DENTAL MANPOWER
Estimating Resources and Requirements

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The dental profession in the United States faces unprecedented change. In this last half of the twentieth century the nature and pace of social and scientific progress augurs a future so different that present experience can provide little preparation for dealing with it. Most established institutions—if they are to continue to fulfill their roles—cannot avoid fundamental realignment and adjustment. The medical institution particularly has been caught in the vortex of social change and technical progress. Despite outpourings of new knowledge on every aspect of health and despite near miracles in drugs and technology, spiraling health demands endanger the ability of the health professions to meet their most basic professional responsibility—supplying care to all who seek it.

By the mid-1960's, the growing imbalance between the supply and demand for health services had become a matter of vocal national concern. THE SURVEY OF DENTISTRY, HEALTH MANPOWER, 1966–75: A STUDY OF REQUIREMENTS AND SUPPLY, the REPORT OF THE NATIONAL ADVISORY COMMISSION OF HEALTH MANPOWER, and such works as Rashi Fein's THE DOCTOR SHORTAGE—all foresee the near certainty of serious manpower shortages in the United States.[1] In response, the health professions have sought new answers and new methods. Although, necessarily, efforts to increase the scarce supply of health professionals have been reemphasized, new attention has been focused on expanding the role and number of auxiliary personnel and on making more efficient use of those employed. New emphasis has also

been given to making the systems for delivering health services more effective and more responsive to social need. In all health professions the choices to be made between alternative methods of providing care are critical and will ultimately determine the levels of productivity and excellence that the health professions attain. The dental profession, which has long watched the growth in demands for care consistently outpace increases in the supply of dentists, is certainly no exception.

Between 1950 and 1966, yearly expenditures for dentists' services by private consumers rose from slightly less than one billion to more than three billion dollars.[2] Visits to dentists rose by nearly 15 per cent in the six-year interval between the 1957–58 and the 1963–64 National Health Surveys, increasing from just over 250 million visits a year to approximately 300 million visits.[3] In 1958 about 37 per cent of the population—some 60 million people—visited a dentist at least once a year; by 1964 this had risen to 42 per cent—nearly 81 million people.

The growth of organized care programs and new methods of financing care have given impetus to the rising level of dental service demands, especially during the 1960's. Enrollment in prepaid dental plans doubled during the 1950's, doubled again in the four years between 1960 and 1964, and then redoubled by 1966.[4] Enrollment under these plans, increasing from 700,000 persons in 1960 to three million in 1966, has grown faster than did subscription to hospital and surgical plans in the early stages of their development.

Care demands have been further increased by a host of publicly financed programs for disadvantaged children, the aged and other special groups. Through Head Start, Medicaid and simliar undertakings, public expenditures for dental care grew from about three million dollars in 1960 to more than 55 million dollars in 1966.[5] And, when this chapter was written, the full impact of Medicaid was yet to be felt and a new dental health program, which will bring millions of young children into dental offices on a regular basis, was still on the horizon.

Expressed demands for care have risen dramatically. Yet no comparable expansion has taken place in the supply of dentists. The size of the gap between the demand for and actual provision of dental services will be the emphasis of this study. Specifically, how many services are provided by the current supply of dental manpower? How has the increase been realized in the number of services provided? Does the volume of services being provided constitute an adequate

TABLE I. TRENDS IN DENTIST SUPPLY, 1950 TO 1968[7]

	1950	*1960*	*1965*	*1968*
Total dentists	87,150	101,950	109,300	113,600
Active dentists	75,300	82,600	86,300	92,000
Federal dentists	2,600	6,600	7,050	8,000
Inactive dentists	9,250	12,750	15,850	13,600
Total dentists per 100,000 persons	57.2	56.4	56.4	56.8
Active dentists per 100,000 civilians	49.9	46.6	45.0	46.5

response to demand? That is, would demand levels have risen still higher had the dentist supply been larger, and has the supply of practitioners, in essence, served as a damper on demands for care?

There is also the question of the future. What will happen as demands continue to rise? Can dentistry respond effectively to still higher levels of demand or is it possible that a point of diminishing returns will soon be reached?

Such questions are basic to any program of action designed to meet dental care needs. The situation that prompts them is rooted in conditions that have developed over many years. Perhaps the best way to begin the search for answers is to look at these conditions.

DENTAL MANPOWER IN THE MID-1960'S

The United States had 113,600 dentists in 1968, not counting the 3,400 dentists who graduated that year[6] (see Table 1). This is 26,500 more than were in the total dentist supply in 1950.[7] But population growth in the 1950's and early 1960's was so great that the ratio of dentists to population declined slightly, falling from 57.2 to 56.8 dentists per 100,000 persons during these years. In terms of the number of active dentists available to serve civilians the decline was greater; both the number of inactive dentists and the number employed by the federal government grew between 1950 and 1968. As a result only 46.5 active dentists cared for every 100,000 civilians in 1968 compared with 49.9 in 1950. This decline, however, does not accurately measure changes that have occurred in the availability of dental care. Trends in the dentist-to-population ratio, at best, only roughly approximate changes in the relation between the demand and the supply of services. The ratio fails to measure changes that occur in the ability of the individual dentist to provide care. It is also unable to reflect changes in the amount of care the average person seeks. In other words, neither

TABLE 2. TRENDS IN DENTAL AUXILIARY MANPOWER SUPPLY, 1950 TO 1967[8]

	1950	*1960*	*1967*
Dental hygienists	7,100	13,000	15,000
Dental assistants	55,200	83,000	95,000
Dental technicians	21,000	24,000	27,000

TABLE 3. PERCENTAGE OF DENTISTS EMPLOYING AUXILIARIES, 1958, 1961, 1964[9]

	1958	*1961*	*1964*
Dentists with no employees	18.2	17.4	10.1
Dentists with dental hygienists	14.0	15.0	20.2
Part-time hygienist only	7.5	9.2	10.9
More than part-time hygienist	6.5	5.8	9.3
Dentists with dental assistants	75.5	76.7	82.4
Part-time assistant only	9.8	8.3	7.3
One full-time assistant	58.4	58.7	62.9
Two full-time assistants or more	7.3	9.7	12.2
Dentists with dental technicians	5.4	5.1	6.3
Part-time technicians only	1.9	2.0	2.1
More than part-time technician	3.5	3.1	4.2
Dentists with receptionists	16.1	19.3	28.6
Part-time receptionist only	5.2	5.8	5.9
More than part-time receptionist	10.9	13.5	22.7

unit of the dentist-to-population ratio is constant over time. A particular objective of this chapter is to develop measures that have units that are constant from year to year.

Since 1950, many changes in dental practice have greatly affected the amount of care the average dentist provides. Most important has been the increased employment of dental auxiliaries, a dental manpower component not counted in the traditional ratio of professionals to population. In 1950 dentists and commercial dental laboratories employed an estimated 80,000 dental hygienists, dental assistants and dental laboratory technicians—the three recognized dental auxiliaries. By 1967 the auxiliary work force had grown to nearly 140,000[8] (see Table 2). In other words the average number of auxiliaries per dentist was 1.5 in 1967 compared with 1.1 in 1950.

Data from the American Dental Association triennial SURVEY OF DENTAL PRACTICE, presented in Table 3, show the percentage of dentists working alone reduced by almost half in the six years between 1958 and 1964. At the same time significant increases took place in

full-time and multiple auxiliary employment.[9] The growing use of dental assistants provides the most striking example of the changing pattern of auxiliary utilization. The percentage of dentists employing only part-time assistants declined while the percentage of dentists with at least two full-time assistants almost doubled.

This expanded use of auxiliaries has greatly increased dentist productivity. Because of its national scope, the most useful estimate of productivity increases accruing from use of auxiliaries comes from the American Dental Association survey. Based on number of patient visits, the survey reported that in 1965 dentists with no auxiliaries were 30 per cent less productive than the average dentist.[10] In contrast, dentists with four or more full-time auxiliaries were 85 per cent more productive than the average dentist.

It is increasingly common for dentists to associate with other dentists. In 1952, an estimated 6.6 per cent of the dentists shared costs or employees. Another 1.6 per cent were practicing in a complete partnership.[11] By 1964, 9.1 per cent shared costs and 3.6 per cent were engaged in partnerships. This trend has also contributed to dentist productivity. In 1964, dentists who shared costs reported nine per cent more patient visits than did dentists in solo practice; dentists in full partnerships reported 18 per cent more visits than did solo practice dentists.[12] Gains in productivity have also come from changes in dental equipment. For example, respondents to the 1959 survey who used high or super-speed handpieces reported a clear increase in number of patients treated.[13] Similar gains may have also resulted from improvements of office design and increasing delegation of bookkeeping and fee collection to commercial firms.

The total impact of all factors affecting dentist productivity—and those mentioned above are by no means all—is not the sum of the factors. Each factor to a certain extent affects the others. To date, the factors have not been measured independently. For instance, dentists in partnerships have more employees, but it is not known to what extent their increased productivity is a result of partnership and to what extent it is a result of auxiliary utilization. Until the factors are measured independently direct computations of total increases in productivity will have to be foregone.

It is possible, however, to make an indirect computation, based on the close association of age with the many productivity components. Younger dentists tend to work longer hours.[14] Younger dentists employ auxiliaries more frequently.[15] Younger dentists seem to adopt innova-

FIGURE I. DENTIST AGE AND RELATIVE PATIENT VISIT LOAD, 1964[18]

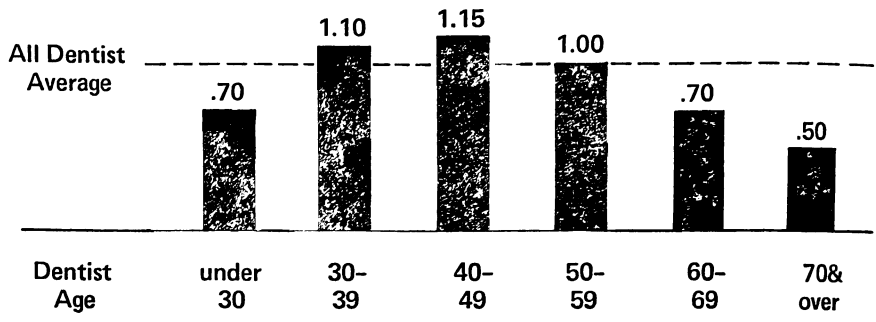


TABLE 4. AGE-ADJUSTED ESTIMATES OF THE NUMBER OF PATIENTS AND PATIENT VISITS PER DENTIST IN SELECTED YEARS[19]

	1949	*1952*	*1955*	*1958*	*1961*	*1964*
Average number of patients per dentist	925	975	1,010	1,060	1,080	1,190
Average number of patient visits per dentist	2,400	2,540	2,630	2,780	2,850	3,100

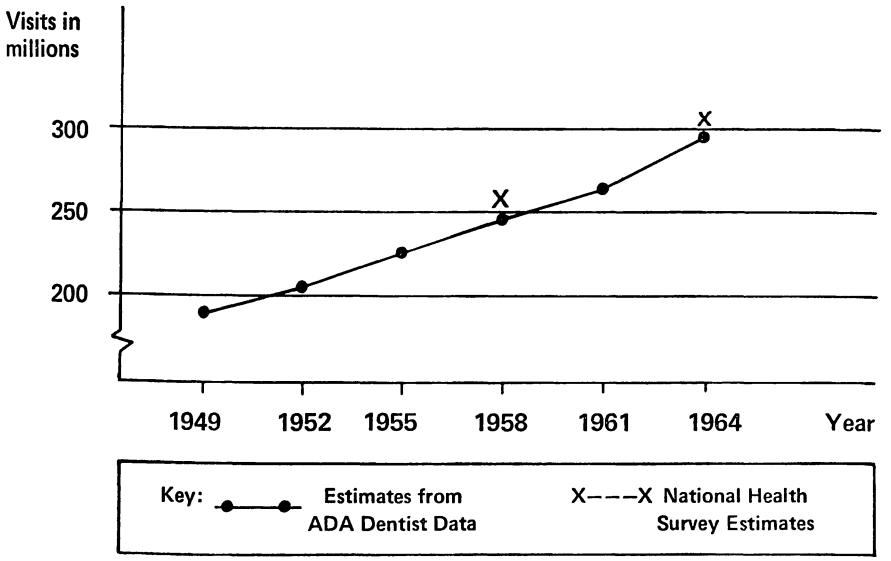
tions more readily. The proportion of dentists, for instance, who had adopted high-speed handpieces by the late 1950's was greater for the younger age groups.[16] To a large extent, this association between age and productivity is natural. Young dentists, having graduated recently, have been trained in recent methods and practices and do not have to break established habits. An interesting speculation is that much of the gain in productivity that has occurred resulted from the replacement of retiring dentists, having lower productivity, with new graduates. Productivity gains from this replacement process may be much greater than those resulting from established dentists changing their methods of practice.[17] In any case, age is correlated with the factors affecting dentist productivity and can provide an indirect measure of the combined effects of these factors. The ratios of productivity in Figure 1 show that only dentists in their thirties and forties are more productive than the average dentist.[18] These dentists are half-again as productive as dentists in their sixties, and twice as productive as dentists who are seventy or over.

In estimating past trends in productivity, this relation between dentists' age and productivity is particularly important. Unless data are

adjusted to restrict variation in the age distribution of the dentist population being measured, variation in the age distribution of respondents can lead to wide fluctuations in the average productivity figure for all dentists. When this type of age adjustment is made for dental visit data obtained from past surveys of dental practice, a persistent trend of increases in the productivity of the average dentist appears[19] (see Table 4). Increases in productivity have averaged two per cent per year between 1949 and 1964. Both the average number of office visits provided and the average number of patients cared for rose by nearly 30 per cent per dentist in this period.[20]

This estimate of increased productivity may be compared to others based on the dollar value of dental services provided rather than on the number of visits and of patients seen. This method, used by Hann and Weiss, is that of adjusting total consumer expenditures for dental care to reflect increases in dental fees that have occurred and estimating the increase in gross expenditures per dentist.[21] Hann found a 52 per cent increase in consumer expenditures per dentist between 1950 and 1963 and Weiss found a 44.2 per cent increase for the same period. Although the methodology of these estimates is sound, the reliance of both on the Consumer Price Index for estimates of increases in dental fees probably resulted in an overestimation of productivity increases.

FIGURE 2. ESTIMATED TOTAL DENTIST VISITS BY YEAR, 1949–1964[26]



During this period the Consumer Price Index, based on only two dental procedures, rose an average of three per cent per year.[22] In contrast, the equivalent increase for the more broadly based composite fee of the American Dental Association was slightly over four per cent per year.[23] Using the composite fee to adjust for price increases, Hann's estimate of 52 per cent becomes 36 per cent and Weiss' 44.2 per cent increase becomes 29.4 per cent.[24] Thus, inasmuch as Hann's estimate comes to 2.8 per cent per year and Weiss' comes to 2.2 per cent per year, these two expenditure-based estimates of gains in dentist productivity are only slightly higher than the estimate of two per cent based on patient visit data.[25]

Estimates of the total number of patient visits obtained by multiplying the number of dentists for past years by the patient visits per dentist estimates of Table 4, also correspond closely to estimates of the National Health Survey[26] (see Figure 2). The 1958 estimates are within five per cent of each other and the 1964 estimates vary by less than one per cent. Because the data sources of the two types of estimates of total number of patient visits are completely independent, the one based on data obtained from the dentists and the other based on data obtained from patients, this correspondence is particularly impressive.

Figure 2 also emphasizes the growth in the supply of dental services between 1949 and 1964. In these 15 years the amount of care supplied grew by more than 50 per cent, from fewer than 200 million patient visits in 1949 to almost 300 million in 1964. Most of this increase in the supply of care is attributable to growth in dentist productivity. The growth of the dentist supply between 1950 and 1965 was limited to 15 per cent; dentist productivity grew by 30 per cent.

THE GROWTH IN DEMANDS FOR DENTAL CARE

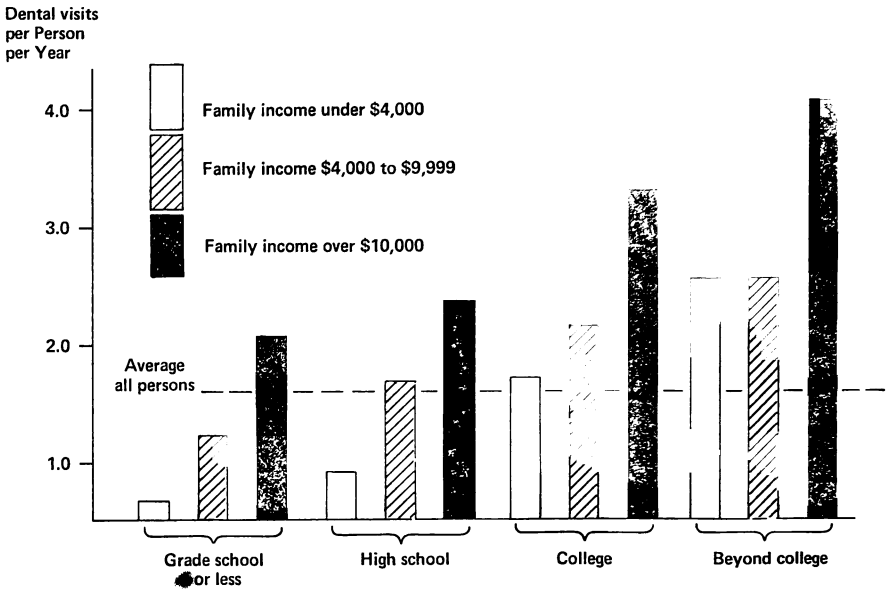
Just as the supply of dental care has grown through increases in the number of dentists and in their productivity, total demand for dental care has also grown through increases in population and in care demands per capita. It is difficult to measure the increases in care demands, however, partly because of the technical problems inherent in these estimates, but also because the concern is to measure both the care actually provided and the care that was or would have been sought had service been available. Because estimates of demand in relation to demographic factors are based on surveys of the number of dental visits actually made, only realized care demands are mea-

sured by these surveys. Unrealized or unmet care demands are excluded by the form of measurement. The technical problems largely involve attempts to measure social, psychologic and cultural factors that, although quite important, present such problems for quantification that for now they must be largely ignored in computations.[27] As a result, measurements of total care demands must be incomplete and arrived at through inference. The method used will be to calculate the changes in care demands that would be expected to occur over a period of years to reflect known changes in demographic characteristics affecting the level of care demands.

Over the 15 years between 1950 and 1965, little, if any, increase in per capita care demands can be attributed to those demographic characteristics (such as age, sex, race or location) that can be regarded as unvarying and predictable. This is mainly the result of the slow rate of change of these characteristics of the population. Age distribution of the population definitely varied between 1950 and 1965.[28] The changes, however, were such that the percentage of the population in age groups with high dental care demands varied little over the 15-year period.[29] The same is true of sex differences; the ratio of men to women changed far too little to influence care demands. Although the characteristic of race is related to care needs, the apparent relation between race and the amount of care a person seeks is not necessarily causative. Of the major differences in care demands between white persons, who made an average of 1.67 dental visits each in 1964, and nonwhite persons, who made an average of 0.91 visits, about 80 per cent is a reflection of education and income differences.[30] The remaining 20 per cent may reflect other aspects of the social environment and care need differentials. Even changes in location, though major, have not resulted in changes in care demands. Increases in metropolitan residence, which raised care demands, were offset by an increase in the population living in the South, where relatively low demand rates prevail.[31]

Some less predictable characteristics, which are responsive to social action, such as education, family income and personal attitudes, had a profound effect on the level of care demands between 1950 and 1965. As noted before, however, attitudinal data have not yet been developed to the point where they are amenable to use in computations because they have only sporadically been tied to empirically confirmed evidence of dental visits. Still, preliminary indications suggest the need for further research in this area.[32] A recent study suggests that parental

FIGURE 3. DENTAL VISITS PER PERSON PER YEAR BY FAMILY INCOME AND EDUCATION OF HEAD OF HOUSEHOLD, 1963–1964[35]



attitudes are more important than income and education in determining whether a child visits the dentist regularly or only when a specific complaint exists.[33] Such a finding, if quantified in another study, would definitely refine projections and estimates of care demands.[34] Until then, it can only be noted that this important type of factor has been neglected and that an underestimate of undeterminable proportions has resulted.

The two factors of income and education can be quantified and related to actual dental visits on a nationwide basis. Figure 3 shows how different levels of family income and education affect the average number of dental visits per person.[35]

Not only do income and education strongly influence care demands independently, but when both factors rise together, as is generally the case, the corresponding increase in care demands reflects the dual influence. If the head of the household did not attend high school and family income is under $4,000 an average of fewer than 0.7 dental visits per family member per year was reported. If education is the same but family income exceeds $10,000, family members averaged

just over 2.0 visits per person—three times the number of visits recorded when both income and education were low. Similarly, when education is increased to the college level while income remains under $4,000, an average of 1.7 visits per person was reported. When both an income of over $10,000 and a college education are present, family members reported 3.3 visits per year, fully five times as many visits as reported by members in the lowest category.

For the 1950–1965 period, the high demand rates associated with higher income and education were particularly important. In this period, median family income more than doubled, rising from $3,300 in 1950 to almost $6,900 in 1965[36] (see Table 5). At the same time, the median number of years of school completed by adult men rose from 9.3 years to 11.8 years—that is, in 1950 the average education was that of just entering high school and by 1965 his education was that of almost completing high school.[37] When the demand rates shown in Figure 3 are applied to the income and education profiles of the population for 1950, 1965 and the years between, relative measures of the effects of growing income and higher education on care demands are obtained. Thus, if the population of previous years can be assumed to have sought dental care at the same rate in relation to education and income as the 1963–64 population reported it did in the National Health Survey, the doubling of family income in this 15-year period would have increased relative demand from a low 1.13 visits per person per year in 1950 to 1.76 visits per person in 1965.[38] The slower rise

TABLE 5. RELATIVE INCREASES IN DENTAL CARE DEMANDS ASSOCIATED WITH CHANGING INCOME AND EDUCATION LEVELS, 1950 TO 1965[36]

	Income-Related Demand Increases		
	Median Family Income	*Relative Demand Index*	*Percentage Increase*
1950	$3,319	1.13	
1955	$4,421	1.32	16.8
1960	$5,620	1.54	36.3
1965	$6,882	1.76	55.8
	Educaion-Related Demand Increases		
	Median School Years Completed	*Relative Demand Index*	*Percentage Increase*
1950	9.3	1.40	
1955	n.a.	n.a.	
1960	10.6	1.52	8.6
1965	11.8	1.58	12.9

TABLE 6. INDEPENDENT EFFECTS OF INCOME AND EDUCATION LEVELS ON DENTAL CARE DEMANDS, 1963–1964 (AVERAGE DENTAL VISITS PER PERSON PER YEAR)[40]

Reported Visits by Income	*All Persons*	*Reported Dental Visits, by Education*				*Expected Visits Computed from the Distribution of Education Levels*	*Care Demands Attributable to Income Alone*
		Grade School	*High School*	*College*	*Beyond College*		
All persons	1.6	1.0	1.6	2.4	3.3	1.6	
Under $2,000	.8	.6	.9	1.6	*	1.3	−.5
$2,000 to $3,999	.9	.7	.9	1.7	*	1.4	−.5
$4,000 to $6,999	1.4	1.1	1.5	2.0	2.3	1.5	−.1
$7,000 to $9,999	1.9	1.4	1.9	2.3	2.7	1.7	.2
$10,000 to $14,999	2.6	2.0	2.2	2.9	3.8	1.9	.7
$15,000 and over	3.4	2.1	2.7	3.8	4.3	2.2	1.2
Expected visits computed from the distribution of income levels	1.6	1.3	1.6	2.0	2.3		
Care demands attributable to education alone		−.3	.0	.4	1.0		

* Data inadequate for a reliable estimate.

in education levels would have resulted in an increase of relative demand from 1.40 visits in 1950 to 1.58 visits in 1965.[39]

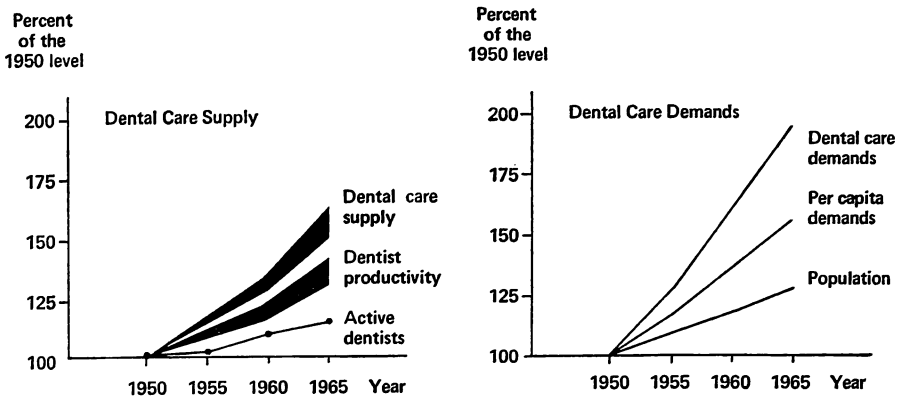
The total increase in care demands was not so great as the combination of these two indexes would indicate, however, because education and income are interrelated and reflect each other. This interrelation and a measure of the independent effects of each factor is shown in Table 6.[40] In families where the head of the household has no more than a grade school education, the average care demands are 0.3 visits per person below the average that would be expected on the basis of the distribution of family income reported by families in this education category. Likewise, an income of under $4,000 depresses average care demands by 0.5 visits below that demand level that the educational levels of these families would otherwise indicate. High income and education have the opposite effect. Families where the father has an education beyond college reported 1.0 visits more than would be expected and families with incomes of over $15,000 reported an average of 1.2 additional visits per person.

If this estimate of the independent effect of educational level changes on care demands is applied to the shifts in the percentage of the population in each education category, an approximation is obtained of the increase in total care demands caused by higher levels of education and not reflected in the growth of care demands ascribed to increases in family income. For the time between 1950 and 1965, this adjustment is 0.07 visits per person per year.[41] When this increase from the independent effects of education is combined with the increases from income changes, the total increase in care demands attributable to these two important factors is 0.7 visits. Even after adjusting for changes in the value of the dollar, the relative demand index increased from 1.19 visits in 1950 to 1.83 visits in 1965, for a total increase of 54 per cent and an annual increase of 3.6 per cent.[42]

THE CHANGED BALANCE BETWEEN MANPOWER SUPPLY AND CARE DEMANDS

Major increases in productivity realized by the nation's dentists between 1950 and 1965 were not adequate to match increases in care demands. Not only did the population grow faster than the dentist supply in this period but care demands per person rose much faster than did dentist productivity. In Table 1, the active manpower supply was shown to have increased by 11,000 dentists, or 14.6 per cent. Be-

FIGURE 4. A COMPARISON OF ESTIMATED INCREASES IN THE DENTAL CARE SUPPLY AND DENTAL CARE DEMANDS FROM 1950 TO 1965



cause of the increase in productivity, the rise in service capability was considerably greater than this, exactly how much greater depending on the estimate of productivity chosen. The three productivity estimates made above see the average productivity of the nation's dentists as having risen 30.0, 34.5 and 42.0 per cent between 1950 and 1965. Expressed differently, these estimates have 100 dentists in 1965 providing the care provided by 130, 135 or 142 dentists of 1950. Thus, the total supply of services available in 1965, instead of being only 14.6 per cent greater than in 1950, actually was 49, 54 or 63 per cent greater because the slight rise in number of dentists was compounded by a much greater rise in the productivity of all dentists. Yet during the same 15 years the population grew 27 per cent and average care demands per person increased an estimated 54 per cent (see Figure 4).[43] The total increase in care demands, then, was a full 95 per cent (127 per cent times 154 per cent) during the 15 years from 1950 to 1965—as much as twice the growth that was obtained in the supply of care.

The meaning of this disparity can be expressed more clearly in terms of the number of dentists that would be required to restore the 1950 balance of care demands and services. Without the complicating factors of productivity and rising care demands, almost 95,000 dentists would have been needed to maintain the 1950 ratio of 49.9 active dentists to every 100,000 persons for the larger population of 1965. This is about 8,700 more than the 86,300 dentists that were available. In terms of a measure of services, however, the estimated deficit is

much greater. By 1965, care demands had risen to where they would have required the services of 150,600 dentists operating at the 1950 level of productivity. As it was, the 86,300 dentists available in 1965 provided services equal to those of between 114,000 to 127,000 dentists of 1950, depending on which estimate of productivity is used. Thus the 1965 care balance had a deficit of services equivalent to the care supplied by 24,000 to 36,000 dentists of 1950—or by 18,000 to 27,000 dentists operating at the higher productivity levels of 1965.[44]

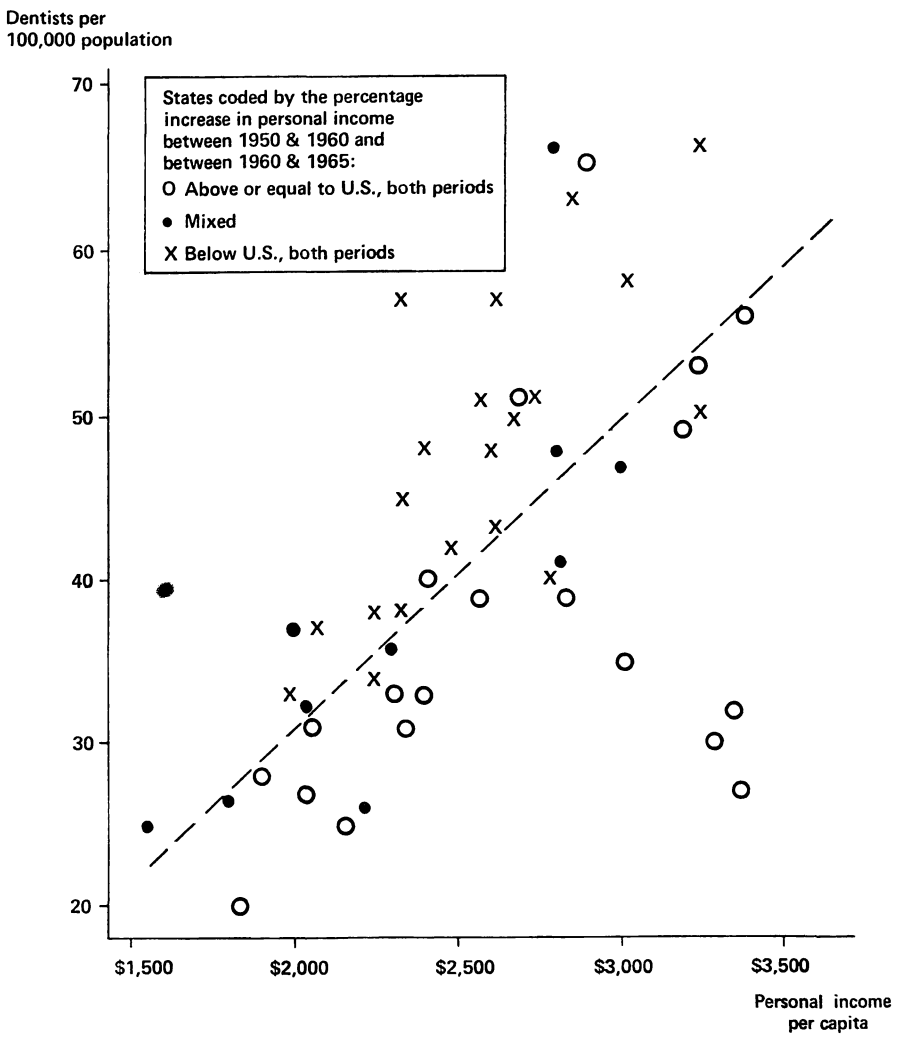
Where and in what form did this shortage develop? The care situation in 1965 was not one where a fifth of those seeking care was turned away outright. The expression rather was in terms of delay and deferment, a buildup of latent care demands in the less conscientious, and it was concentrated more heavily in certain parts of the nation. Data from the 1965 survey of dental practice show an almost linear relation between the size of a city and the average length of time a patient must wait for an appointment[45] (see Table 7). Patients in cities of less than 10,000 population had to wait an average of more than 14 days for an appointment, more than twice the average of 7.3 days that patients had to wait in large metropolitan areas of over one million. Similar, but less marked differences existed between regions of the country. The delay for patients in the New England, Central, North-

TABLE 7. AVERAGE LENGTH OF WAIT FOR AN APPOINTMENT REPORTED BY DENTISTS BY SIZE OF CITY, 1964[45]

		Percentage Distribution by City Size				
Average Wait	*Total*	*Under 1,000*	*1,000 to 2,500*	*2,500 to 5,000*	*5,000 to 10,000*	*10,000 to 25,000*
Total	100	100	100	100	100	100
One week or less	61	61	53	48	49	54
Two to five weeks	34	22	30	43	42	40
Six or more weeks	5	17	17	9	9	6
Mean wait in days	11.5	14.6	16.0	15.3	15.0	12.6

Average Wait	*25,000 to 50,000*	*50,000 to 100,000*	*100,000 to 250,000*	*250,000 to 500,000*	*500,000 to One Million*	*Over One Million*
Total	100	100	100	100	100	100
One week or less	60	59	58	66	67	80
Two to five weeks	34	38	39	30	30	19
Six or more weeks	6	3	3	4	3	1
Mean wait in days	11.9	10.7	11.5	10.4	10.3	7.3

FIGURE 5. INFLUENCE OF STATE ECONOMIC GROWTH UPON THE RELATION BETWEEN THE AVERAGE PER CAPITA DENTIST SUPPLIES AND PERSONAL INCOME OF STATES[47]



west, and Far West regions averaged more than 12 days.[46] Those in Southeast regions had an average wait of just under 12 days, patients in the Middle Atlantic region averaged a ten-day wait and patients in the Southwest had, on the average, only an eight-day wait for a dental appointment.

Relatively greater shortages were also to be found in states that had

experienced above average economic and population growth, suggesting that the dentist supply does not automatically compensate quickly for changes in the concentration of care demands. Figure 5 shows a direct relation between per capita income and the per capita dentist supply,[47] although still with a considerable divergence from any close correlation. In part, this can be seen as the result of licensure restrictions and other difficulties related to practice relocation that have made the dentist supply relatively unresponsive to economic and demographic changes and, in part, this may be the result of a lack of knowledge as to where the need for dentists is greatest. In Figure 5, the states have been divided into three groups according to the percentage increase in total personal income between 1950 and 1960 and between 1960 and 1965.[48] Twenty states experienced increases greater than or equal to the national average in both periods, ten states had mixed growth and the remaining 20 states had below average growth in both time periods. When the states are arbitrarily separated in half as shown, the group that has low dental manpower supplies in relation to per capita income contains 85 per cent of the high-growth states and the group that has high dental manpower supplies in relation to per capita income contains 85 per cent of the low-growth states. Shortages of supply are much more likely to be found in states that have rapidly growing economies and population than in states of less-rapid growth.

DENTAL MANPOWER IN YEARS AHEAD

The passage of time has brought an increase in both those seeking care and in the amount of care sought. This course can be expected to continue to 1980 and beyond as greater numbers of persons realize their care needs and attain the ability to actually seek care through the effects of more widespread affluence and of the expanding organized care programs. A critical feature of assessing future changes in the care balance will be to diagnose the potential of presently inarticulate care *wants* to become care *demands.*

Future demands will be met with a growing supply of dentists. The Health Professions Educational Assistance Act of 1963 has done much to augment the supply of professional manpower, principally by helping to finance dental school construction and expansion. Continued extension of this Act is expected to increase the number of first-year student places from the 1965 level of 3,800 to a 1980 level of 6,000, as the number of graduates increases from 3,200 to more than 5,300.

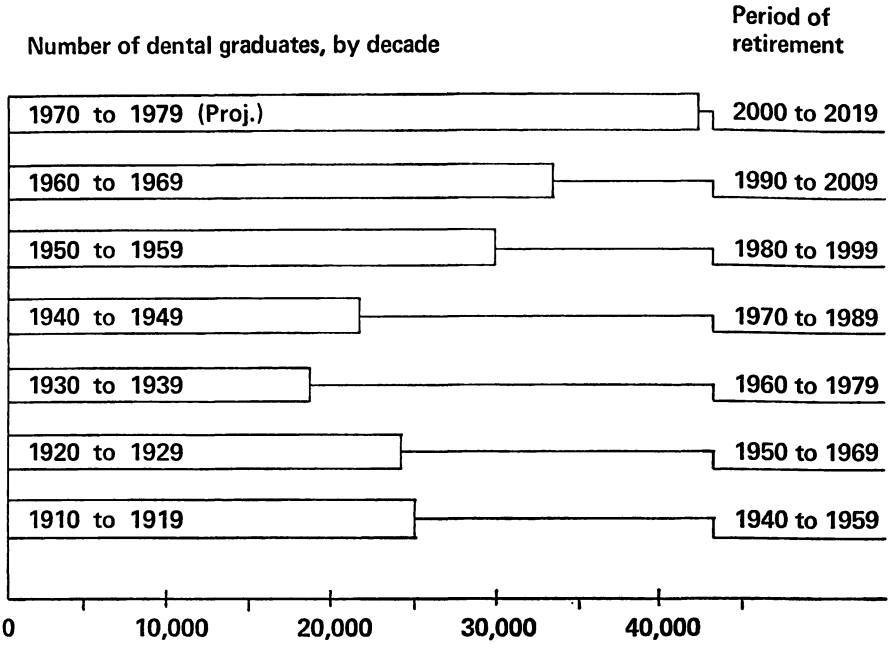
However, because of the cumulative effect of this type of expansion, large increases in the number of graduates will only be realized in the last few years. As a result, only 10,000 to 12,000 more dentists will be added to the 1980 supply than would have been available without the school construction program.[49] Additional dental school expansion in the 1970's would be unlikely to appreciably alter this total for 1980. Planning, financing and construction of a dental school typically requires from four to six years and another four years elapses before the first class graduates. With an eight- or possibly ten-year delay, construction would have had to be decided upon before 1970 if any dentists were to have been added to the labor force before 1980.

Consequently, the 1980 dentist supply can be estimated with some degree of confidence. Of the total of 109,300 dentists alive in 1965, 76,800 will survive to 1980 (assuming the 1965 white male mortality rates).[50] Expanded training facilities will graduate between 58,000 and 60,000 dentists between 1965 and 1980 giving total dentist supply of 134,800 to 136,800 dentists in 1980. Retirement and employment changes into the federal service lower the number of active dentists in 1980 to an estimated 111,000 to 113,000.[51] These estimates represent an increase of 24,000 to 26,000 dentists over the 1965 dentist supply. Thus, the growth projected between 1965 and 1980 is between 29 and 31 per cent, compared with only 15 per cent for the previous 15-year period.

The faster rate of growth anticipated in the dentist supply cannot be ascribed entirely to the greater number of graduates. It must also be attributed to a slower rate of retirement in the future (see Figure 6). The number of dentists graduated in past decades has a decided impact on the proportion of the dentist supply that is retired at any given time. In the 1950's and early 1960's members of the large graduating class of 1910 to 1929 were reaching retirement age while the work force depended on the smaller numbers of dentists who graduated in the 1930's and 1940's.[52] This distribution not only depressed the rate at which the dentist supply grew, but also resulted in a disproportionately large share of the total supply being retired. By 1980, however, the situation will have been reversed. The 1980 active dentist supply will contain graduates of the large classes graduated during the 1950's, 1960's and 1970's while retirees will be drawn largely from the graduates of the small classes of the 1930's and 1940's. As a result, the 1980 dentist count will include a relatively small number of retired dentists.

From whatever source, more dentists will be sorely needed for the vast

FIGURE 6. DENTISTS GRADUATING BY DECADE, 1910 TO 1970[52]



potential future increases in care demands. This potential arises from the extensive nature of dental diseases. A recent national survey found that in the average American over 20 of the 32 teeth were missing, had been filled or were decaying.[53] The survey also found that three adults in four with natural teeth remaining showed some evidence of gingivitis or destructive periodontal disease. It has been estimated that only one person in 30 escapes dental decay.[54] The result of this high incidence of dental disease has been a high recurring need for dental care, but today only a few of those persons with care needs actually seek dental care. The National Health Survey found that only 42 per cent of the civilian, noninstitutional population had visited a dentist during the preceding year.[55] Considering that at least a portion of this 42 per cent was persons who sought only partial emergency treatment, the percentage of the American population that received complete or adequate care must have been much lower. This inattention to dental care needs has created a tremendous backlog of unmet care needs. Tooth decay alone is estimated to have caused a backlog of over 700 million unfilled cavities in the United States.[56] When all types of dental care needs are considered, estimates are that between 500,000 and 800,000

dentists working for a full year would be needed to erase the backlog of unmet needs.[57]

As in the past, future growth of family incomes and educational levels will translate more and more of the backlog of unmet care needs into expressed care demands. The future, however, will differ from the past in the amount of change in care demand realized. Between 1965 and 1980, consumer income is projected as increasing by 120 per cent, from 535 billion dollars to 1,180 billion dollars.[58] The current trend toward more even distribution of this income among family units is expected to continue. By 1980, only 14 per cent of all consumer units is expected to have incomes under 4,000 dollars; 30 per cent is expected to have incomes between 4,000 and 9,999 dollars; 28 per cent to have incomes between 10,000 and 14,999 dollars; and 28 per cent is expected to have incomes of 15,000 dollars or more.[59] In the 15 years between 1965 and 1980, the proportion with incomes under 4,000 dollars is expected to be halved and the proportion of those with incomes over 10,000 dollars is expected to more than double. Should the 1980 population continue to seek care in relation to family income at the 1963–64 rates, the shift to higher income categories would increase per capita demands to 2.28 visits per person per year.[60]

In similar fashion, care demand increases are expected to be generated by rising educational levels. By 1980, the proportion of men with grade school education is expected to drop by more than 50 per cent and the proportion with education beyond college is expected to nearly double.[61] This shift would result in an average demand rate increase of 0.08 visits per person per year, independent of any coincident rise in income levels. Taken together, these two causes of higher care demands would raise per capita care demands in 1980 to an average of 2.36 visits per person per year, a 36 per cent increase over the 1965 level.[62]

In addition to the care demand increase from continued rise in income and education levels, increases will be generated by a new source: the growth of organized care programs, both public and private. Between 1965 and 1980 these programs will for the first time become a significant factor in raising care demands by enabling persons of limited means to obtain more adequate dental care than they could if they depended on their own resources alone. Private organized care programs, such as dental service corporations, commercial nonprofit insurance plans and some group practices and clinics have been increasing their combined enrollment at the rate of 50 per cent per year.[63] This

growth is expected to continue until, in 1980, private prepaid dental care plans are projected to cover an estimated 25 million persons, ten per cent of the population expected in 1980.[64]

A like expansion is anticipated for public care programs. Medicaid, Title XIX of the 1965 Social Security Amendments, extends public care services to persons previously ineligible, those who are capable of self-support but unable to afford needed medical care.[65] By 1975, Medicaid is expected to be operative in all states, with dental services expected to be one of the basic types of care available. Despite the fact that Medicaid is a new program, dental benefits were available in 21 of the 28 participating states as of September, 1967, entitling an estimated 11 million persons to benefits.[66] During fiscal year 1967, 67.7 million dollars were expended for dental benefits under the Medicaid program, providing care equivalent to the services of at least 1,500 dentists.[67] Another recent public program provides dental care to needy children in grade school.[68] Such a program could well be expanded to provide for a care-at-cost arrangement for children from more prosperous families. A public program that is expected to become law would provide dental care for an estimated 3.6 million armed forces dependents on a shared-cost basis.[69] Finally, the possibility exists that other programs will be initiated, one of which could be an extension of Medicare to include a wider range of dental benefits than is now available.[70]

Measuring the impact of the above programs on the translation of dental care needs into dental care demands is impossible at this time. The number of eligible persons and the extent to which they will utilize available services are unknown. Still, the examination of alternative possibilities for the future role of organized care programs can clarify the potential impact of these programs on dental care demands. Three sets of assumptions, starting with the most conservative, are suggested for 1980.

Low activity. The least growth that can be expected for organized care programs would be for existing private plans to grow at about one-half the expected rate, and for existing public programs to grow at a curtailed level. Two-thirds of the enrollees in prepaid dental care plans are expected to be in families whose income is between 4,000 and 9,999 dollars, and one-third is expected to be in the 10,000- to 14,999-dollar category. Medicaid is expected to be operative in all states, but limited to persons eligible for welfare. Dental Care for Children is expected to be limited to much the same population as is covered by

Medicaid. The expected effect on care demands is that eligible persons will seek care at the rate of the next higher income group rather than at the rate of their own income group.

Medium activity. The medium growth rate that can be expected is one where prepaid dental care plans would enroll 20 million people, one-half from each of the middle income categories. Medicaid would be extended to all medically needy persons. Dental Care for Children would be extended to all but the children from the most prosperous families. Dental Care for Armed Forces Dependents would be enacted. Persons covered by all the above programs would experience the moderate utilization of available services as in the low activity assumptions.

High activity. The highest growth that can be expected would involve 25 million persons in prepaid plans, half in each middle income group, and would have utilization that would be of the next higher income group than enrollees are now in. Public programs would be extensive and would have major benefits. Medicaid would be extended to cover all medically needy persons with benefits that increase demand an average of one and one-half income groups. Dental Care for Children would cover all grade school children on a partial cost-reimbursement basis, raising the demand rate for all children to that of the highest income group. Additional dental benefits to Medicaid and the adoption of Dental Care for Armed Forces Dependents would have the effect of increasing demands of eligibles by one income category.

The effects of these three alternative sets of assumptions about the activity levels of organized care programs on the level of per capita care demands are shown in Table 8.[71] The low estimate would increase care demands to 2.48 visits per person per year, a 43 per cent increase

TABLE 8. PER CAPITA CARE DEMAND INCREASES RESULTING FROM ALTERNATIVE LEVELS OF ACTIVITY ASSUMED FOR ORGANIZED CARE PROGRAMS IN 1980[71]

Activity Level Assumed for Organized Care Programs in 1980	*Increased Care Demands Resulting from Organized Care Program Growth as a Percent of Basic Estimate*	*in Additional Visits/ Person/Year*	*Average Per Capita Care Demands in 1980 Visits Per Person/Year*	*Percent of 1965 Level*
Basic 1980 income and education level estimate	100		2.36	136
Low activity assumptions	105	.12	2.48	143
Medium activity assumptions	112	.28	2.64	153
High activity assumptions	120	.46	2.82	163

above the 1965 rate. The medium estimate would increase demands to 2.64 visits, a 53 per cent increase. The high estimate would raise demands to 2.82 visits per person, 63 per cent higher than 15 years before. In all three cases, growth in per capita care demands will be compounded by a growth in population. The 1980 population is expected to be 243.3 million, 25 per cent higher than that of 1965.[72] Total care demands for 1980 would be, respectively, 179 per cent, 191 per cent and 204 per cent of the 1965 total care demands. Even if the provided care in 1965, about 300 million visits, is assumed to be the total demand for that year, the three alternative levels of care demands in 1980 would be 540, 570 and 619 million visits per year.[73]

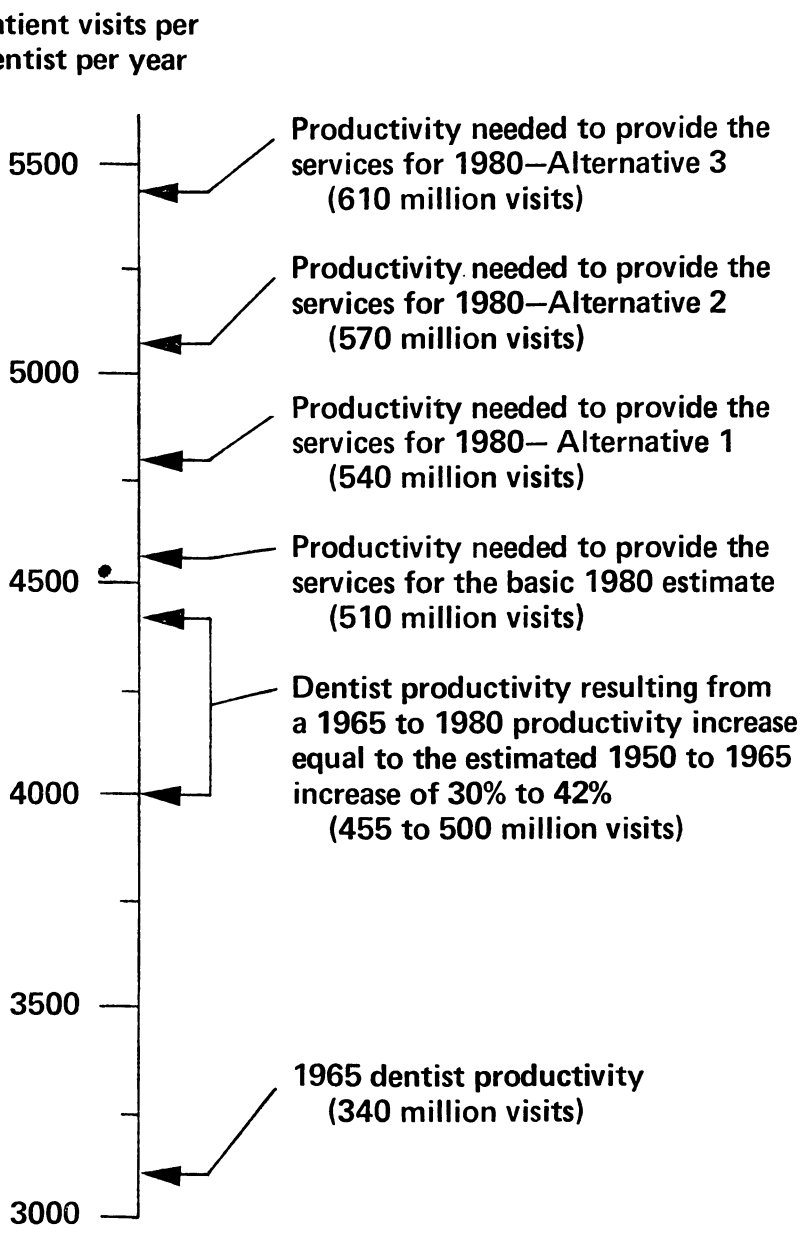
MAINTAINING THE FUTURE CARE BALANCE

Because, as noted earlier, it will not be possible to expand the 1980 supply of dentists beyond the 113,000 now expected, additional efforts to expand the care supply to match growing demands will have to be directed toward increasing the productivity of dentists. Figure 7 shows the levels of productivity that will be needed to produce given amounts of dental care with a force of 113,000 dentists.[74] Quite clearly, the estimated increase between 1950 and 1965, if sustained for the 15 years, would fall far short of meeting the estimated care demands of 1980. If productivity increases 42 per cent by 1980 (the highest estimate of the increase between 1950 and 1965), the supply of dental services would be short of meeting the care demands associated with the low estimate of organized care program activity by the equivalent of 9,000 dentists. The supply would be 16,000 dentists short of meeting the medium level and 25,000 dentists short of meeting the demands of the high level of organized care program activity.[75] If the productivity increase by 1980 is assumed to be only 30 per cent, the dentist shortages would be 21,000 dentists, 28,500 dentists and 38,500 dentists at successive levels of organized care activity. To avoid these shortages of care, dentist productivity would have to increase by 54 to 74 per cent, roughly one and one-half to two times the increases of 1950–1965.

Although any detailed discussion of how such increases in productivity could be achieved must be left to those competent in the subject, some comments and questions may help to delineate the problem.

Fluoridation. Although fluoridation will be widespread by 1980, undue reliance on its effectiveness in diminishing total care demands would be unwise. Despite the considerable benefits that accrue from

FIGURE 7. PRODUCTIVITY REQUIRED FOR 113,000 DENTISTS TO PROVIDE GIVEN AMOUNTS OF CARE[74]



fluoridation, it is not a panacea for manpower problems. Even though fluoridation can reduce tooth decay in children by up to 65 per cent, and new methods of application show much promise, it still must be established that this reduction of dental needs results in a reduction of total care demands.[76] If ability to pay is critical in an individual's decision to seek care, then the effect of fluoridation may well be to divert money budgeted for dental care from caries control to other dental problems. More important, by preventing tooth loss fluoridation may ultimately increase care demands by increasing the number of teeth remaining to be treated. Until the process and factors involved are better understood caution is required in expecting fluoridation to reduce total care demands.

Auxiliary manpower supply. Many plans for increasing dentist productivity assume the presence of large numbers of auxiliaries, which may or may not be available. Even if it is assumed that a much higher proportion of the auxiliaries trained will remain in the labor force rather than retire, at least temporarily, to rear families, the rapid expansion of training facilities now underway will have to be greatly increased. At this writing plans exist for the establishment of but two-thirds of the dental hygiene schools needed by 1975, for two-fifths of the dental assistant schools needed and for only two-tenths the dental technician schools needed.[77] Unless school construction is increased, plans for increasing dentist productivity that require large numbers of supporting personnel will not be realistic.

Auxiliary utilization. To increase average productivity of dentists to over 5,000 patient visits per year, the level needed to meet expected demands (see Figure 7), productivity increases will be necessary among dentists now practicing. Only ten per cent of the dentists provided 5,000 or more patient visits in 1964, and the average for dentists who will still be active in 1980 was no more than 3,750 visits per year.[78] Because these dentists will constitute more than half of the labor force, at least a 20 per cent increase in their productivity would be required for overall productivity to increase to 5,000 visits per dentist. It is not known whether productivity increases of this size can be expected from dentists with established patterns of practice.

One possibility for substantial increases in dentist productivity lies in educating dentists to make greater use of auxiliaries they employ. The scant data available suggests that less than two-thirds of the dentists with dental assistants use them extensively at the chair.[79] Another problem will be the marginal benefit of additional auxiliaries in rela-

tion to cost. Because so little delegation is permitted under dental laws, it is quite possible that additional increases in productivity that could be realized through the employment of a fifth or sixth auxiliary might prove to be uneconomic because the additional income generated would not pay for the auxiliary. Also, is it possible that the low wages now paid dental assistants prohibit the employment of able enough auxiliaries to permit the task delegation needed to raise productivity enough to pay higher wages?

Expanded functions. Little basis may be found for anticipating what changes will occur in task delegation to auxiliaries, although many proposals have been made for loosening restrictive state laws.[80] If state laws are changed to permit auxiliaries to perform more functions, large gains in productivity are possible. However, special training for the dentist and the auxiliaries will probably be needed if major increases in productivity are to be made while maintaining the quality of care.

Care supply after 1980. Although limitations of data have restricted discussion to changes anticipated for 1980 and earlier, a different situation will exist after 1980 because increases in the supply of dental care can be achieved by increasing the number of dentists as well as by increasing their productivity. As the new school places created in the 1960's will do much to meet care demands of 1980 and before, school construction in the early 1970's will significantly affect manpower supplies in 1985 and later years. However, any delay in this construction will cause a repetition of the present situation where school construction has been delayed too long to meet the rapid growth in care demands on a short-term basis. A major problem will be to estimate the needed increase in the manpower supply by 1985 and 1990 in view of trends in dentist productivity—particularly if auxiliary functions have been expanded.

It appears that dentist productivity can be adequately expanded, particularly if more functions are delegated to auxiliaries. A primary problem will be to realize these increases in productivity throughout the dentist population while maintaining an adequate standard of care quality. But the increases in productivity probably will not be realized without conscious and deliberate efforts by the dental profession, the dental education community and the governments concerned. The principal need is for more information and better understanding of the factors involved. In many ways this need is an integral part of the need for more dentists and for higher productivity because, with this lack,

the policies and programs directed at maintaining an adequate balance between the dental care supply and demands upon it will remain uncertain as to both their intent and effect. It is hoped that this analysis will provide an incentive to that study.

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[2] Rice, D. P. and Cooper, B. S., National Health Expenditures, 1950–1966, *Social Security Bulletin,* 31, 14, April 1968.

[3] National Center for Health Statistics, VOLUME OF DENTAL VISITS, series 10, no. 23, Washington, United States Public Health Service, 1965, p. 1;———, DENTAL VISITS, TIME INTERVAL SINCE LAST VISIT, series 10, no. 29, Washington, United States Public Health Service, 1966, p. 1; Division of Public Health Methods, DENTAL CARE, VOLUME OF VISITS, series B, no. 15, Washington, United States Public Health Service, 1960, p. 1; ———, DENTAL CARE, INTERVAL AND FREQUENCY OF VISITS, series B, no. 14, Washington, United States Public Health Service, 1960, p. 1.

[4] FACT SHEET ON DENTAL PREPAYMENT, Washington, Division of Dental Health, United States Public Health Service, 1967.

[5] Rice and Cooper, *op. cit.,* pp. 10, 13.

[6] Graduates of the current year are usually excluded from estimates of the dentist supply because their location and employment status are uncertain during the first six months following graduation and their inclusion would make estimates of state distribution and federal employment difficult.

[7] Estimates prepared by the Division of Dental Health, United States Public Health Service, based on a dentist count obtained from the American Dental Association's AMERICAN DENTAL DIRECTORY. For methodology and rates used to estimate dentist retirement, *see* DENTAL MANPOWER NEEDS IN NEW ENGLAND, New England Board of Higher Education, 1958, p. 37. For population estimates used, *see* United States Bureau of the Census, CURRENT POPULATION REPORTS, series P-25, nos. 311 (July, 1965), 372 (August, 1967), and 386 (February, 1968), Washington, United States Government Printing Office.

[8] DENTAL AUXILIARY FACT SHEET, Washington, Division of Dental Health, United States Public Health Service, 1967.

[9] Moen, B. D., THE 1965 SURVEY OF DENTAL PRACTICE, Chicago, American Dental Association, 1967, p. 21; also, ———, THE 1962 SURVEY OF DENTAL PRACTICE, p. 28, and ———, THE 1959 SURVEY OF DENTAL PRACTICE, p. 27. Although preliminary estimates from the American Association of Dental Examiners survey indicate that about 25 percent of licensed dentists employ no auxiliaries, and thus suggest that these estimates from the Survey of Dental Practice may overstate auxiliary employment, the Survey of Dental Practice data should be a consistent and an accurate measure of employment trends. For historic data *see* Weinfeld, W., Income of Dentists, 1929–1948, *Survey of Current Business,* 15–16, January 1950.

[10] Moen, THE 1965 SURVEY OF DENTAL PRACTICE, *op. cit.,* p. 35; Weinfeld, *op. cit.,* p. 16, provides useful historic data for 1948, tabulating mean employees per dentists by net income.

[11] Moen, B. D., THE 1953 SURVEY OF DENTAL PRACTICE, Chicago, American Dental Association, 1954, p. 14; ———, THE 1965 SURVEY OF DENTAL PRACTICE, *op. cit.,* p. 9.

[12] ———, THE 1965 SURVEY OF DENTAL PRACTICE, *op. cit.,* p. 35.

[13] ———, THE 1959 SURVEY OF DENTAL PRACTICE, *op. cit.,* p. 36.

[14] ———, THE 1965 SURVEY OF DENTAL PRACTICE, *op. cit.,* pp. 30, 32.

[15] *Ibid.,* p. 22.

[16] Moen, THE 1959 SURVEY OF DENTAL PRACTICE, *op. cit.,* p. 36.

[17] Knowing whether productivity increases occur primarily from the replacement of dentists or from changes in established dentists is critical to any evaluation of the future adequacy of the dentist supply, as the latter would permit considerably greater increases in productivity. However, because measurement involves time-series data, it will be quite difficult and will be delayed until the early 1970's.

[18] Moen, THE 1965 SURVEY OF DENTAL PRACTICE, *op. cit.,* p. 34. For verification, a second estimate of relative productivity was obtained by adjusting gross income by age data (*ibid.,* p. 13) for variation in dental fees for the different age groups. *See* Moen, B. D., Dental Fees in 1965, *Journal of the American Dental Association,* 73, 356, August, 1966. The two estimates agree closely.

[19] Moen, THE 1965 SURVEY OF DENTAL PRACTICE, *op. cit.,* p. 34; ———, THE 1962 SURVEY OF DENTAL PRACTICE, *op. cit.,* p. 44; ———, THE 1959 SURVEY OF DENTAL PRACTICE, *op. cit.,* p. 46; ———, THE 1956 SURVEY OF DENTAL PRACTICE, *op. cit.,* p. 38; ———, THE 1953 SURVEY OF DENTAL PRACTICE, *op. cit.,* p. 33; ———, THE 1950 SURVEY OF THE DENTAL PROFESSION, *op. cit.,* p. 19. Because patient visit data were unavailable for the years 1952 and 1955, estimates of the increase in patient visits were made for the periods 1949–1952, 1952–1955, and 1955–1958 on the basis of the percentage increase in the number of patients. The estimated patient visit figure for 1958 was 2,782, the age-adjusted measure 2,784.

[20] Although productivity appears to have increased rapidly between 1961 and 1964, examination of age-specific data of patient visits per dentist per year and auxiliary utilization suggests that a nontypical response caused 1961 data to be unduly low.

[21] Hann, H. J., Prices and Productivity in Dental Care, *Journal of Public Health Dentistry,* 27, 134, Summer, 1967; Weiss, J. H., The Changing Job Structure of Health Manpower, unpublished Ph.D. dissertation, Harvard University, 1966.

[22] *See* The Consumer Price Index: Dentists; Fees and Other Prices, *Journal of the American Dental Association,* 53, 336–339, September, 1956; and Dental Fees in 1962, *Journal of the American Dental Association,* 67, 748, November, 1963.

[23] Data from, Dental Fees in 1956, *Journal of the American Dental Association,* 62, 442–446, April, 1961; and Dental Fees in 1962, *op. cit.*; Dental Fees in 1965, *op. cit.* The estimate for the 1950 to 1965 period was obtained by establishing a ratio for the years 1956 to 1965 and applying the ratio to the 1950–1965 change in the Consumer Price Index.

[24] Because the dental fee factor is in an inverse relation to the productivity increase factor in the original equation, the effect of substituting 61 per cent for 44 per cent is achieved by dividing the productivity increase estimate by 1.39.

[25] Both expenditure-based and visit-based estimates of productivity increases have their limitations. Estimates based on dental visits obscure any increases in productivity that occur in the form of greater amounts of care being provided per visit, although any increase in productivity per hour may be counterbalanced by a shortening of the length of the average visit. Expenditure-based estimates, in turn, cannot be adjusted for changes in the age distribution of dentists and it would be expected that the shift from an older to a younger dentist population would result in higher productivity levels. Although real, such an increase is nonrecurring. Also, dollar expenditures for a given service do not necessarily reflect the manpower resources needed to provide that service, relative to other services. Fee levels and proportional distribution of the types of service change over time, and these changes could affect expenditure levels severely.

[26] National Center for Health Statistics, VOLUME OF DENTAL VISITS, *op. cit.,* p. 16. Division of Public Health Methods, DENTAL CARE, VOLUME OF VISITS, *op. cit.,* p. 12. To achieve comparability with the productivity estimate, all active dentists, including recent graduates, were used in this computation.

[27] For data to be useful in preparing estimates in changes in dental care demand, three requirements must be met: variations in the causative factor must be subject to uniform measure, changes in the demand rate associated with these variations must be quantifiable, and useful historic data or projections must exist for the causative factor. These requirements are particularly difficult to obtain for attitudinal data.

[28] The proportion of the population in the age groups between 5 and 54 decreased from 72.3 per cent in 1950 to 71.4 per cent in 1965. United States Bureau of the Census, *Current Population Reports,* series P-25, nos. 311 and 321.

[29] This decrease affects the average dental demand rate by 1/100th of a dental visit. The dental care demand rates used in these computations, as well as all following computations, were obtained from special tabulations of data from the 1963–1964 National Health Survey, prepared on request by the National Center for Health Statistics. Although in computation, data were carried to one further place to reduce rounding error and in some instances data were broken out further than is customary at the National Center for Health Statistics, general estimates of data reliability and relative standard error can be found *in* National Center for Health Statistics, VOLUME OF DENTAL VISITS, *op. cit.,* pp. 47–54.

[30] Detailed income-education specific dental demand rates for white persons (see Table 8 for example) were applied to the nonwhite population used in the National Health Survey. It was found that a white population of the same income and education distribution as existed among nonwhite persons would have a dental visit per person per year rate of 1.04 compared to the rate of 0.91 measured for nonwhite persons. Thus, 17.1 per cent of the original difference by

race, cannot be explained by income and education levels. One explanation for part of this remainder might be the scarcity of Negro dentists. In 1960 it is estimated that there were over 10,000 Negro persons for every Negro dentist (*see Facts About States for the Dentist Seeking a Location, 1964,* Chicago, Bureau of Economic Research and Statistics, American Dental Association, November, 1964, p. 8). Regarding race and care needs, *see* National Center for Health Statistics, SELECTED DENTAL FINDINGS IN ADULTS, series II, no. 7, Washington, United States Public Health Service, 1965, p. 9: and ———, ORAL HYGIENE IN ADULTS, series II, no. 16, Washington, United States Public Health Service, 1966, p. 10.

[31] Although location changes result in an increase of 0.06 visits per person per year (four per cent), when income differentials are held constant the increase is only 0.03 visits (two per cent). For population data *see* United States Bureau of the Census, THE 1950 POPULATION CENSUS, Washington, United States Government Printing Office; and THE SURVEY OF BUYING POWER, Sales Management, Inc., 1966, p. B. Patient visit data came from the unpublished source cited in reference 29.

[32] McKeithen, E. J., A Study of Attitudes and Motivations Affecting Utilization of Dental Services, *Social Science Research Opportunities in Dental Health,* United States Public Health Service, 1965, pp. 19–23.

[33] Metz, A. S. and Richards, L. G., Children's Preventive Dental Visits: Influencing Factors, *Journal of the American College of Dentists,* 34, 204–212, October, 1967.

[34] To be useful, number or frequency of dental visits by the child would have to be correlated to a quantified measure of parental attitudes, such as their dental visit habits, and other important factors would have to be controlled.

[35] Unpublished data from the 1963–1964 National Health Survey (see reference 29).

[36] Unpublished data from the 1963–1964 National Health Survey (see reference 29). United States Bureau of the Census, *Current Population Reports,* series P-60, no. 51; series P-20, no. 158.

[37] United States Bureau of the Census, STATISTICAL ABSTRACT OF THE UNITED STATES: 1964, 85th edition, Washington, United States Department of Commerce, 1964, p. 113.

[38] It should be noted that the demand estimate of 1.76 visits is a relative figure and does not represent a 0.18 visit increase over the 1963–1964 level necessarily, because the income distribution estimates used differ from those used in 1963–1964 National Health Survey estimates. The use of these estimates, cited in reference 29, is required to obtain comparable income estimated for 1950.

[39] As in the case of the estimate related to income changes, this estimate is obtained by applying the per capita demand rates shown in Table 6 to the changing distribution of the population by educational level.

[40] Data from unpublished 1963–1964 National Health Survey (see reference 29). The estimate of care demands attributable to income, or education, alone were obtained by multiplying the population distribution of the other factor by the "all persons" demand rates associated with the other factor and subtracting the resulting "expected visits" figure from the "all persons" figure for the factor being estimated.

[41] This small increase is not the only effect of increases in education, any more than a similar computation for income would measure the total impact of income. A much larger combined effect exists that can only be assigned to both factors, and in these computations this joint effect is included in the income-based estimate. For sources of data on education levels used in computations, see reference 37.

[42] Several factors have been excluded from the computations. The final estimate probably understates the increases that have occurred in dental care demands. Excluded factors are: (1) fluoridation: this is not thought to greatly influence care demand levels. Although present studies are not conclusive, indications are that the benefits of fluoridation reduce unmet care needs rather than reduce care demands. *See* Douglas, B. L. and Coppersmith, S., The Impact of Water Fluoridation on Dental Practice, *The New York State Dental Journal,* 31, 439–448, December, 1965. (2) Family Size: income computations are based on consumer unit because family size data are available only from 1955. However, family size has decreased for low-income families compared with other families. *See* United States Bureau of the Census, *Current Population Reports,* series P-60, no. 24, p. 15 and no. 51, p. 20. Two sources of underestimation of demand increases result. First, within each income category of National Health Survey data, reported dental visits vary inversely with family size. Thus, it would seem that the larger low-income families of 1950 would have had demand rates lower than the 1963–1964 rates used in the computations of the present analysis. Second, the use of consumer units instead of persons in an underestimation of population shifts to higher income categories. (3) Inflation: the 1950 and 1965 income distributions are expressed in current rather than in constant dollars. Consequently, the proportion of consumer units in the lower income groups in 1950 is overstated, resulting in an overestimate of care demand increases. The implicit price deflator for personal consumption expenditures over this period is 31 per cent. *See* United States Bureau of the Census, *Long Term Economic Growth: 1860–1965,* Washington, United States Government Printing Office, October, 1966, p. 200. Assuming the maximum transfer of consumer units to higher income categories to adjust for this 31 per cent inflation, the care demand rate is increased by about 0.06 visits per person per year in 1950. This overestimate is less than one-half the size of the underestimate that results from the exclusion of family size from the computations. (4) Female employment: female employment increases dental care demands. National Center for Health Statistics, VOLUME OF DENTAL VISITS, op. cit., p. 23. Though an unidentified amount of this increase reflects an increased income, the exclusion of this factor results in an underestimate of care demand increases. (5) Parental attitudes: although possibly as important as education or income level, the data insufficiencies of this factor do not permit its inclusion. The result is an underestimate of unknown dimensions. (6) Adequacy of 1950 care supply: the entire analysis assumes the 1950 supply of dental care to be adequate. However, the 1950 ratio of persons per dentist represents a decline from 1940 and 1930.

[43] United States Bureau of the Census, *Current Population Reports,* series P-25, no. 372, August, 1967.

[44] The required number of dentists figure was obtained by multiplying the 1950 dentist supply by the percentage increase in care demands between 1950 and 1965, and dividing the product by the percentage increase in care supply for the same time period.

[45] Moen, THE 1965 SURVEY OF DENTAL PRACTICE, op. cit., p. 38. Data categories have been combined.

[46] *Ibid.,* p. 37.

[47] HEALTH RESOURCES STATISTICS, 1965, United States Public Health Service, 1966, p. 47; THE SURVEY OF BUYING POWER, op. cit., p. B-3.

[48] United States Bureau of the Census, STATISTICAL ABSTRACT OF THE UNITED STATES, 1966, Washington, United States Government Printing Office, 1966, p. 331. Total income is used because it reflects both growth in the population and growth in per capita income.

[49] For a summary of the provisions as amended by Public Law 89-290, *see* Sullivan, E., Health Professions Educational Assistance Amendments of 1965 (P.L. 89-290), *Health Education and Welfare Indicators,* Washington, United States Department of Health, Education and Welfare, November, 1965, p. 9. Estimates by the Division of Dental Health, as of July 1968, are that without HPEA construction only 48,000 dentists would be graduated in the 1965–1980 period. With HPEA school construction, the estimates of graduates are greater. The low estimate of 58,000 graduates assumes federal asssistance for dental school construction to cease after 1969; the high estimate of 60,000 assumes the continuation of funding at the level of $35 million per year through the early 1970's. Both estimates assume 10.5 per cent student attrition. *See* HEALTH MANPOWER SOURCE BOOK, section 18, Washington, United States Public Health Service, 1964, p. 50.

[50] These estimates are prepared by the Division of Dental Health, United States Public Health Service. Active dentists in 1980 are estimated by computing estimated surviving dentists in 1980, and subtracting estimated retirement.

[51] To maintain the federal service component at 7,300 dentists more than 5,000 dentists would be needed to replace dentists leaving federal service.

[52] *The Number of Dental Schools in Operation in the United States and the Number of Graduates from Each Year from 1841 to 1958,* Council on Dental Education, American Dental Association, #1268/1, mimeographed. *Dental Students' Register, 1961/1962,* Council on Dental Education, American Dental Association.

[53] National Center for Health Statistics, *Decayed, Missing, and Filled Teeth in Adults: United States, 1960–1962,* series 11, no. 23, Washington, United States Public Health Service, February, 1967, p. 20. National Center for Health Statistics, *Periodontal Disease in Adults: United States, 1960–1962,* series 11, no. 12, Washington, United States Public Health Service, November, 1965, p. 13.

[54] Mitchell, G. E., The False Economy of Dental Neglect, *Economic Benefits from Public Health Services,* Washington, United States Public Health Service, April, 1964, p. 19.

[55] National Center for Health Statistics, *Dental Visits, Time Interval Since Last Visit, op. cit.,* p. 1.

[56] Mitchell, *op. cit.,* p. 19.

[57] *Ibid.,* p. 21. *Social Security Bulletin,* Social Security Administration, February, 1967, p. 9. Expenditures of $15 billion equals about five and one-half times present expenditures. Five and one-half times the present dentist supply is 485,000 dentists. Young, W. O. and Striffler, D. F., THE DENTIST, HIS PRACTICE, AND HIS COMMUNITY, Philadelphia, W. B. Saunders Company, 1964, p. 180. (One dentist for every 250 persons equals about 800,000 dentists.)

[58] *U.S. Economic Growth to 1975: Potentials and Problems,* Subcommittee on Economic Progress of the Joint Economic Committee, Congress of the United

States, 1966, pp. 16 and 24. The lower assumption B is used and extended by the author to 1980. This assumption projects a GNP at a real growth rate of 4.0 per cent per year with a 1.5 annual increase in GNP implicit price. Extended to 1980, this projection gives a GNP of $1,470 billion in current dollars. The 1975 personal income estimate, in current dollars, is $961.9 billion.

[59] *National Economic Projections to 1976–1977,* report no. 66-N-1, National Planning Association Center for Economic Projections, September, 1966, Table 13. These projections are quite comparable to the Joint Economic Committee projections cited in reference 57, foreseeing a consumer unit income of $999 billion in 1976, compared with the JEC projection of $962 billion in 1975. Like the personal income projections, these income distribution projections were extended to 1980. The method used was the multiple triordinate graphic extension of the National Planning Association data.

[60] Patient visits are computed by multiplying the 1963–1964 demand rates shown in Table 6 by the percentage distribution of consumer units by income shown in Figure 7. Cumulate multiplication results in total patient visits.

[61] *Current Population Reports,* series P-20, no. 158, Washington, United States Bureau of the Census, December, 1966, p. 18. Estimates used are those for males, 25 years and over.

[62] To maintain consistency, National Planning Association data were used to estimate the 1965 income distribution. On this basis, the appropriate 1965 demand rate to be used for computing the percentage increase from 1965 to 1980 is 1.73 visits per person.

[63] *Fact Sheet on Dental Prepayment,* Washington, Division of Dental Health, United States Public Health Service, January, 1967.

[64] SUPPLEMENT TO REPORTS OF OFFICERS AND COUNCILS, 1964, Chicago, American Dental Association, 1964, pp. 60–71; and Committee on Dental Health Plans, American Academy of Periodontology, Report of the 1964 Dental Health Plan Committee, *Journal of Periodontology,* 36, January–February, 1965. *See also* the speech, The Role of Dental Care in Group Purchase of Health Benefits, given by Mitchell, G. E., at the 1964 Group Health Institute, Minneapolis, May 15, 1964.

[65] *See* Sections 1901 through 1905 of Public Law 99–97 (79 Stat. 343-52). Also see Summaries of Recent Legislation Affecting Dentistry, Division of Dental Health, United States Public Health Service, February, 1967, p. 17; and Notes: Income for Maintenance of the Medically Needy, *Welfare in Review,* 5, 17, March, 1967. A good discussion of programs and trends can be found *in* Pelton, W. J., Comprehensive Dental Care for Everyone, *Journal of the Alabama Dental Association,* 52, 17–27, April, 1968.

[66] Data received from the Division of Program Operations, Social Security Administration, October, 1967.

[67] When the estimated average gross income for dentists in 1967 of $42,000 is divided into $67.7 million, an estimate of 1,612 dentists is obtained. Expenditure estimate obtained from Division of Program Operations, Social Security Administration, April, 1968.

[68] For provisions *see,* Social Security Amendments of 1967: Report of the Committee on Finance, United States Senate, Report No. 744, November, 1967, Washington, United States Government Printing Office, 1967, pp. 194, 196–197, 313.

[69] Senate Bill 2614, 90th Congress, First Session, November 1, 1967, and House Unit Report Urges Kin Dental Care in 1968, *Navy Times,* November 15, 1967, p. 1.

[70] *See* Sections 1801, *et seq.,* of Public Law 99-97 (79 Stat. 275–332), Title XVIII of the Social Security Amendments of 1965.

[71] Because many programs were directed at specific age groups, computations must be made in terms of individuals rather than in terms of consumer units. Therefore, a projection of the population by age and family income was prepared and used to compute the percentage increase in care demands resulting from each of the three alternatives.

[72] *Current Population Reports,* series P-25, no. 359, Washington, United States Bureau of the Census, February, 1967, series B.

[73] If the estimate of a care shortage of 18,000 dentists, made earlier, is assumed, the 1965 care demand estimate becomes 363 million visits. In this case, 1980 care demand estimates would be 650, 693 and 741 million visits.

[74] Patient visits per dentist per year obtained by dividing the total number of visits per year by 113,000 dentists.

[75] Shortage figures were obtained by multiplying the 1965 dentist supply by the percentage increase in care demands between 1965 and 1980, and dividing the product by the percentage increase in care supply for the same time period. Any shortage projected for 1980 would be in addition to that which existed in 1965.

[76] See reference 42 regarding this question.

[77] *Dental Auxiliary Fact Sheet,* Division of Dental Health, United States Public Health Service, 1967.

[78] Moen, THE 1965 SURVEY OF DENTAL PRACTICE, op. cit., pp. 33–35.

[79] Preliminary results from a survey of dentists being jointly conducted by the American Association of Dental Examiners and the United States Health Service.

[80] Kesel, R. G., Dental Practice, *in* THE SURVEY OF DENTISTRY, *op. cit.,* pp. 182–283. TRANSACTIONS: 1966, Chicago, American Dental Association, November, 1966, pp. 36, 37, 47. News of Dentistry, *Journal of the American Dental Association,* 75, 1330–1331, December, 1967.