean, Graduate Studies, Medical College of Georgia.
 Dr. Louis J. Boucher, Associate Dean, School of Dentistry.

*See Appendix G for methodology.

Table A-11. Revenue - Average Clinic Income Per Dental Student Per Year.

YEAR	1ST YEAR STUDENTS	2ND YEAR STUDENTS	3RD YEAR STUDENTS	4TH YEAR STUDENTS	ADVANCED EDUCATION	TOTAL INCOME	AVERAGE INCOME
1969-1970	576				24,000	24,576	819.20
1970-1971	864	6,768			32,000	39,632	582.82
1971-1972	1,344	10,152	12,000		48,000	71,496	558.56
1972-1973	1,344	15,792	18,000	36,000	80,000	151,136	787.17
1973-1974	1,344	15,792	28,000	54,000	96,000	195,136	855.86
1974-1975	1,344	15,792	28,000	84,000	128,000	257,136	1,004.44

ASSUMPTIONS:

1. Each first year student will derive \$24.00 total income.
2. Each second year student will derive \$282.00 total income.
3. Third year students will complete 5 comprehensive care patients at an estimated 20 visits per patient and an estimated income of \$5.00 per patient visit (\$500 per year).
4. Fourth year students will complete 15 comprehensive care patients at an estimated 20 visits per patient and an estimated income of \$5.00 per patient visit (\$1,500 per year).
5. Each student enrolled in an advanced education program will derive \$4,000.00 per year total income.

SOURCE:

Projected clinic income memorandum of 31 March 1970.

Dr. Louis J. Boucher, Associate Dean, School of Dentistry.

Table A-12. Student Kit Cost per Undergraduate Dental Student Per Year.

YEAR	NUMBER OF FRESHMAN	TOTAL FRESHMAN KIT COST	NUMBER OF SOPHOMORES	TOTAL SOPHOMORE KIT COST	TOTAL COMBINED KIT COST	COST PER STUDENT
1969-1970	24	38,400			38,400	1,600.00
1970-1971	36	57,600	24	16,800	74,400	1,240.00
1971-1972	56	89,600	36	25,200	114,800	989.65
1972-1973	56	89,600	56	39,200	128,800	748.84
1973-1974	56	89,600	56	39,200	128,800	631.37
1974-1975	56	89,600	56	39,200	128,800	575.00

ASSUMPTIONS:

1. Cost of Freshman Kit is \$1,600.00.
2. Cost of Sophomore Kit is 700.00.
3. Cost of both kits will remain constant.

SOURCE:

Dr. Arthur O. Rahn, School of Dentistry.

Table A-13. Summary of Federal and State Costs Per Dental Student Per Year*

	FY 1969	FY 1970	FY 1971	FY 1972	FY 1973	FY 1974
TOTAL GROSS						
Federal Cost	7,775.47	4,204.79	2,192.03	1,401.70	1,144.19	1,096.00
Less Income**	0	0	0	0	0	0
TOTAL NET						
Federal Cost	7,775.47	4,204.99	2,192.03	1,401.70	1,144.19	1,096.00
	(18.73%)	(14.95%)	(10.23%)	(8.34%)	(6.75%)	(6.77%)
TOTAL GROSS						
State Cost	35,277.56	25,287.95	20,583.81	16,994.09	17,479.56	16,901.13
Less Income**	1,534.20	1,359.29	1,357.78	1,591.86	1,662.44	1,801.02
TOTAL NET						
State Cost	33,743.36	23,928.66	19,226.03	15,402.23	15,817.12	15,100.11
	(81.27%)	(85.05%)	(89.77%)	(91.66%)	(93.25%)	(93.23%)

* Same for both undergraduate and graduate dental students.

** Tuition and clinic income comprise total income which is assumed to defray state costs only.

Table A-14. Projected Extramural Funds.

YEAR	PROJECTED RESEARCH FUNDS	80% FEDERAL	20% STATE
1969-1970	157,000	125,600	31,400
1970-1971	316,500	253,200	63,300
1971-1972	450,000	360,000	90,000
1972-1973	600,000	480,000	120,000
1973-1974	770,000	616,000	154,000
1974-1975	960,000	768,000	192,000

ASSUMPTIONS:

Federal and State Funding are assumed to be about 80% and 20% respectively.

SOURCE:

Dr. Louis J. Boucher, Associate Dean, School of Dentistry.

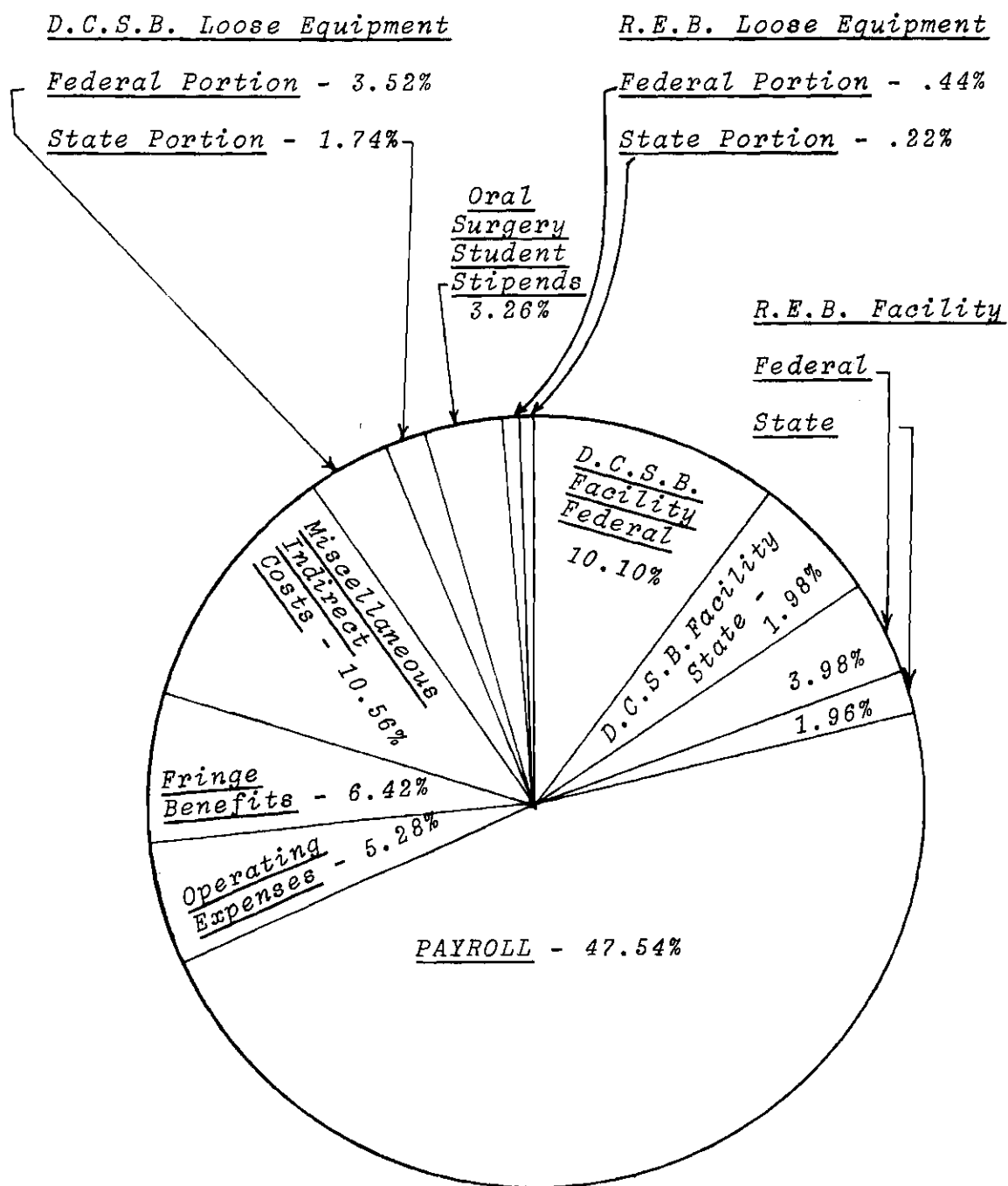


Figure A-1. Cost of Dental Education Per Dental Student
 Fiscal Year 1969.

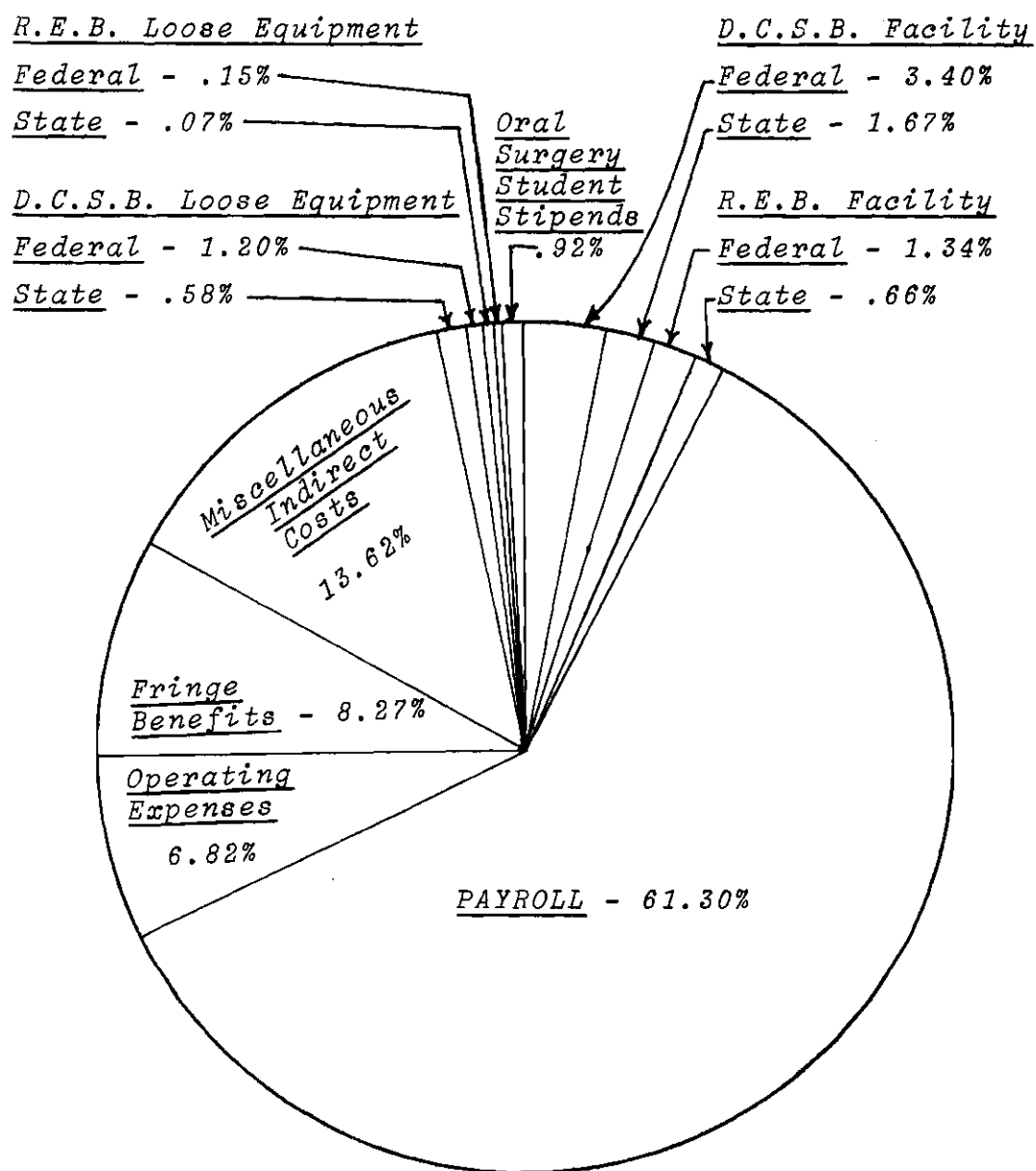


Figure A-2. Cost of Dental Education Per Dental Student
 Fiscal Year 1974.

Table A-14. Dental Clinical Services Building
Determination of Equivalent Annual Cost.

Initial Facility Cost - \$5,906,107.38

E.A.C.: Equivalent Annual Cost

C.R.F.: Capital Recovery Factor

Federal Principal: 67% - \$3,957,091.94

State Principal: 33% - \$1,949,015.44

E.D.S.E.: Equivalent Dental Student Enrollment (Table 3)

	40 YEAR AMORTIZATION
5% C.R.F.	0.05828
Federal E.A.C. \$	230,619.32
Total Federal \$	9,224,772.73
State E.A.C. \$	113,588.62
Total State \$	4,543,544.79

METHOD:

$$\frac{\text{E.A.C.}}{\text{E.D.S.E.}} = \frac{\text{COST/DENTAL STUDENT}}{\text{YEAR}}$$

Table A-15. Research and Education Building Determination
of Equivalent Annual Cost

Initial Facility Cost (25% of Total Facility for Dentistry)

= \$2,322,563.22

E.A.C.: Equivalent Annual Cost

C.R.F.: Capital Recovery Factor

Federal Principal: 67% = \$1,556,117.36

State Principal: 33% - \$766,445.86

E.D.S.E.: Equivalent Dental Student Enrollment (Table 3)

	40 YEAR AMORTIZATION
5% C.R.F.	0.05828
Federal E.A.C. \$	90,690.52
Total Federal \$	3,627,620.79
State E.A.C. \$	44,668.46
Total State \$	1,786.738.59

METHOD:

$$\frac{\text{E.A.C.}}{\text{E.D.S.E.}} = \frac{\text{COST/DENTAL STUDENT}}{\text{YEAR}}$$

Table A-16. Determination of Payroll Expenditures.

Personnel Projections*

YEAR	FACULTY MEMBERS	FACULTY INCREASE	NON-FACULTY EMPLOYEES	NON-FACULTY INCREASE
1969-1970	32	-	25	-
1970-1971	50	18	41	16
1971-1972	67	17	90	49
1972-1973	78	11	114	24
1973-1974	89	11	138	24
1974-1975	89	0	142	4

*The above personnel projections were estimated by the School of Dentistry, July 1970.

Personnel Payroll ProjectionsNotation:

ΔE = increase in number of employees

$F C_i$ = previous year's total faculty payroll cost

$\overline{F C_i}$ = previous year's average faculty payroll cost

$F C_{i+1}$ = projected year's total faculty payroll cost

$N C_i$ = previous year's total non-faculty payroll cost

$\overline{N C_i}$ = previous year's average non-faculty payroll cost

$N C_{i+1}$ = projected years total non-faculty payroll cost

FOR i = 70, 71, 72, 73

Table A-16. (Continued)

METHOD:

$$1) \quad F C_{i+1} = [F C_i + (F C_i) (.07) + (\overline{F C_i}) (\Delta E)]$$

$$2) \quad N C_{i+1} = [N C_i + (N C_i) (.04) + (\overline{N C_i}) (\Delta E)]$$

$$3) \quad (F C_{i+1} + N C_{i+1}) = \text{PROJECTED YEAR'S TOTAL PAYROLL COST}$$

$$4) \quad \frac{(F C_{i+1} + N C_{i+1})}{E.D.S.E.} = \frac{\text{COST/DENTAL STUDENT}}{\text{YEAR}}$$

Table A-17. Determination of Total Direct Cost and Operating Expenditures.

METHOD:

1. Total Direct Cost = Payroll Cost (90%) + Operating Expenditures (10%)
2. $\frac{\text{Payroll Cost}}{0.9} = \text{Total Direct Cost}$
3. (Total Direct Cost - Payroll Cost) = Operating Expenditures
4. $\frac{\text{Operating Expenditures}}{\text{E.D.S.E.}} = \frac{\text{Cost/Dental Student}}{\text{Year}}$

YEAR	PAYROLL COST	TOTAL DIRECT COST	OPERATING EXPENDITURES
1969-1970	849,252.21	943,613.57	94,361.36
1970-1971	1,277,454.00	1,419,393.33	141,939.33
1971-1972	2,004,668.71	2,227,409.68	222,740.97
1972-1973	2,514,070.76	2,793,411.96	279,341.20
1973-1974	3,073,050.63	3,414,500.70	341,450.07
1974-1975	3,287,250.55	3,652,500.61	365,250.06

Table A-18. Dental Clinical Services Building Estimates
of Loose Equipment Depreciation Cost.

NOTATION:

C.R.F.: Capital Recovery Factor

E.A.C.: Equivalent Annual Cost

E.D.S.E.: Equivalent Dental Student Enrollment (Table 3)

YEARS DEPRECIATED	5% C.R.F.	TOTAL PRINCIPAL	E.A.C.	CUMULATIVE E.A.C.
10*	0.12950	495,679.06	64,190.44	64,190.44
20**	0.08024	698,213.56	56,024.66	120,215.10

METHOD:

$$1. \text{ Federal E.A.C.} = (.67) (\text{Cumulative E.A.C.}) = \$80,544.12$$

$$2. \text{ State E.A.C.} = (.33) (\text{Cumulative E.A.C.}) = \$39,670.98$$

$$3. \frac{\text{E.A.C.}}{\text{E.D.S.E.}} = \frac{\text{Cost/Dental Student}}{\text{Year}}$$

*Dental Equipment

**Furniture

Table A-19. Research and Education Building Estimates
of Loose Equipment Depreciation Cost.

NOTATION:

C.R.F.: Capital Recovery Factor

E.A.C.: Equivalent Annual Cost

E.D.S.E.: Equivalent Dental Student Enrollment (Table 3)

YEARS DEPRECIATED	5% C.R.F.	TOTAL PRINCIPAL	E.A.C.	CUMULATIVE E.A.C.
5*	0.23097	2,215.30	511.67	511.67
10	0.12950	3,202.00	414.66	926.33
10*	0.12950	1,794.03	232.33	1,158.66
15	0.09634	2,277.20	219.39	1,378.05
15*	0.09634	76,598.25	7,379.48	8,757.53
20*	0.08024	5,737.50	460.38	9,217.91
25	0.07095	50,391.00	3,575.24	12,793.15
25*	0.07095	35,221.50	2,498.97	15,292.12

METHOD:

1. Federal E.A.C. = (.67) (Cumulative E.A.C.) = \$10,245.72.

2. State E.A.C. = (.33) (Cumulative E.A.C.) = \$ 5,046.40.

3. $\frac{\text{E.A.C.}}{\text{E.D.S.E.}} = \frac{\text{Cost/Dental Student}}{\text{Year}}$

*Cost figures which represent 25% of combined equipment cost shared
with the School of Medicine.

Table A-20. Determination of Tuition Revenues.

UNDERGRADUATE TUITION

YEAR	RESIDENT STUDENTS	TOTAL RESIDENT TUITION	NON-RESIDENT STUDENTS*	TOTAL NON-RESIDENT TUITION	TOTAL UNDERGRADUATE TUITION
1969-1970	22	18,150	2	3,300	21,450
1970-1971	56	46,200	4	6,600	52,800
1971-1972	108	89,100	8	13,200	102,300
1972-1973	160	132,000	12	19,800	151,800
1973-1974	190	156,750	14	23,100	179,850
1974-1975	209	172,425	15	24,750	197,175

ADVANCED EDUCATION ENROLLMENT**

YEAR	ORAL SURGEONS (SALARIED)	ORTHODONTISTS (NON-SALARIED)	DENTAL TUITION	GRADUATE SCHOOL NON-TUITION
1969-1970	6	-	-	-
1970-1971	6	2	-	-
1971-1972	6	6	-	-
1972-1973	6	6	4	4
1973-1974	6	6	6	6
1974-1975	6	6	10	10

Table A-21. Determination of Tuition Revenues

DENTAL GRADUATE TUITION

YEAR	RESIDENT GRADUATES	TOTAL RESIDENT TUITION	NON- RESIDENT GRADUATES***	TOTAL NON-RESIDENT TUITION	TOTAL GRADUATE TUITION
1969-1970	-	-	-	-	-
1970-1971	-	-	-	-	-
1971-1972	-	-	-	-	-
1972-1973	2	810	2	1890	2700
1973-1974	3	1215	3	2835	4050
1974-1975	5	2025	5	4725	6750

*Non-resident undergraduate students = 6.66% of total dental enrollment.

**SOURCE: Dr. Louis J. Boucher, Associate Dean, School of Dentistry.

***Non-resident graduate students who pay tuition = 50% of total graduate students who pay tuition.

METHOD:

$$\frac{(\text{Undergraduate} + \text{Graduate Total Tuition})}{\text{E.D.S.E.}} = \frac{\text{Average Tuition/Dental Student}}{\text{Year}}$$

Table A-22. "Dental Student Equivalents" for Apportionment of School of Dentistry Costs and Revenues Among Participating Programs.

Category	Program Dentistry	Dental Advanced Education	Allied Health Sciences		
			Dental Hygiene	Dental Assistant	Dental Technician
Facilities	1.00	1.00	1.00	1.00	1.00
Equipment	1.00	1.00	1.00	1.00	1.00
Faculty Payroll	1.00	1.00	.50	.25	.25
Non-Faculty Payroll	1.00	1.00	.50	.25	.25
Operating Expenditures	1.00	1.00	.50	.25	.25
Fringe Benefits	1.00	1.00	.50	.25	.25
Miscellaneous Indirect Cost	1.00	1.00	.50	.25	.25
Oral Surgeon Stipends	1.00	1.00	-	-	-
Student Kit Cost	1.00	-	-	-	-
Tuition	1.00	1.00	-	-	-
Clinic Income	1.00	1.00	-	-	-

SOURCE:

Dr. Louis J. Boucher, Associate Dean, School of Dentistry.

Dr. Thomas J. Zwemer, Associate Dean, School of Dentistry.

Table A23. Projected Student Enrollments.

<u>Entering/Total Enrollment</u>						
PROGRAM	1969-70	1970-71	1971-72	1972-73	1973-74	1975-75
DENTISTRY	24/24	36/60	56/116	56/172	56/204	56/224
DENTAL ADVANCED* EDUCATION	/6	/8	/12	/20	/24	/32
DENTAL HYGIENE	12/23	18/30	24/42	24/48	24/48	24/48
DENTAL ASSISTANT	-	-	12/12	24/36	24/48	24/48
DENTAL TECHNICIAN	-	-	6/6	12/18	12/24	12/24

ASSUMPTIONS:

1. Academic attrition rates are assumed to be insignificant.
2. Maximum enrollment for the period under consideration is assumed to be 224 dental students, 48 dental hygiene students, 48 dental assistant students, and 24 dental technician students.

SOURCE:

Office of the President, Vice President and Treasurer, and Registrar,
Medical College of Georgia.

*Includes graduate and postgraduate students.

Table A24. Equivalent Student Enrollments* for Cost and Revenue Apportionment.

<i>Fiscal Year</i>	<i>Category</i>	<i>Dentistry</i>	<i>Advanced Education</i>	<i>Dental Hygiene</i>	<i>Dental Assistant</i>	<i>Dental Technician</i>	<i>Total</i>
FY	Facilities & Equipment	24	6	23	-	-	53
1	Oral Surgeon Stipends	24	6	-	-	-	30
9	Student Kit Cost	24	-	-	-	-	24
6	Revenue**	24	6	-	-	-	30
9	All Other	24	6	11.5	-	-	41.5
FY	Facilities & Equipment	60	8	30	-	-	98
1	Oral Surgeon Stipends	60	8	-	-	-	68
9	Student Kit Cost	60	-	-	-	-	60
7	Revenue**	60	8	-	-	-	68
0	All Other	60	8	15	-	-	83
FY	Facilities & Equipment	116	12	42	12	6	188
1	Oral Surgeon Stipends	116	12	-	-	-	128
9	Student Kit Cost	116	-	-	-	-	116
7	Revenue**	116	12	-	-	-	128
1	All Other	116	12	21	3	1.5	153.5
FY	Facilities & Equipment	172	20	48	36	18	294
1	Oral Surgeon Stipends	172	20	-	-	-	192
9	Student Kit Cost	172	-	-	-	-	172
7	Revenue**	172	20	-	-	-	192
2	All Other	172	20	24	9	4.5	229.5

Table A24. (cont). Equivalent Student Enrollments* for Cost and Revenue Apportionment.

Fiscal Year	Category	Dentistry	Advanced Education	Dental Hygiene	Dental Assistant	Dental Technician	Total
FY	Facilities & Equipment	204	24	48	48	24	348
1	Oral Surgeon Stipends	204	24	-	-	-	228
9	Student Kit Cost	204	-	-	-	-	204
7	Revenue**	204	24	-	-	-	228
3	All Other	204	24	24	12	6	270
FY	Facilities & Equipment	224	32	48	48	24	376
1	Oral Surgeon Stipends	224	32	-	-	-	256
9	Student Kit Cost	224	-	-	-	-	224
7	Revenue**	224	32	-	-	-	256
4	All Other	224	32	24	12	6	298

* Equivalent enrollment is the product of the "Dental Student Equivalent" of each school for each category (Table 2) and the projected total enrollment (Table 1) of that school for a particular year.

** Revenue: Tuition and clinic income.

Table A25. Summary of Costs Per Dental Students* Per Year.

COST COMPONENTS	1969 1970	1970 1971	1971 1972	1972 1973	1973 1974	1974 1975
D.C.S.B. Facility**						
Federal \$	4,351.31	2,353.26	1,226.70	784.42	662.70	613.35
State \$	2,143.18	1,159.07	604.19	386.36	326.40	302.10
R.E.B. Facility**						
Federal \$	1,711.14	925.41	482.40	308.47	260.60	241.19
State \$	842.80	455.80	237.60	151.93	128.36	118.80
Direct Cost						
Payroll	20,463.91	15,391.01	13,059.73	10,954.56	11,381.67	11,031.04
Operating Expenses	2,273.77	1,710.11	1,451.08	1,217.17	1,264.63	1,225.67
Indirect Cost						
Fringe Benefits	2,762.63	2,077.79	1,763.06	1,478.87	1,536.53	1,489.19
Miscellaneous	4,547.54	3,420.22	2,902.16	2,434.35	2,529.26	2,451.34
D.C.S.B. Loose Equipment						
Federal \$	1,519.70	821.88	428.43	273.96	231.45	241.21
State \$	748.51	404.81	211.02	134.94	114.00	105.51
R.E.B. Loose Equipment						
Federal \$	193.32	104.55	54.50	34.85	29.44	27.25
State \$	95.22	51.49	26.84	17.16	14.50	13.42

Table A25. Summary of Costs Per Dental Students* Per Year. (Continued)

COST COMPONENTS	1969 1970	1970 1971	1971 1972	1972 1973	1973 1974	1974 1975
Oral Surgeon Stipends	1,400.00	617.65	328.13	218.75	184.21	164.06
Student Dental Kit*** Combined Kit Cost	1,600.00	1,240.00	989.65	748.84	631.37	575.00
TOTAL GROSS COST	44,653.03	30,732.94	23,765.49	19,144.63	19,255.12	18,572.13
Tuition	715.00	776.47	799.22	804.69	806.58	796.58
Clinic Income	819.20	582.82	558.56	787.17	855.86	1,004.44
Student Dental Kit**** Combined Kit Cost	1,600.00	1,240.00	982.65	748.84	631.37	575.00
TOTAL MISCELLANEOUS INCOME	3,134.20	2,599.29	2,347.43	2,340.70	2,293.81	2,376.02
NET FEDERAL AND STATE COST	41,518.83	28,133.65	21,418.06	16,803.93	16,961.31	16,196.11

* Due to the apportionment assumptions by the School of Dentistry, net costs are the same for both undergraduate and advanced education students, and gross costs for the two groups differ only by the undergraduate student kit cost.

** Based upon 40-year estimated useful life of facility.

*** Average cost per student for both freshman and sophomore kits (see Table 15).

**** Student kit cost defrayed directly by students.

NOTE: Facility costs associated with rental of present temporary facilities and costs associated with the use of ETMH facilities have been excluded from the analysis.

APPENDIX B

PROSTHODONTIC SERVICES MODEL

COMPLETE DENTURES MODEL

(See Figure B-1, Segments A and B)

Definition of Terms

PRUL:	Prevalence rate for complete edentulousness.
PROA:	Prevalence rate for one-arch edentulousness.
T1:	Mean time to treat one-arch edentulousness.
T2:	Mean time to treat complete edentulousness.
RN:	Mean (weighted) time to treat one- and two-arch edentulousness for a member of the susceptible population.
PER 1:	Mean percent of dentist chairside time allocated to all denture services, 1962-1970.
PER 2:	Mean percent of dentist chairside time allocated to all denture services, 1971-1985.
TDHRS _i :	Total number of dentist chairside hours allocated to all dental services by active, non-Federal dentists.
DHDEV _i :	Total number of dentist chairside hours devoted to all denture services by all active, non-Federal dentists.
TREAT:	Total number of dentist chairside hours devoted only to complete (upper <u>and</u> lower arch) denture services.
TOTTR:	Total number of completely edentulous (both arches) patients treated (cumulative).
POP _i :	Number of persons in the 18-79 year age group.
NHNED _i :	Number of hours of complete denture need in year i.
UNHRS _i :	Number of dentist-hours of untreated complete denture need in year i (cumulative).
UNPED _i :	Number of untreated complete denture patients in year i (cumulative).
TBAR:	Mean (weighted) time required to treat a person known to have one- or two-arch edentulousness.

CROWNS, BRIDGES, AND REMOVABLE PARTIAL DENTURES MODEL

(See Figure B-1, Segments C and D)

Definition of Terms

PREV:	Prevalence rate for 1 to 32 missing teeth.
TB:	Mean dentist chairside time required to treat each crown, bridge, and removable partial denture (c_i , b_i , and p_i) patient.
RATE:	Weighted mean time for c_i , b_i , and p_i service per member of the susceptible population.
PRCT 1:	Mean percent of dentist chairside time devoted to c_i , b_i , and p_i services, 1962-1970.
PRCT 2:	Mean percent of dentist chairside time devoted to c_i , b_i , and p_i services, 1971-1985.
DHD _i :	Total number of chairside hours spent providing c_i , b_i , and p_i services by all active, non-Federal dentists.
MHN _i :	New hours of c_i , b_i , and p_i need in year i .
UNH _i :	Number of untreated hours of c_i , b_i , and p_i need at the end of year i (cumulative)
UNP _i :	Number of untreated c_i , b_i , and p_i patients at end of year i (cumulative)

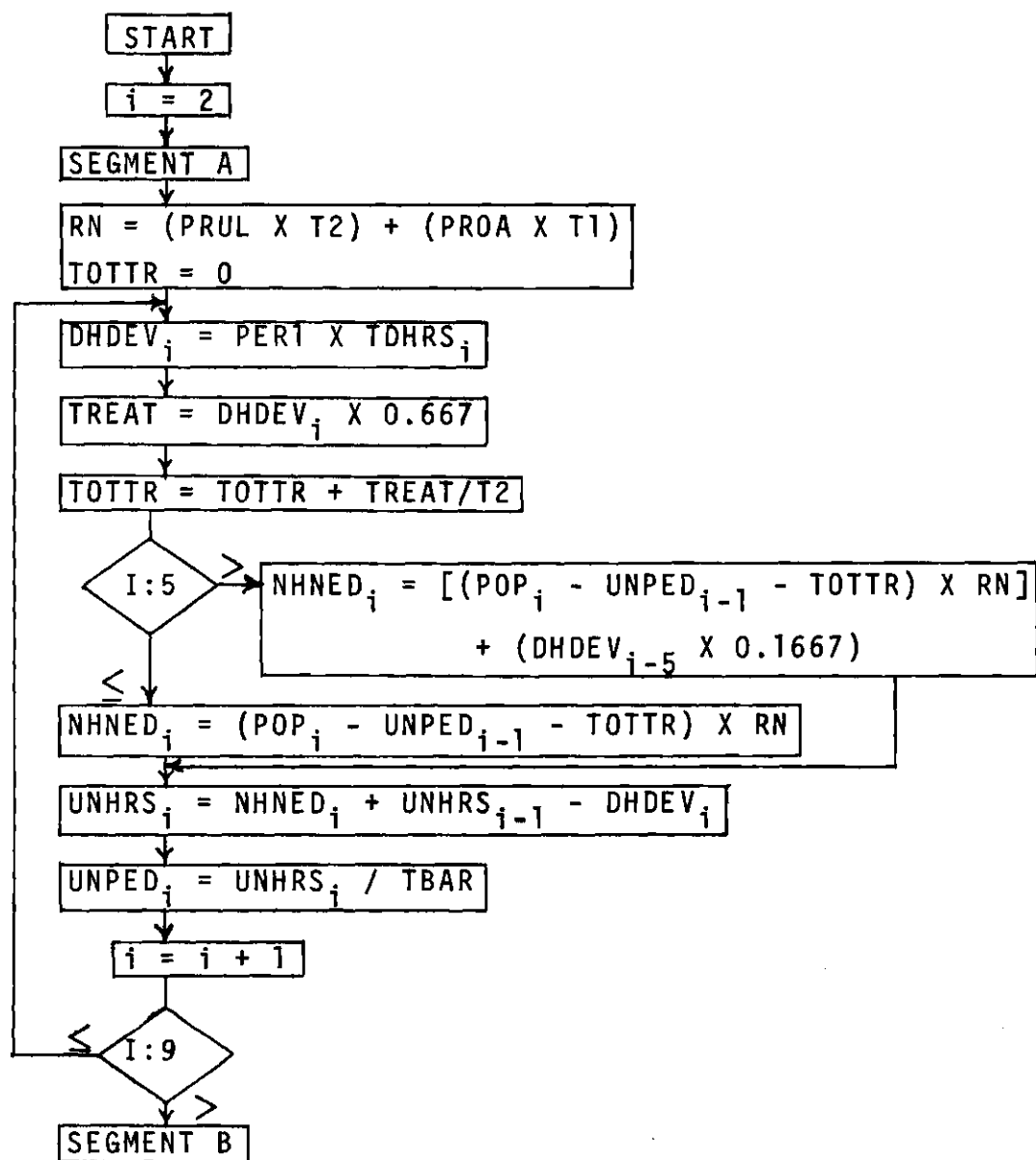


Figure B-1. Flow Diagram of the Prosthodontic Services Model (Segment A of the Complete Dentures Model).

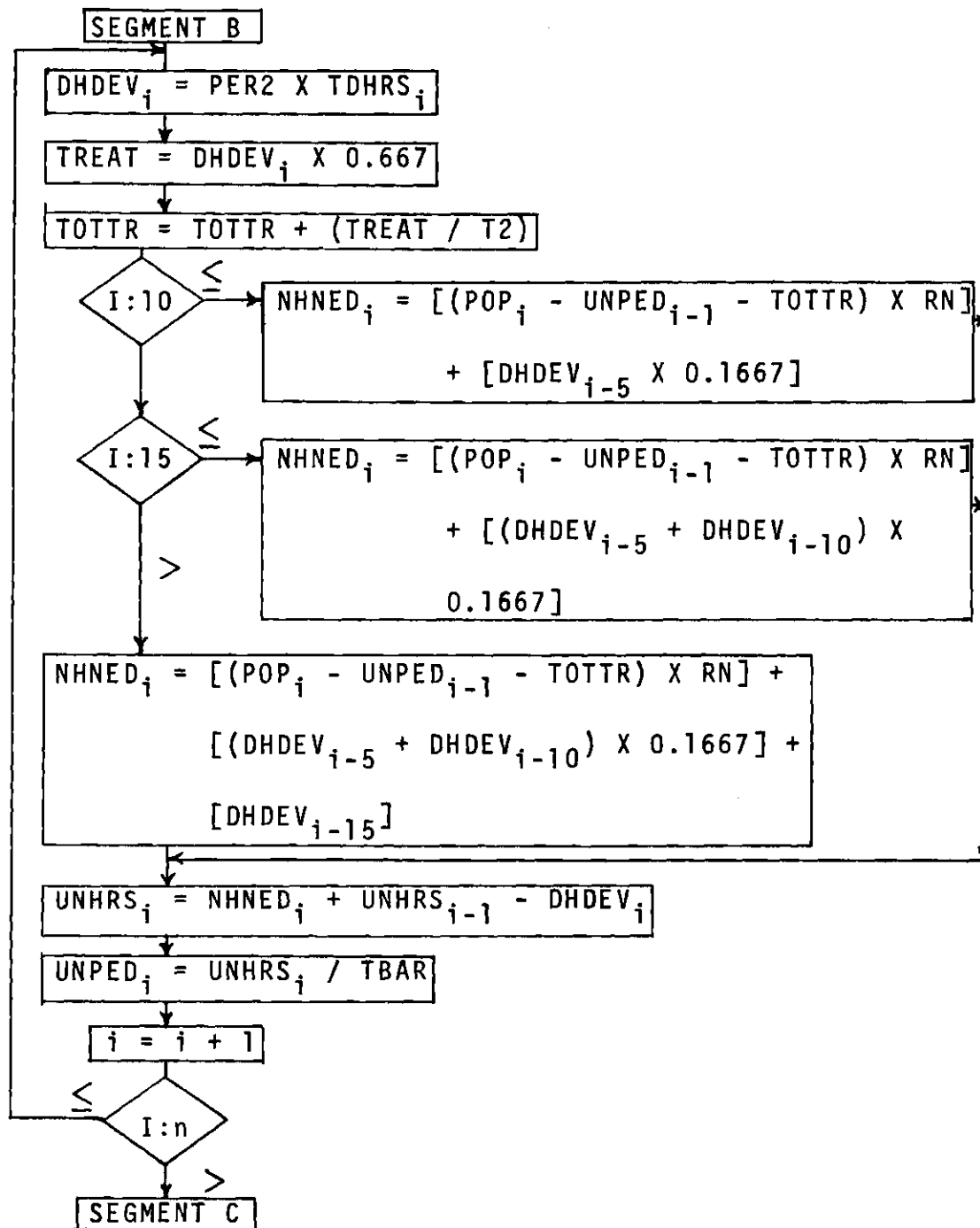


Figure B-1. Flow Diagram of the Prosthodontic Services Model
(Segment B of the Complete Dentures Model). (Continued)

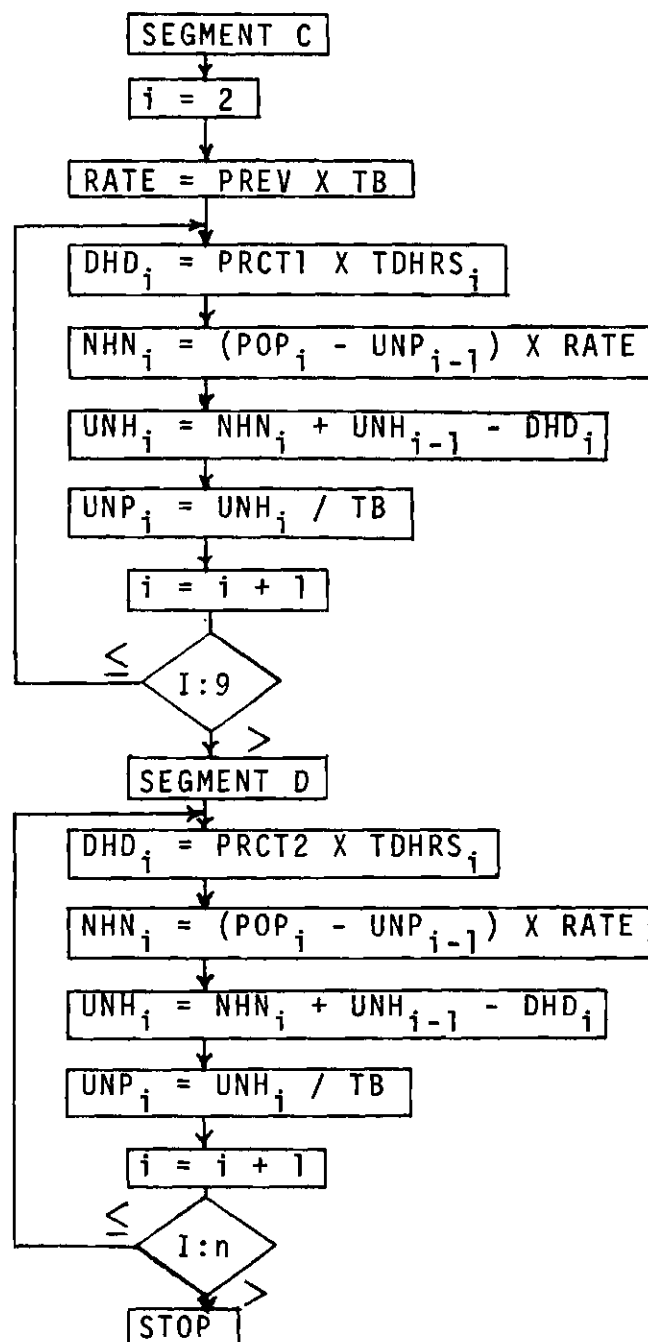


Figure B-1. Flow Diagram of the Prosthodontic Services Model
(Segments C and D of the Crowns, Bridges, and Complete
Dentures Model). (Continued)

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VITA

Richard Massey Bramblett was born October 11, 1938, at Savannah (Chatham County) Georgia, to Richard Leon and Mary Katharine (née Massey) Bramblett. He attended primary public schools in Wilmington, North Carolina, and primary and secondary public schools in Screven County, Georgia, and graduated from Screven County High School in June, 1956.

He entered Georgia Institute of Technology in September 1956 under the Cooperative Plan. His cooperative work experience was in outside plant engineering with Southern Bell Telephone and Telegraph Company in Atlanta, Georgia. As an undergraduate, he was active in Toastmasters International, American Institute of Industrial Engineers, Georgia Tech YMCA organizations and Board of Directors, and Alpha Tau Omega social fraternity. In June, 1961, he received the degree Bachelor of Industrial Engineering, Cooperative Plan.

Following graduation, Mr. Bramblett joined Western Electric Company, Incorporated, in New Orleans, Louisiana, as a management/engineering trainee. In April, 1962, he entered the United States Army as Second Lieutenant to fulfill the military service commitment made through the Reserve Officer Training Corps program at Georgia Tech. He served two and one-half years on the staff and faculty of the U.S. Army Chemical Center and School at Fort McClellan, Alabama. He was appointed Chief Tactical Officer, responsible for the orientation, training, and evaluation of all newly-commissioned officers of

the U.S. Army Chemical Corps. He also served as instructor at the School and field technical advisor for state national guard units. Lt. Bramblett was awarded a certificate of achievement and was honorably discharged with the rank of First Lieutenant in September 1964.

On July 20, 1963, Mr. Bramblett married Grace Ann Hodgkinson of Detroit, Michigan.

Mr. Bramblett entered the Graduate School of Industrial Engineering at Georgia Institute of Technology in September, 1964, to pursue the Master of Science and Doctor of Philosophy degrees. He joined the Hospital Systems Research Group as a teaching and research assistant. During this period, Mr. Bramblett gained experience teaching in the School of Industrial Engineering, continuing education short courses, and a grant-supported hospital systems analyst training program. He received the degree Master of Science in Industrial Engineering in June, 1967. His master's thesis was entitled "Optimal Quantities for Hospital Supply Groupings."

In July 1967, having completed his formal doctoral coursework, Mr. Bramblett was given the opportunity to join a collaborative effort between Georgia Tech and the Medical College of Georgia to establish an industrial engineering program within the School of Medicine under a grant from the National Fund for Medical Education. Encouraged by Dr. Harold E. Smalley, who directed the affiliated program with the Medical College and who also was his faculty advisor, Mr. Bramblett was employed full-time as Staff Industrial Engineer in the School of Medicine. Mr. Bramblett moved to Augusta in July 1967.

In 1967 and 1968, industrial and systems engineering activities at the Medical College of Georgia were expanded. Under the Federally-sponsored graduate training program, "Program in Hospital and Medical Systems," directed by Dr. Harold Smalley and administered jointly by Georgia Tech and the Medical College of Georgia, industrial and systems engineering programs of the Schools of Medicine and Dentistry, Eugene Talmadge Memorial Hospital, and a clinical facilities planning project were combined as a division of the Medical College of Georgia. Mr. Bramblett continued to be responsible for industrial and systems engineering activities in the School of Medicine, was responsible for a similar program in the School of Dentistry, and conducted special studies for the president of the college, as Senior Systems Engineer in the Division.

In the fall of 1968, Mr. Bramblett directed a project for the School of Dentistry to prepare projections of dental manpower requirements for the Office of Comprehensive Health Planning of the State of Georgia. Having completed his written and oral comprehensive examination, Mr. Bramblett proposed dental manpower planning as the topic for his doctoral research. Subsequently, having received an academic appointment as assistant professor at the Medical College, Mr. Bramblett was able to conduct a portion of his doctoral research as an intramurally-supported research activity of the institution.

In July 1972, all computer services and industrial and systems engineering activities of the Medical College were combined into a single Division of Systems and Computer Services. Mr. Bramblett was appointed Assistant Director of the new division, with responsibility

for all computer systems development and industrial and systems engineering service activities of the Medical College.

Since July 1967, Mr. Bramblett's responsibilities and experience at the Medical College of Georgia have included graduate and undergraduate instruction, inservice education, health manpower and systems research, engineering service projects, and program development, administration, and supervision.

Two children have been born, Amy Katharine on September 26, 1968, and Cheryl Virginia on November 25, 1971, while Mr. Bramblett has been in Augusta.