Population and Access to Prosthetists[1]

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Concern with delivery systems for health care has become widespread within government and within many of the professional groups involved in the provision of care. As part of this concern, much attention has been focused upon locating health facilities so as to enable maximum access for populations in need of services. It is recognized that location factors do not produce or explain utilization, nor necessarily effect quality of health services. Still, the location of facilities is a basic determinant of *potential* access to services, whether or not utilization occurs. Without a facility to use there is no utilization. With a facility accessible, there may be some utilization. Judgments of the adequacy of services begin, but do not end, with the question of availability or potential success within geographic territories.

This paper describes the geographic dispersion of certified prosthetists and certified facilities in the United States. It also presents an imperfect but useful analysis of the potential access which certain general populations have to prosthetists, based upon ratios of facilities to population. In general, the accessibility of prosthetic services seems extremely uneven.

Caution in interpreting these findings must be exercised. Again, results do not necessarily relate to quality of services and no such implication should be drawn. Also, there are

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many additional factors which influence actual accessibility and real utilization of prosthetic services. Among these are the additional number of competent but uncertified prosthetists, the restriction of practice by some prosthetists to institutionalized or other special populations (e.g., VA), transportation, economic, and many other social factors influencing decisions to use health services.

While this analysis cannot yield conclusions about the quality of services nor the efficacy of utilization in relation to population needs, it is useful in several ways. It identifies a number of geographic areas and cities where there is reason to believe that prosthetic services are insufficient by being absent, or nearly so. Questions about service quality in such areas are unnecessary if there are no services. The analysis also identifies areas and cities where further investigation of actual accessibility would be likely to be most fruitful. This preliminary work provides a basis for selecting areas or cities for comparison purposes in further work seeking to define adequate prosthetic services for populations. It offers a starting point to the profession for self-examination and eventually may enable the profession to set goals, plan education programs, and influence the availability of services.

Our interest in the access problem results from intensive interviews with upper- and lower-extremity amputees throughout the country during the last five years. The more than 500 amputees with whom we talked gave clear evidence that the accessibility of adequate prosthetic services has considerable influence upon continuity of prosthesis wearing, decision to permanently discontinue use, and general levels of physical and social performance. Further, we heard claims that access to prosthetic services varies considerably by geographic areas.[3]

To better comprehend the availability of such services, we plotted locations of all certified limb facilities on a map of the United States. This exercise clearly demonstrated that tight clusters of facilities occur in and around certain big cities and that many large areas of the country have no certified prosthetists. Such a pattern can be expected because of the variation in population density.

The question then becomes: Does the distribution of prosthetic services match the distribution of population such that potential access is equal throughout the country? A further question, not investigated here, is: Are the human problems of obtaining prosthetic services within reasonable limits throughout the country?

The second question requires original field data which can only be obtained at considerable expense, requiring special funding. The first question can be attacked using al-

[3] Experiences of the amputees we interviewed were not known to be representative of all amputees, or of those in any one area. Our respondents were the widely dispersed patients of a single clinic caseload. Their reports could not yield a systematic picture of the availability of prosthetic services within any one geographic area, or the country as a whole. But they were highly suggestive. Patients were dispersed from Alaska to Puerto Rico, from Los Angeles to New Hampshire, from North Dakota to Texas. In all, 345 people were extensively interviewed, less extensive data was collected for over 500.

ready existing information. The issue is whether the geographic distribution of facilities is consistent with the distribution of people needing prosthetic services. An estimate of this relationship can be made by comparing population figures to the number of prosthetists in the same area.[4] There is certainly no ratio of population to prosthetists which is known to be satisfactory; that is, representative of optimum service accessibility. It would be hazardous to estimate the size of population which could be satisfactorily served per average prosthetist.

However, we can still detect regions with high and with low ratios of population to certified prosthetists and interpret the ratios using added knowledge of areas and services.[5] Variation in a series of such ratios for different areas would suggest, at the least, that in some areas prosthetic services are potentially less available than in others. Extreme variation would suggest that inadequate availability exists in some areas, if need is constant, and/or oversupply might exist in others, the latter being much less likely according to our respondents. Using existing data, and avoiding the problem of establishing an expected patient volume per prosthetist, our method of comparing ratios is as close as we can practically and inexpensively come to estimating whether there are satisfactory numbers of prosthetists for populations.

Following this logic we sought to learn whether access to prosthetists is likely to be a problem in the 25 most populous metropolitan areas of the country. United States Census population figures for 1970 were obtained for each metropolitan area.[6] Counts were made of all certified prosthetists and facilities in each metropolitan area using the *1971 Registry for Certification* published by the Board for Certification. Ratios of total population to certified prosthetists and ratios of total population to certified facilities were computed for each area and are shown in Table I.

Inspection of the ratios reveals a striking degree of variation even among our most populous areas. Within our 25 largest cities, the highest ratio was almost eight times the lowest for the number of facilities. The number of certified prosthetists varied by a factor of about three and one-half. Thus, Newark has eight times as many people per certified facility as Cleveland. Milwaukee has about three and one-half times as many people per certified prosthetist as Cleveland.

[4] Provided we accept certain assumptions specified later.

[5] For example, certain facilities utilize personnel in ways that effectively serve more clients, especially using uncertified prosthetists. The numbers of such people may vary in different regions. Cities vary in the degree to which their services are depended upon by people living outside the metropolitan area limits defined by the census. Reputations about quality and speed of services are certainly relevant qualifications to any ratios. I am indebted to A. Bennett Wilson, Jr., Executive Director, Committee on Prosthetics Research and Development, for examples illustrating this important point. The need for a thorough study by AOPA should be obvious.

[6] Population figures were obtained from the U.S. Bureau of Census, *Number of Inhabitants* (1970), by state. The AOPA 1971 listing of individual prosthetists was used. Hand counting was done carefully but may be subject to slight error. Census data for each state was used to compile lists of political divisions included in each SMSA. Judgment was required when a listed address was near an SMSA which was incompletely defined.

TABLE 1

POPULATION RELATIVE TO CERTIFIED PROSTHETISTS AND FACILITIES IN THE 25 LARGEST U.S. METROPOLITAN AREAS

STANDARD METROPOLITAN STATISTICAL AREAS		CERTIFIED		RATIOS	
Area	1970 Total Population	Facilities	Prosthetists	Population in Thousands Facilities	Prosthetists
New York	11,571,899	12	49	964:1	236:1
Los Angeles-Long Beach	7,032,075	17	25	414:1	281:1
Chicago	6,978,947	10	23	698:1	303:1
Philadelphia	4,817,914	8	13	602:1	371:1
Detroit	4,199,931	4	12	1050:1	350:1
San Francisco-Oakland	3,109,519	8	13	389:1	239:1
Washington, D.C.	2,861,123	3	10	954:1	286:1
Boston	2,753,700	6	11	459:1	250:1
Pittsburgh	2,401,245	2	5	1201:1	480:1
St. Louis	2,363,017	3	9	788:1	263:1
Baltimore	2,070,670	3	8	690:1	259:1
Cleveland	2,064,194	1	3	2064:1	688:1
Houston	1,985,031	2	5	993:1	397:1
Newark	1,856,556	7	7	265:1	265:1
Minneapolis	1,813,647	5	9	363:1	202:1
Dallas	1,555,950	2	5	778:1	311:1
Seattle-Everett	1,421,869	3	6	474:1	237:1
Anaheim-Santa Ana-Garden Grove	1,420,386	0	4	—	355:1
Milwaukee	1,403,688	3	7	468:1	201:1
Atlanta	1,390,164	2	5	695:1	278:1
Cincinnati	1,384,851	2	3	693:1	462:1
Paterson-Clifton-Passaic	1,358,794	1	3	1359:1	453:1
San Diego	1,357,854	2	3	679:1	453:1
Buffalo	1,349,211	1	2	1349:1	675:1
Kansas City	1,253,916	2	3	627:1	418:1

SOURCES: Population figures were obtained from the U.S. Bureau of Census, **Number of Inhabitants (1970)**, by state. **1971 Registry of Certified Facilities and Individuals in Orthotics and Prosthetics,** American Board for Certification in Orthotics and Prosthetics, Inc., Washington, D.C., 1971.

The size of the population per prosthetist is large. Table 1 ratios are in thousands of people for each certified prosthetist. Thus, Cleveland has 688,000 people for each certified prosthetist. While the presence of apprentices and uncertified prosthetists, some working in certified facilities, would reduce the ratios, it remains a rough index to service access.

Inspection of Table 1 reveals some differences concomitant with population size among the metropolitan areas. The most populous areas (the first eight listed, New York through Boston) have predominantly middle ratios (five) and low ratios (three), presumably having average or better access to prosthetists, among the 25 areas compared. The eight metropolitan areas which fall in a middle category according to population size (Pittsburgh through Dallas on the list in Table 1) are mixed in ratios, low (four), middle (two) and high (two), generally having average or better access to prosthetists. The nine metropolitan areas with the smallest populations among these 25 (Anaheim through Kansas City) have predominantly high ratios; five of the nine are high ratio cities, two each are low and middle ratio. These ratios may indicate less access

to prosthetists.

Unlike any other consecutively listed metropolitan areas in the list, the last five areas all fall at one extreme and all have high population ratios. While this pattern is weak, it may indicate a trend towards higher ratios and less access as city size decreases, perhaps after a threshold level of population is reached.

It is reasonable to expect that even greater variation would be revealed if ratios were computed for smaller cities. This would in part be due to the small numbers of prosthetists but also to the absence of services in many populous areas.

This does not suggest that any specific ratio reflects adequate access, It is most probable that no city has an adequate supply of prosthetists in relation to the numbers of people with deficiencies and the services they need. This is what our interviews suggest.

It must be noted that this method of estimating the relative availability of prosthetic services rests upon the following assumptions. The total number of people in an area is used as an index to the number in that population with prosthetic service needs. Comparisons between cities are based on the assumption that, among our largest metropolitan areas, the proportion of each population which is afflicted is probably about the same. It is also assumed that because there are concentrations of facilities and prosthetists in these areas, the differences between them in the number of people who are served per prosthetist will average out. If it does not average out, then there is chance of misinterpretation of the ratio variation, provided that those cities with high populations per prosthetist are the same cities in which prosthetists are able to serve more people.[7] It seems unlikely that there are sufficient differences in the numbers of patients served per average prosthetist *and* that these differences occur in a pattern to offset the effect of population ratios.

If these assumptions can be accepted as reasonable, then a nationwide look at the variation between ratios is warranted. Table 2 groups cities roughly into the one-third having the lowest ratios, the one-third having the highest ratios, and a middle one-third. Those with the lowest ratios, having the smallest population for each prosthetist, are likely to be cities where prosthetists are more accessible, based on sheer numbers alone. Metropolitan areas with the highest ratios probably have less accessible prosthetic services. It is interesting that no region of the country can be identified, from Table 1, as having either mostly cities with relatively easy access to prosthetists or as having mostly cities with rela-

[7] If the number of people who are served by low volume prosthetists differ from the number served by high volume prosthetists by a factor of three and one-half or more, then we must modify conclusions based on the finding of variations by a factor of three and one-half in the ratios of prosthetists to population. As an example, if a high population ratio city such as Cleveland was known to have high volume prosthetists serving three and one-half times as many patients as a low population ratio city such as Milwaukee, where it was known that low volume prosthetists were serving less than one-third as many patients as were served by the Cleveland prosthetists, then the three and one-half fold difference in prosthetist to population ratios would be offset or equalized and a conclusion of differing availability would be inaccurate.

TABLE 2

GROUPED DATA—CERTIFIED PROSTHETISTS RATIOS TO POPULATION

Low Ratios—Greatest Access—201:1 to 265:1 (thousands)

Milwaukee	Seattle	Baltimore
Minneapolis	San Francisco	St. Louis
New York	Boston	Newark

Middle Ratios—Average Access—278:1 to 371:1 (thousands)

Atlanta	Chicago	Anaheim
Los Angeles	Dallas	Philadelphia
Washington, D.C.	Detroit	

Highest Ratios—Least Access—397:1 to 688:1 (thousands)

Houston	Paterson	Buffalo
Kansas City	Cincinnati	Cleveland
San Diego	Pittsburgh	

SOURCES: Population figures were obtained from the U.S. Bureau of Census, **Number of Inhabitants (1970)**, by state. **1971 Registry of Certified Facilities and Individuals in Orthotics and Prosthetics,** American Board for Certification in Orthotics and Prosthetics, Inc., Washington, D.C., 1971.

tively difficult access. A mixture of both high and low ratio metropolitan areas appears in each general zone.

A listing of cities and ratios for each AOPA region, Table 3, reveals the same mixed results in general. The exception is that, in Region V, two of the three large metropolitan areas have high population ratios, Cleveland (688:1) and Cincinnati (462:1), and the third has only a middling ratio, Detroit (350:1). An opposite pattern occurs in Region VI where two low ratio cities, Milwaukee (201:1) and St. Louis (263:1 occur with a middle range

TABLE 3

POPULATION PER PROSTHETIST RATIOS BY REGIONS OF AOPA

I	Boston	250:1	L	VI	Milwaukee	201:1	L
					Chicago	303:1	
II	New York	236:1	L		St. Louis	263:1	L
	Buffalo	675:1	H				
	Newark	265:1	L	VII	Minneapolis	202:1	L
	Paterson	453:1	H		Kansas City	418:1	H
III	Philadelphia	371:1		VIII	Houston	397:1	H
	Washington, D.C.	286:1			Dallas	311:1	
	Pittsburgh	480:1	H				
	Baltimore	259:1	L	IX	Los Angeles	281:1	
					Anaheim	355:1	
IV	Atlanta	278:1			San Diego	453:1	H
V	Detroit	350:1		X	San Francisco	239:1	L
	Cleveland	688:1	H				
	Cincinnati	462:1	H	XI	Seattle	237:1	L

KEY: H = High ratio cities, having larger populations per prosthetist (397:1 to 688:1)—thousands)
L = Low ratio cities, having smaller populations per prosthetist (201:1 to 265:1—thousands)

SOURCES: Population figures were obtained from the U.S. Bureau of Census, **Number of Inhabitants (1970)**, by state. **1971 Registry of Certified Facilities and Individuals in Orthotics and Prosthetics,** American Board for Certification in Orthotics and Prosthetics, Inc., Washington, D.C., 1971.

city, Chicago (303:1). In the remaining regions where there are two or more metropolitan areas, high population ratio cities appear with offsetting low ratio areas. Middle range areas are well scattered among all regions.

Combining the ranking of ratios for prosthetists and for facilities we can list metropolitan areas in which there may be scarcity of both shops and certified prosthetists. Note that this conclusion is tentative, at best, and subject to modification by detailed knowledge of the quantity and character of services. The potentially difficult access areas are Cleveland, which ranks at the extreme on both prosthetist and facility ratios, Buffalo, Pittsburgh, Houston, and Paterson. Paterson is the only one of these geographically near another area with ratios likely to be offsetting. The cities which are likely to have the readiest access, with low population ratios for both individual prosthetists and facilities, are Seattle, Milwaukee, Boston, San Francisco, Minneapolis, and Newark. Again, Newark may be used by Paterson area clients, reducing its real access.

It appears from this analysis that, even among populous metropolitan areas, we find sufficient variation in the numbers of certified prosthetists per population to expect important differential effects upon the availability of services and, therefore, upon the well-being of patients. It seems likely that the variation in access is even more extreme among smaller metropolitan populations. It is important not only to document this distribution more fully but to learn in more direct and concrete terms about the problems of access to services.

Returning to our basic question about the reality and effects of thinly spread prosthetic facilities away from the city clusters, we must reemphasize the need for research on the human problems of obtaining services. From the analysis of metropolitan areas it seems clear that the problems of obtaining access to prosthetists are not limited to people living in ranch and farm areas. While research on personal problems of access is more complicated and must await the mounting of considerable research resources, it is useful to outline the dimensions of the problem for areas where the number of prosthetists is low.

Half of our states have only three or fewer facilities certified in prosthetics; twenty-four states have only two or less, fourteen have only one, and seven states have no facility certified in prosthetics. If both prosthetic and orthotic facilities are counted, the picture is only slightly better. Six states have no facilities, of either kind, thirteen have one or less, and seventeen states have two or less. Lists of these states are shown in Tables 4 and 5.

Generally, the states with few facilities are relatively less populous, either relating to low density or small size. However, many are likely to have a higher proportion of amputees in the general population, based on the contributions of certain etiologies to the total afflicted. The long-standing leading causes of amputation have been farm machine accidents and gunshot (primarily hunting) accidents. While these causes are dropping in rank among

TABLE 4

CERTIFIED PROSTHETIC FACILITIES IN STATES WITH FEW FACILITIES

(Excludes Shops for Orthotics Only)

No Facilities	One Facility	Two Facilities	Three Facilities
Alaska	Delaware	Alabama	Kentucky
Maine	Hawaii	Arizona	Oklahoma
New Hampshire	Idaho	Arkansas	
North Dakota	Kansas	District of Columbia	
Rhode Island	Nebraska	Mississippi	
South Dakota	Nevada	Montana	
Wyoming	Vermont	New Mexico	
		Oregon	
		Utah	
		West Virginia	
Total = 7 States	Total = 7 States	Total = 10 States	Total = 2 States

NOTE: The number of certified facilities per state indicates whether or not there is any possibility of in-state quality service for a population of whatever size. It is especially important because of the changing sources of payment and referral from or through state agencies.

TABLE 5

CERTIFIED PROSTHETIC AND/OR ORTHOTIC FACILITIES IN STATES WITH FEW FACILITIES

No Facilities	One Facility	Two Facilities
Maine	Nevada	Montana
New Hampshire	Idaho	Arizona
North Dakota	Nebraska	New Mexico
South Dakota	Vermont	West Virginia
Wyoming	Delaware	
Rhode Island	Alaska	
	Hawaii	
Total = 6 States	Total = 7 States	Total = 4 States

reasons for new amputations, they probably are still the causes which contributed the most cases among all existing (prevalent) cases. These causes occur mostly in rural areas and therefore we might expect a higher proportion of amputees in rural, less populous, states. In addition, these same states tend to have older populations and therefore may have more geriatric amputees, relative to total population, than states having more prosthetic facilities.

The lack of facilities in some states is to some degree compensated for by the existence of other facilities nearby. For example, the low number of facilities in Rhode Island, Delaware, and the District of Columbia must be viewed in the perspective that concentration of facilities occur in Boston and Hartford, Philadelphia, and Baltimore. The question of whether the human problems of time, cost and inconvenience deter access for people within these densely populated areas must await specific study.

Many states without suitable prosthetic facilities are not adjoined by

other states having a concentration. These become zones of sparse prosthetic resources. In New England, three states of the six have no certified prosthetic facility and a fourth (Vermont) has one, located in the extreme northwest corner of the state. In effect, all of Maine and New Hampshire and two-thirds of Vermont must be served from Boston. Most dramatic, all of both Dakotas, half of Minnesota, half of Montana, most of Nebraska, all of Wyoming, and much of Kansas, all geographically contiguous, are without a certified prosthetic or orthotic facility. It seems doubtful that the scattered shops next to this vast area can offer adequate access to services. This leaves a zone in which there are no certified facilities that is about 1,000 miles wide east to west at the top and 1,000 miles long from north to south. The concentrations of certified facilities nearest to this giant vacant V shape in our northern midwest occur at Chicago, Denver, Oklahoma City and Minneapolis.

Population figures and demographic descriptions such as those used here are not direct measures of prosthetic service accessibility. However, they provide means to estimate the existence, extent, and location of problems in access. It is our conclusion that access to prosthetic services is clearly unequal and deserves national attention. Adding what is known about the effectiveness of shops and individual prosthetists, professional judgments can be made defining the problems and establishing their priorities. Hopefully, resources will be allocated not only for the research needed to describe the human problems of access to prosthetic services but also to alleviate those problems.