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ABSTRACT

The diffusion and U.S. geographic distribution of primary care physicians are discussed in three papers. The literature on the diffusion issue is reviewed in the first paper. After introducing diffusion concepts, measures, and problems, current evidence for the diffusion of physicians are assessed, and efforts to forecast future needs for physicians in health manpower shortage areas are considered. In the second paper, forecasts are presented of population-to-primary care physicians ratios in U.S. counties over the 1982-1994 period. The forecasts are based on an econometric model developed by the Modeling and Research Branch of the Office of Data Analysis and Management, a federal agency. These forecasts do not provide estimates of physician needs in shortage areas because the majority of shortage areas are not whole counties. Therefore, the third paper went beyond the county-level forecasts to project rates of change in population-to-physician ratios for subcounty shortage areas and to calculate future needs based on the current shortage area designation criteria. Assumptions underlying the forecasts of the econometric model are also identified, with attention to projections of the supply of physicians at the national level and the county level projections of population and income. (SW)

Diffusion and the Changing Geographic Distribution of Primary Care Physicians

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FOREWORD

In January 1983, the Bureau of Health Care Delivery and Assistance asked the Bureau of Health Professions to provide analytic information on the geographic distribution of primary care physicians to be considered in developing a 10-year plan and legislative proposal for the National Health Service Corps (NHSC) in anticipation of the expiration of its authorizing legislation at the end of Fiscal Year 1984. The three papers in this report were prepared by the Bureau of Health Professions' Office of Data Analysis and Management (ODAM) in response to that request. The ODAM was asked to do the work involved because it conducts the health manpower shortage area (HMSA) designation program and carries out an intensive program of research into the geographic distribution of health professionals.

The papers provide two types of information requested by the Bureau of Health Care Delivery and Assistance. These were, first, an assessment of the rate of diffusion of primary care physicians due to the past and projected rapid increases in their numbers, and second, a projection of future needs for physicians in primary care health manpower shortage areas. In response, the ODAM provided a review of the literature on the "diffusion" issue (the first paper in this report) as well as forecasts of the diffusion of primary care physicians from an econometric model developed by ODAM's Modeling and Research Branch (the second paper in the report). While the forecasts provided a quantitative estimate of the effect of diffusion on the future geographic distribution of primary care physicians among counties in the continental United States, they did not provide estimates of physician needs in shortage areas because the majority of shortage areas are not whole counties. Therefore, a third effort went beyond the county-level forecasts to project rates of change in population-to-physician ratios for sub-county shortage areas and to calculate future needs based on the current shortage area designation criteria.

While it is clear that geographic diffusion of physicians has taken place and will continue to take place, our ability to forecast its progress, particularly at the micro-level, is still under development. Efforts are under way within the Bureau of Health Professions to refine the models used to make the forecasts and projections presented in the second and third papers of this report. Further developments and refinements will be reported in future reports and professional journals. Meanwhile, those interested in further information on the material presented in this report should contact Mr. Howard V. Stambler, Director, Office of Data Analysis and Management, Bureau of Health Professions, Room 8-41, 5600 Fishers Lane, Rockville, Maryland 20857.

Thomas D. Hatch
Director
Bureau of Health Professions

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TABLE OF CONTENTS

LIST OF TABLES

The Geographic Diffusion of Physicians

Forecasts of Population-to-Primary Care Physician Ratios in U.S. Counties, 1982-1994

THE GEOGRAPHIC DIFFUSION OF PHYSICIANS

THE GEOGRAPHIC DIFFUSION OF PHYSICIANS

Summary

A number of recent analytical and research efforts have addressed the issue of changes in geographic distribution and the "diffusion" of health professionals, especially of physicians. Although the term "diffusion" has a number of meanings and interpretations, in most cases the term has been used to refer to an hypothesized geographic dispersion of physicians resulting from the recent large increases in their numbers. Whether or not the occurrence of diffusion can be demonstrated has significant policy implications for the role and scope of the National Health Service Corps. This report reviews and synthesizes the results of recent research on the diffusion of physicians and summarizes the present state of knowledge about it; it also presents recent data on some changes in the geographic distribution of physicians at the county level developed by the Office of Data Analysis and Management. Although county data are not completely satisfactory for testing hypotheses about diffusion, they represent the lowest level of data that is regularly available for analysis and do provide some useful insights into the progress of diffusion in the U.S.

Changes in the geographic distribution of physicians at the county level over the last decade are clearly consistent with expected patterns of diffusion when changes in physician specialty composition are taken into account. The total number of patient care physicians under 35 years of age has increased strongly in rural counties, suggesting that a replacement process for older physicians may now be occurring where it was not in evidence in previous decades. Although the number of office-based primary care physicians appears to be increasing more slowly in counties with under 25,000 inhabitants, these same county groups have had larger percentage increases in other types of physicians, i.e., specialists.

This pattern is consistent with the overall change in the composition of the physician supply that has occurred nation-wide over the past decade (i.e., 1970-1979); the total number of GP/FP physicians declined while the numbers of specialists increased markedly. Extensive examination of the patterns of physician location over the past decade, by centers of economic activity, shows that diffusion has occurred primarily in those physician specialties which dominate the overall increase in physician supply and that these specialties are the ones which have diffused into smaller areas.

On the other hand, the increase in FP practitioners nationwide has been largely offset by declines in the number of general practitioners, so that diffusion into smaller towns has not yet been noted for this GP/FP group. But, as the increasing number of family practice physicians continues to replace and augment the disappearing traditional general practitioner, diffusion of family practice physicians will also be observed more clearly in the future.

Recent econometric research has also confirmed that the operation of market mechanisms in large part underlies the geographic distributions of both physicians and dentists. Thus, the necessary competitive market functions for diffusion appear to be evident. The tentative measurements of the speed of diffusion that have been made indicate that market adjustments in the distribution of physicians are proportional to the magnitude of the disparity

between supply and demand, but are not rapid. Econometric models of the distribution of primary care physicians developed by the modeling research program of the Bureau of Health Professions are currently being adapted for use to forecast the diffusion implications of future increases in primary care physicians on the number of Health Manpower Shortage Areas.

Introduction: Diffusion Concepts, Measures, and Problems

In understanding and assessing the contents and findings presented here, it is important to keep in mind the various concepts, measures and analytical problems associated with empirical investigation of the diffusion issue. The concept of diffusion was introduced into the discussion of health manpower policy with the report of a study by Schwartz, et. al.[1] The extent of diffusion in the geographic distribution of physicians has since become of intense interest. Unfortunately, there has been some confusion over the definition and appropriate methods of measuring diffusion. Consequently, the first step in this papers' assessment of the diffusion of physicians is to clarify the different meanings of the concept.

Among the alternative definitions of the verb, diffuse, two are most appropriate within the context of this report. The more general one means to "spread freely over a wide area." The second, narrower definition means "the movement of entities of interest from a site of greater concentration to a site of lesser concentration when movement between the two sites is impeded but not prevented." The second definition implies a tendency toward equalization. As will be explained subsequently, these two definitions have different policy implications for interpreting the patterns of movement that may be taking place.

The noun, diffusion, also has two appropriate definitions--the act of diffusing and the state of being diffuse. The former indicates a process at work while the latter indicates the outcome of that process.

When these concepts are applied specifically to the diffusion of physicians, several different measures for diffusion could be appropriate. If physicians were spreading to places that previously did not have them or had fewer of them, one would observe increased numbers of practitioners in previously less well-served areas. However, an increase in the number of physicians would not necessarily imply an equalization of their density. Rather, the number of physicians could be increasing in less well-served areas while increasing more rapidly in other areas, thus producing a less equal overall distribution while concentration increased in all areas. If one were interested in assessing whether or not a process of equalization were under way, changes in the physician-to-population ratio would be the measure of most interest. If one were also concerned with the current state of diffusion, measurement of either the total number of physicians in an area or the relative density of physicians between areas at a point in time would be needed.

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[1] Schwartz, W.B., Newhouse, J.P., Bennett, B.W., Williams, A.P., The Changing Geographic Distribution of Board-Certified Physicians, RAND Corporation Pub. No. R-2673-HHS/RC, October, 1980.

Substantial problems confront empirical measurement and assessment based on any of the concepts of diffusion. Foremost among these is that the necessary information is largely unavailable and/or dated. Only limited current data are available concerning the number of health professionals and their density at county levels and even less at sub-county geographic levels.

Even when such data are available, other problems remain. One is the varying definitions and coverage of the health professional category being examined. Primary care physicians provide a particularly appropriate example, since primary care physicians are the focus of this paper and of the NHSC itself. Different decisions have been made by researchers and others as to how to count and measure physicians and services to be included in "primary care." General surgeons and OB/GYNs have been included in some measures because part of the services they provide are primary care.2/ Other measures have excluded them because the proportion of primary care they provide has either been too small or because the measure needed to deal with physicians as whole entities. Similar decisions must also be made on whether to include, for example, all active physicians, only non-Federal physicians, only U.S. graduate physicians, or total (active and inactive) physicians, on how to count part-time practitioners, and how to count residents in the primary care fields.

The appropriate geographic area to use also often poses a problem. Although there is general agreement that the area chosen should represent a "rational" market or service area for consumers, there is much less consensus on the actual choice of an area. In rural parts of the country, the county is often viewed as the best measure readily available, but it is far from ideal.3/ Area definitions become even more difficult for urban and suburban areas, where the county measure is frequently inappropriate but where alternative data are not available. (This issue frequently arises in the identification of health manpower shortage areas where concerned parties may disagree on what the appropriate service area should be.) To overcome the problems in assuming that the county represents a rational market area, some researchers have created special data bases to investigate the diffusion question with the "town," or center of economic activity, as the unit of analysis. The results of this particular type of research will be discussed later.

The pattern of diffusion observed will depend on the major forces driving it, e.g., economic growth or decline, an exogenous expansion of supply, or other factors. Other factors that change over time in concert with the particular causes of diffusion can obscure the evidence of diffusion unless their separate effects can be controlled or isolated statistically. Examples of

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2/ For purposes of shortage area designation and NHSC activities, primary care physicians generally include GP/FPs, internists, pediatricians, and OB/GYNs. The Health Professions Educational Assistance Act of 1976 defines primary care so as to exclude OB/GYNs.

3/ For further discussion, see Chapter III of the Report of the Graduate Medical Education National Advisory Committee to the Secretary, Department of Health and Human Services, Volume III, Geographic Distribution Technical Panel.

such other factors are the general movement of population from urban to nonmetropolitan areas and changes in economic activity in rural areas over time. Thus, the resolution of the diffusion question is a complex research problem to which direct empirical observation may contribute little insight. In the following pages, recent studies are reviewed to see what evidence they provide on diffusion of primary care physicians and current data on geographic distribution are analyzed for evidence concerning the same questions. Included are several empirical studies that investigate the existence of conditions that are necessary for diffusion and several that have looked for directly observable manifestations of diffusion. The paper ends with a discussion of efforts to actually measure or quantify rates of diffusion, and a description of the work being done by the Bureau of Health Professions to forecast the geographic distribution of physicians.

Current Evidence for Diffusion of Physicians

The following discussion of existing evidence for diffusion of physicians is divided into two parts. Included are (1) recent data on changes in the distribution of physicians and (2) qualitative empirical studies related to the issue of diffusion.

Observed Changes in Geographic Distribution During the 1970s

Trends in physician distribution are typically described in terms of population-to-physician ratios for SMSAs and for different sizes of non-SMSA counties. The latest available data allow observation of recent trends from 1975 to 1979. First, however, it may be instructive to look at the aggregate changes in the numbers of physicians that took place nationwide in the 1970s.

Physician diffusion during the late 1970s would have been precipitated by the significant expansion of physician supply that occurred during the decade. As shown in Table 1, the supply of active physicians (both MDs and DOs) increased sharply during the 1970s. The national supply of active physicians grew by 27 percent between 1970 and 1979, as did the supply of MDs alone. The numerically smaller numbers of DOs grew by 37 percent. By the end of 1979, the number of active physicians in the U.S. was estimated to be more than 87,000 above the 1970 level. The supply of primary care physicians--defined here to include GP/FPs, internists, and pediatricians--increased slightly more rapidly, rising by 31 percent over the period. The ratio of active physicians to population rose 17 percent (from 209 to 225 per 100,000) during this period, while the primary care physician/population ratio grew 23 percent (from 62 to 76 per 100,000 population).

Physicians are distributed geographically quite differently according to their type of activity. Table 2 presents physician/population ratios for nine categories of counties for physicians in selected activities and specialty groupings. The county categories used are the familiar AMA groupings, as determined from estimated 1978 populations. As can be seen from the table, the data show that very large differences in physician/population ratios exist among areas when all active non-Federal physicians are considered. However, when office-based, patient care physicians are considered, the differentials are much less; when office-based, primary care physicians are considered, the

geographic differential is further reduced. For example, the least populous counties have only 17 percent of the physician/population ratio of the largest SMSA counties (in terms of all active MDs), but have 55 percent of the largest SMSA counties' ratio for office-based primary care MDs. When MDs and DOs are examined together, the primary care physician/population ratio of the least populous counties improves to 62 percent of that of the largest counties. In short, the disparity between types of counties is much less significant for primary care physicians.

Much of the population/ratio differential between metropolitan counties and the more rural counties reflects the large numbers of non-patient care physicians and hospital-based physicians in metropolitan areas, two-thirds of whom are in training. Most of the remaining difference is in the relative supply of specialists. The difference between the highest and lowest ratios for primary care is only about one-quarter of the difference between the highest and lowest total office-based patient care ratios.

Significant changes have occurred in the location of active, non-Federal MDs and DOs over the past decade. Table 3 shows that the greatest growth in numbers of such physicians between 1970 and 1979 occurred in the very large nonmetropolitan counties and in the smaller metropolitan counties. Even the counties with the smallest populations (nonmetropolitan counties with less than 10,000 inhabitants) had a 14 percent increase in numbers of physicians between 1970 and 1979, in marked contrast to the decade of the 1960s when most categories of rural counties actually showed physician losses.

A similar pattern emerges from an examination of trends in physician/population ratios (see Table 4). One significant development during this period was the practically non-existent growth in nonmetropolitan areas between 1970 and 1973. From the mid- to late-1970s, on the other hand, the growth in the physician ratios of all but the two most rural groups of counties was generally comparable.

More detailed examination of the recent 1975-79 period highlights some of the changes in distribution during this time. Data for all of the States for this period are shown in Tables 5 and 6. Between 1975 and 1979, there was a 10 percent gain nationally in the ratio of active, non-Federal physicians per 100,000 population and a 9 percent improvement in the office-based primary care MD and DO physician ratio. For individual States, improvements in the active physician/population ratio ranged from a high of 25 percent (in Alaska) to a low of 2 percent (in Nevada and Wyoming). The change in the ratio for office-based primary care physicians over the period ranged from a 31 percent improvement (in the District of Columbia) to a 16 percent loss (in Wyoming).

Geographic changes in physician specialties for different types of counties during this same period show a somewhat different pattern, as shown in Tables 7 and 8. Table 7 compares the 1975-1979 increases in office-based primary care physicians with those of all other patient care MDs across different sizes of county. The percentage increase in the numbers of primary care physicians is notably less in the two most rural county groups, which also show practically no increase in primary care physicians per 100,000 population. In contrast, the metropolitan and larger nonmetropolitan counties show significant gains in numbers of primary care physicians, as well as clear increases in their ratios of primary care physicians to population.

When non-primary patient care MDs are considered, however, the situation is reversed. Although numerical gains are slight, the least populous county group clearly shows a large percentage increase in its non-primary care physician supply. On the other hand, the smallest percentage growth in non-primary patient care MDs occurred in metropolitan counties.

Table 9 presents 1975-1979 changes in the numbers of selected individual MD specialties. Within the primary care MD categories, the numbers of GP/FPs have remained essentially the same for all area types. A 1980 inventory conducted by the American Academy of Family Physicians, which located about 70 percent of the FPs who completed their training in 1977, 1978, or 1979, showed that 35 percent of the respondents were located in nonmetropolitan counties and nearly 9 percent were in rural counties with under 25 percent urban population.[4/] Thus, it is probable that the relatively stable numbers of GPs/FPs in the less populous counties represent slight declines in GPs combined with slight increases in FPs.

A final aspect of interest relates to the higher proportions of young physicians in these more rural groups of counties. Since the mid-1970s, the growth in total active physicians relative to population has been nearly even for all those groups of counties with over 25,000 inhabitants. The supply of physicians in the two county groups with fewer than 25,000 population, during this period increased more slowly relative to population; however, the number of young MD physicians under 35 years increased strongly in these county groups. Since physicians tend to establish an initial office location shortly after their residency training and to relocate to different areas only infrequently, the relatively greater numbers of young physicians locating in these areas may be viewed as a harbinger of changes to come in the overall distribution of FPs and of physicians in general. Table 9 presents data on the numbers and percentages of active non-Federal MDs in the three least populous county groups and for the subsets of those which include designated health manpower shortage areas.[5/] (It was not possible to include DO physicians because age data for them were unavailable.) The table also shows these young MDs as a percentage of all MDs in the area. As the table shows, the numbers of young MDs (those under 35) are increasing rapidly in all three categories of smaller counties.

4/ The Location of Family Practitioners and other Medical Specialists in Shortage and Other Rural Areas, DHPA/BHPr, 1980 mimeographed.

5/ The reason for showing only the three smaller county groups is that designations are made for both whole and part-county areas, and data for "shortage counties" within each county group include some physicians in non-designated parts of some counties. While this is not thought to be serious for the three county groups presented, it would become increasingly serious for larger counties where part-county designations are more the rule than the exception.

Empirical Studies of Geographic Distribution

Only a few empirical studies of physician geographic distribution address the issue of diffusion. Because of the great interest in the diffusion issue, these few studies have received considerable attention. Unfortunately, however, their methodological weaknesses and variations in conceptual frameworks and definitions have not been taken sufficiently into account. No single study can or has considered all the dimensions of this complex phenomenon. For example, one major study includes only primary care physicians while another is limited to board-certified practitioners. Taken together, however, the few important studies have provided a reasonably consistent picture. Principal findings from several of these studies are presented and discussed here and some conclusions drawn from them.

Three papers have been published on this subject by researchers at the RAND Corporation. The first and the best known of these studies is the one published in 1980 by Schwartz, et. al.[6] This study presented both the concept of the diffusion process and empirical data covering the period 1960-1977. The point of departure and a major contribution of the RAND study was their development of a unique data base. The RAND group points out that trends in county-level data can be misleading when viewed from the perspective of location theory. To overcome this problem, the group created a data base with the "town," or center of economic activity, as the unit of analysis.

The RAND concept of the diffusion process is based on standard location theory. Under this theory, a physician is expected to establish a practice in the most desirable location. The community selected would not necessarily be the one which would yield the highest income, however, because other community attributes are known to be major factors in the location decision. As the supply of physicians increases relative to the demand for their services, the workload per physician is expected to decline and the market area served by the typical physician is expected to decrease.

The empirical portion of the RAND study was based on the premise that the validity of the location theory concept could be confirmed if physicians were shown to be locating in smaller towns as competition for patients forced them into new and less well-served market areas. The investigators found that this was indeed the case. The study showed that from 1960 to 1977, more of the towns examined had at least one board-certified physician in each of the eight specialties studied. As a representative example of their findings, one specialty (internal medicine) is discussed here. As the table below shows, in 1960, 46 (or 25 percent) of the 185 towns in the 10,000 to 20,000 population range that RAND studied had at least one board-certified internist. By 1977, the proportion had increased to 51 percent. Similar increases typically occurred in other town size groups and in other specialties.

6/ Schwartz, W.B., Newhouse, J.P., Bennett, B.W., and Williams, A.P. "Do Board-Certified Specialists Diffuse: Facts, Theory, and Implications" The New England Journal of Medicine, Vol. 303, October 30, 1980, pp. 1032-1038.

Percentage of Communities with Board-Certified Internists in 1960 and 1977

	Percentage of Communities with Board-Certified Internists, by Size of Population						
	2.5-5	5-10	10-20	20-30	30-50	50-200	200+
	in thousands						
1960	2	11	25	65	85	90	100
1977	9	23	51	92	98	95	100
Number of towns in each population range (1970)	621	361	185	52	59	37	33

Although this RAND study conclusively established that board-certified MDs were locating in smaller towns in 1977 than in 1960, conclusions about the net change in the total supply of physicians in these towns cannot be drawn from these data; nor, therefore, can they be used to draw conclusions about diffusion. One reason was that there has been a phenomenal increase since 1960 in the proportion of all physicians who were board-certified. Furthermore, the retirement of non board-certified MDs or DOs was not counted as a decrease in the supply of physicians. Consider, for example, a hypothetical town of 15,000 people which had 2 GPs, 1 internist, 1 OBG, and 1 general surgeon in 1960, none of whom were board-certified. If by 1977 the 2 GPs had retired and a board-certified internist had established practice in this town, the RAND approach would consider this as evidence supporting the diffusion theory even though the total supply of physicians in the town had actually decreased.

It is clear from these studies that physicians are indeed locating their practices in nonmetropolitan counties. However, the magnitude of this diffusion heavily depends on the type of physician, the specific geographic area, and the time period. In rural counties greater growth has been observed in specialties other than primary care.

In order to determine whether their results were influenced by considering only board certified physicians, a second study was conducted by researchers at the RAND Corporation.[7/] After updating their data base to allow consideration of the change between 1970 and 1979 in numbers of types of towns having each of a number of types of specialty physicians, and extending coverage of physicians to include all nonfederal physicians except residents, the RAND group strengthened their previous conclusions. In particular, they note that diffusion of physicians to smaller towns paralleled the overall growth rates in each specialty. Between 1970 and 1979 the numbers of specialists accellerated, while the number of general and family practitioners

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7/ Newhouse, J.P., A.P. Williams, W.B. Schwartz, and B.W. Bennett, The Geographic Distribution of Physicians: Is the Conventional Wisdom Correct? RAND Corporation Publication R-2734-HJK/HHS/RWJ/RC, October, 1982.

decreased (due to the rapid disappearance of the general practitioner). These national trends were reflected (in a statistically significant way) in the patterns of change into small towns where the fastest growth of physician supply had been in the specialties. Whereas between 1970 and 1979 a decline of general and family practitioners occurred in the smallest towns (i.e., those with populations between 2,550 and 5000), more of these towns had various types of specialists than in 1970. The evidence provided by the RAND group supports an economic interpretation of the impact of the increased supply of physicians on geographic distribution, both in total and in terms of its specialty composition. While specialists may have no predisposed preference to locate in large cities, they do serve larger market areas than general and family practitioners. Nevertheless, as the numbers of specialists have increased, economic pressures have forced them to diffuse into smaller and smaller centers of economic activity. On the basis of these observations, the RAND group predicted that, in the future, as the output of family practitioners replaces and augments the declining numbers of general practitioners, a diffusion of family practitioners to the smallest towns would be observed as well.

The third paper published by the RAND group reinforces their earlier conclusions by demonstrating that the distance that individuals must travel to see a physician of a particular type has declined over time.[8/] If physicians are locating in smaller towns as predicted by location theory, then one would expect a decrease in the distance that patients have to travel to see a particular type of physician. The most recent RAND study demonstrates that decreases in distance travelled are likely to have occurred for all specialties, except general and family practice, over the period 1970-1979. For example, 63 percent of the residents in the rural areas studied by the RAND researchers were within 30 miles of an orthopedic surgeon in 1970. By 1979 this figure had increased to 80 percent, reflecting the diffusion of orthopedic surgeons in rural areas.

The RAND studies are an important contribution since they clearly demonstrate that observed physician location patterns are consistent with economic theory. Even if most of the increased supply of physicians do locate in urban areas, significant numbers are establishing practices in rural areas. However, the RAND studies emphasize only one dimension of the increased supply of physicians. That is, do physicians choose practice locations as one would expect them to? There remains the larger question "Has the diffusion of physicians increased accessibility and the utilization of physician services?" Although the three RAND papers do not address this issue directly, location theory predicts that certain phenomena are likely to occur. As physicians compete for patients the size of the market area decreases, but the number of visits provided by the typical physician should also decrease. Those expectations are consistent with the results of physician surveys which have shown a downward trend in patient visits per physician. The Physician Capacity Utilization Surveys conducted by Mathematica Policy Research showed a decline

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8/ Williams, A.P., W.B. Schwartz, J.P. Newhouse and B.W. Bennett, "How Many Miles to the Doctor?" The New England Journal of Medicine: 309, (October 20, 1981), pp. 958-63.

in patient visits per physician between 1975 and 1979.9/ A decline of 5 to 6 percent was observed in metropolitan areas, but an even greater decline of nearly 16 percent occurred in nonmetropolitan areas.

Sloan and Kehrer also studied the growth of primary care MDs over the 1975-1979 period. By contrast to the RAND studies, their figures indicate the change in the total supply of physicians in rural areas. Because Sloan and Kehrer did not measure changes in physician supply by size of town, however, their results are not exactly comparable to RAND's. Sloan and Kehrer used the more typical measure of changes in the physician supply--the number of primary care physicians per thousand population in counties. This ratio remained virtually unchanged over the 1975-1979 period in rural counties. Since the rural population increased by about 7 million over this period, the Mathematica study findings of increased numbers of primary care physicians but no change in the primary care physician-to-population ratio is consistent with the RAND results.

However, many observers have pointed out that primary care is also provided by many physicians who are not in primary care specialties as typically defined. Thus, primary care provided by the growing numbers of non-primary care physicians may be significantly augmenting the amount of primary care provided in rural counties. Only slightly more than a third of the physicians now in rural counties are GPs. Even if one includes internists and pediatricians, the proportion of physicians in the primary care specialties is only slightly over 50 percent. Significant increases in the number of surgeons and other specialists in nonmetropolitan areas have occurred in recent times, as shown in the table below. Thus, GPs are being replaced by family practitioners and being augmented by various medical specialists, largely but not exclusively internists and pediatricians. Although the numbers of surgeons are also increasing, the greatest increases are occurring in the medical and surgical support specialties (anesthesiology, pathology, and radiology) and psychiatry.

Physicians in Nonmetropolitan Counties

	Percent Increase 1975-1980	Number in 1980
All Patient Care MDs	27.5	49,228
Office based practice MDs		
General practice	2.4	14,896
Medical specialists	50.2	8,186
Surgical specialists	24.8	11,835
Other specialists	54.1	7,429

Although the RAND study strongly suggested that a diffusion of specialists is occurring, it also confirmed that the more specialized the physician the larger the town that is required to support such a practice. However, in this

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9/ Sloan, F.A. and Kehrer, B.H. "Patterns of Delivery of Primary Care Services in the United States, 1975-1979: Findings From the Physician Capacity Utilization Surveys." DHPA Report No. 15-82-7.

regard a more comprehensive study was conducted by staff members of the Bureau of Health Professions. Lawlor and Reid showed that there a clear relationship existed between physician specialties and county characteristics, as shown below.10/

Size of County by Highest Order Specialty Present in 1975

Physician type	Number of counties	Average Population size
None	175	4,317
GP/FP	792	10,927
General surgeon	328	17,795
Internists	104	23,643
Surgical specialists	50	31,600
OBG	44	34,391
Pediatricians	156	51,382
Other medical specialists	738	230,737
Nonconforming counties	691	25,140

In 78 percent of the counties there was a clear hierarchy in the distribution of specialists. That is, the specialists appeared in counties in a well defined order. Few counties were without physicians, and about 25 percent had only general practitioners. The next type of county which was observed contained a general surgeon as well as general practitioners. After that, other specialists appeared in the following order: internists, other surgeons, OBGs, and then pediatricians. (For example, the table entry "internist" indicates that these counties had GPs/FPs, general surgeons, and internists and did not have any "higher order" specialties, such as OBGs or pediatricians.) The relatively early entry of general surgeons and relatively late entry of pediatricians into the hierarchy raises some questions as to what specialties functionally provide primary care in rural areas. Only 22 percent (691) of the counties did not fit this pattern. Thus, the results indicated that a larger market area was required to provide enough patients for more specialized physician services.

In another study, Madison and Combs studied 951 young physicians who as of 1977 had recently established practices in very rural counties.11/ Most were in primary care specialties, few were not board certified, a surprising proportion were foreign medical graduates, and most U.S. graduates were from schools in rural States. Even though these communities were quite rural, two-thirds of the physicians had located in towns where there were at least

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10/Lawlor, A.C. and Reid, J.T. "Hierarchical Patterns in the Location of Physician Specialists Among Counties." Inquiry: 18 (Spring, 1981), pp. 79-90.

11/Madison, D.L. and Combs, C.D. "Location Patterns of Recent Physician Settlers in Rural America" Journal of Community Health: 6, (Summer, 1981), pp. 267-74.

four other physicians. There was a marked difference between NHSC and private sector physicians with regard to size of community. Seventy percent of the NHSC physicians, but only 38 percent of the private physicians, located in towns of less than 2500 people. This study provides more evidence that physicians are locating in even the most rural areas, but by studying only new entrants Madison and Combs could not draw conclusions regarding the total supply of physicians.

Efforts to Forecast Future Needs for Physicians in HMSAs

While the studies reviewed in the previous section of this report have investigated the diffusion process in qualitative terms, efforts to quantify diffusion effects for the purpose of projecting or forecasting primary care physician needs in HMSAs have been pursued for some time by the Bureau of Health Professions. As with the designation of current shortage areas, the major problem in forecasting future shortage areas and manpower needs has been the availability of suitable data. Specifically, one requires, at a minimum, projections of population in future years, and projections of the numbers of private practitioners that will locate in different types of areas in those years. Early efforts to develop estimates of future needs for physicians in HMSAs relied on crude techniques for projecting these variables involving the allocation of available State projections of the variables to counties on the basis of historical patterns of change. The projection of needs based on these techniques proved to be unreliable, unrealistic, and there not useful. Two developments have occurred recently, however, which have allowed the development of a useful forecasting capability.

First, the modeling research program at the Bureau of Health Professions has successfully developed an econometric model of the distribution of primary care physicians across counties. The model is based on concepts of market adjustment to disequilibrium between supply and demand, and explains how the stock of physicians in a county adjusts over time to disparities between supply and demand created by such events as deaths of resident practitioners or changes in demand produced by economic and demographic changes over time. While the original research objective was to determine the existence and extent of local area diffusion effects of the increasing national supplies of physicians, the model developed can also be used for forecasting provided that reliable estimates of the future values of the input variables used by the model can be obtained or developed.

This problem was solved recently by a second development when year-by-year long-term forecasts of county population and income from econometric forecasting models became available to the Bureau from a commercial forecasting source. These forecasts have been obtained by the Bureau and are being incorporated, along with the econometric county disequilibrium model, into computer software for forecasting the allocation of future primary care physicians across counties in the U.S. Preliminary tests of the forecasting model show that the aggregate forecasts between the last year of data to which the model was fit (1979) and the the most recent year for which data are available on the number of shortage areas and the numbers of physicians (1982) are accurate. The long-term aggregate 15-year forecasts are stable and do not degenerate (i.e., they remain consistent with the historical relationships

between the variables described by the model). While the aggregate forecasts are acceptable, more work remains to be done before the forecasts for individual counties or groups of counties can be validated.

Table 1: Total Active and Primary Care Physicians (MDs and DOs) and Ratio to Population for Selected Years, 1970 to 1979

	1970	1975	1976	1977	1978	1979	Percent Increase 1970-79
Numbers of Active Physicians (MDs and DOs)	323,215	354,340	363,103	387,979	391,911	410,599	27
MDs 1/	310,875	340,280	348,443	363,619	375,811	393,729	27
DOs	12,340	14,060	14,660	15,360	16,100	16,870	37
Ratio per 100,000 Population	155	163	165	171	176	182	17
Numbers of Primary Care Physicians (MDs and DOs)	130,101	144,694	150,541	156,308	159,483	170,287	31
MDs	171,761	130,634	135,881	140,948	143,383	153,417	30
DOs 2/	12,340	14,060	14,660	15,360	16,100	16,870	37
Ratio per 100,000 Population	62	66	69	71	71	76	23

1/ Active MD physician estimates exclude varying numbers of "Not Classified" physicians, of which OHPA estimates about 90 percent are active. However, those physicians cannot be allocated in the more detailed tables to follow and are thus excluded here, although some erratic variation of totals results. Detailed tables also exclude "Address unknown" active physicians and consequently do not exactly add to these totals.

2/ While it is estimated that 80 to 90 percent of active physicians are in primary care, all are allocated to primary care in this table and the detailed tables to follow because the proportion of DOs in primary care is not constant by geographic area and total allocation introduces less distortion than a constant proportional allocation.

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6/1/83

Table 2: Active, Non-Federal Physicians (MDs & DOs) by Activity per 100,000 Population, by AMA County Groupings; December 31, 1979

AMA County Classification 1978	Number of Counties	Active, Non-Federal MDs per 100,000 Population, 1979				Active, Non-Federal MDs & DOs per 100,000 Population, 1979	
		Total	Patient Care	Office-based Patient Care	Office-based Primary Care	Total MD & DO	Office-based Primary Care
Nonmetropolitan Counties							
under 10,000 Inhabitants	740	45	42	38	30	51	36
10,000 to 24,999 Inhabitants	909	57	53	48	33	61	37
25,000 to 49,999 Inhabitants	488	82	76	69	36	87	40
50,000 or more Inhabitants	243	109	100	86	37	114	41
Potential SMSA Counties	42	151	132	105	39	156	44
Metropolitan SMSA Counties							
under 500,000 Inhabitants	337	157	139	108	40	163	45
500,000 to 1 million Inhabitants	130	191	164	116	42	199	50
1 million to 5 million Inhabitants	170	224	187	131	47	235	57
5 million or more Inhabitants	16	270	223	144	55	273	58
Low ratio as a percentage of high ratio		17%	19%	26%	55%	19%	62%

NOTE: This table and subsequent tables employing AMA county classification exclude Alaska and one other county because these areas are not classifiable to the AMA code on the ARF. Physician totals and ratios may also differ very slightly from national and state estimates due to address-unknown physicians that cannot be coded to county.

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6/1/83

Table 3: Trends in Total Active Non-Federal Physicians (MDs & DOs) by County Groupings; Selected Years, 1970 to 1979*

AMA County Classification 1978	Estimated Active, Non-Federal Physicians (MDs & DOs)				Percent Increase 1970 to 1979
	1970	1973	1976	1979	
Nonmetropolitan Counties					
under 10,000 Inhabitants	1,984	2,041	2,104	2,268	14
10,000 to 24,999 Inhabitants	7,459	7,728	8,549	9,498	27
25,000 to 49,999 Inhabitants	10,995	11,679	13,406	15,417	40
50,000 or more Inhabitants	14,757	15,998	18,899	21,782	48
Potential SMSA Counties	3,847	4,138	4,954	5,690	48
Metropolitan SMSA Counties					
under 500,000 Inhabitants	46,681	51,193	61,103	71,692	54
500,000 to 1 million Inhabitants	37,444	41,475	49,319	56,201	50
1 million to 5 million Inhabitants	112,064	124,121	142,652	161,842	44
5 million or more Inhabitants	52,786	56,088	60,184	64,664	23

*NOTE: Data for DO physicians are available for 1971, 1974, 1976, and 1981 and in this table estimates were made for other years by interpolation between known years, except 1970 was assumed to be equal to 1971. Other tables do not interpolate.

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6/1/83

Table 4: Trends in Total Active Non-Federal Physicians (MDs & DOs) per 100,000 Population by County Groups; Selected Years, 1970 to 1979*

AMA County Classification 1978	Estimated MD and DO Physicians per 100,000 Population							
	1970	1973	percent increase over '70	1976	percent increase over '73	1979	percent increase over '76	percent increase 1970 to 1979
Nonmetropolitan Counties								
under 10,000 Inhabitants	48	49	2	49	0	50	2	4
10,000 to 24,999 Inhabitants	55	55	0	59	7	61	3	11
25,000 to 49,999 Inhabitants	72	73	1	81	11	87	7	21
50,000 or more Inhabitants	91	93	2	106	14	113	7	24
Potential SMSA Counties	122	125	2	145	16	156	8	28
Metropolitan SMSA Counties								
under 500,000 Inhabitants	124	130	5	150	15	163	9	31
500,000 to 1 million Inhabitants	146	156	7	182	17	198	9	36
1 million to 5 million Inhabitants	178	191	7	216	13	234	9	31
5 million or more Inhabitants	220	237	8	256	8	273	7	24

*NOTE: Data for DO physicians are available for 1971, 1974, 1976, and 1981 and in this table estimates were made for other years by interpolation between known years, except 1970 was assumed to be equal to 1971. Other tables do not interpolate.

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Table 5: Changes in the Supply of Active, Non-Federal MD and DO Physicians by State: 1975 to 1979

	Number of M.D. and D.O. Physicians		Ratio to Population		Percent Change in Ratio
	1975	1979	1975	1979	
Total	348,952	413,411	164	181	10
Alabama	3,541	4,646	98	119	21
Alaska	324	460	92	115	25
Arizona	3,850	4,990	173	184	6
Arkansas	2,032	2,602	96	114	19
California	42,384	50,936	201	215	7
Colorado	4,643	5,725	183	198	8
Connecticut	6,535	7,529	211	242	15
Delaware	880	975	152	164	8
District of Columbia	3,155	3,370	441	529	20
Florida	13,412	17,407	161	179	11
Georgia	5,998	7,416	122	136	12
Hawaii	1,412	1,763	163	183	12
Idaho	797	995	97	105	8
Illinois	17,848	20,802	160	182	14
Indiana	6,004	6,983	113	127	12
Iowa	3,471	3,994	121	137	13
Kansas	3,129	3,743	137	158	15
Kentucky	3,950	4,724	116	129	11
Louisiana	4,804	5,966	127	142	12
Maine	1,444	1,791	136	159	17
Maryland	8,392	10,574	205	251	22
Massachusetts	13,108	14,963	225	261	16
Michigan	14,991	17,100	164	185	13
Minnesota	6,472	7,564	165	186	13
Mississippi	2,096	2,580	89	102	15
Missouri	7,750	8,768	163	178	9
Montana	832	1,011	111	129	16
Nebraska	1,955	2,277	127	145	14
Nevada	724	992	122	124	2
New Hampshire	1,214	1,414	148	154	4
New Jersey	12,886	14,387	176	195	11
New Mexico	1,461	1,892	127	146	15
New York	44,738	46,420	247	264	7
North Carolina	6,663	8,308	122	141	16
North Dakota	641	819	101	125	24
Ohio	16,192	18,314	150	170	13
Oklahoma	3,364	4,249	124	140	13
Oregon	3,794	4,675	166	178	7
Pennsylvania	20,851	23,639	176	199	13
Rhode Island	1,760	1,989	190	210	10
South Carolina	2,960	3,857	105	124	18
South Dakota	589	717	86	104	21
Tennessee	5,613	6,934	134	151	13
Texas	16,395	21,102	134	148	10
Utah	1,789	2,246	148	154	4
Vermont	916	1,064	194	208	7
Virginia	6,798	11,162	137	169	23
Washington	5,675	7,112	160	172	8
West Virginia	2,181	2,610	121	134	11
Wisconsin	6,157	7,318	134	156	16
Wyoming	382	488	102	104	2

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6/1/83

Table 6: Changes in the Supply of Office-based Primary Care M.O. and O.O. Physicians by State; 1975 to 1979

	Number of M.O. and O.O. Physicians		Ratio to Population		Percent Change in Ratio
	1975	1979	1975	1979	
Total	99,472	116,609	47	51	9
Alabama	1,080	1,280	30	33	10
Alaska	125	175	36	44	22
Arizona	1,274	1,677	57	62	9
Arkansas	729	906	34	40	18
California	11,593	13,721	55	58	5
Colorado	1,392	1,734	55	60	9
Connecticut	1,468	1,646	47	53	13
Oelaware	254	298	44	50	14
District of Columbia	510	592	71	93	31
Florida	3,972	5,415	48	56	17
Georgia	1,690	1,980	34	36	6
Hawaii	418	560	48	58	21
Idaho	343	412	42	44	5
Illinois	4,800	5,528	43	48	12
Indiana	2,170	2,362	41	43	5
Iowa	1,365	1,633	48	56	17
Kansas	1,071	1,260	47	53	13
Kentucky	1,245	1,403	37	38	3
Louisiana	1,253	1,436	33	34	3
Maine	585	733	55	65	18
Maryland	1,722	2,073	42	49	17
Massachusetts	2,861	2,935	49	51	4
Michigan	5,296	6,271	58	68	17
Minnesota	1,873	2,179	48	53	10
Mississippi	723	861	31	34	10
Missouri	2,518	2,965	53	60	13
Montana	350	400	47	51	9
Nebraska	657	727	43	46	7
Nevada	235	325	40	41	3
New Hampshire	384	431	47	47	0
New Jersey	3,783	4,198	52	57	10
New Mexico	493	599	43	46	7
New York	9,557	9,622	53	55	4
North Carolina	1,878	2,261	34	38	12
North Oakota	264	296	41	45	10
Ohio	5,077	5,839	47	54	15
Oklahoma	1,306	1,652	48	55	15
Oregon	1,231	1,510	54	57	6
Pennsylvania	6,397	7,460	54	63	17
Rhode Island	480	536	52	57	10
South Carolina	914	1,118	32	36	13
South Oakota	245	290	36	42	17
Tennessee	1,405	1,695	34	37	9
Texas	5,248	6,423	43	45	5
Utah	471	557	39	38	-3
Vermont	273	309	58	60	3
Virginia	1,854	2,945	37	45	22
Washington	1,816	2,205	51	53	4
West Virginia	665	762	37	39	5
Wisconsin	1,995	2,233	43	47	9
Wyoming	164	176	44	37	-16

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6/1/83

Table 7: Increases in Office-based, Primary Care Physicians (MDs and DOs) between 1975 and 1979 by Selected County Groups

AMA County Classification 1978	Office-based primary care MD and DO Numbers 1975	Numbers 1979	Ratio/Pop 1975	Ratio/Pop 1979	Percent increase in numbers	All other patient care MD 1975	All other patient care MD 1979	Percent increase in numbers
Non-Metropolitan Counties								
Under 10,000 inhabitants	1,572	1,693	37	38	8	341	505	48
10,000 to 24,999 inhabitants	5,431	5,946	38	38	9	2,383	3,130	31
25,000 to 50,000 inhabitants	6,403	7,418	39	42	16	5,409	7,156	32
Other non-metropolitan	8,417	9,801	40	43	15	12,166	15,468	27
Metropolitan (SMSA) Counties	77,524	90,934	49	55	17	178,401	215,261	21

Note: The 1975 number of DO physicians was assumed to be equal to the known 1976 supply and the 1979 number was assumed to be equal to the known 1981 supply in this and following tables. Due to the relative supplies of MDs and DOs, this is not thought to seriously bias the analysis.

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6/1/83

Table 8: Numbers of Primary Care Physicians, by Selected County Groups, 1975 and 1979

1978 AMA County Classification	Office-based physicians (Primary Care Specialties)							
	GP/FP	MDs	DOs		Internists		Pediatricians	
	1975	1979	1975	1979	1975	1979	1975	1979
Nonmetropolitan counties								
under 10,000 inhabitants	1,257	1,253	249	328	57	85	9	27
10,000 to 24,999 inhabitants	4,262	4,330	696	892	347	521	126	203
25,000 to 50,000 inhabitants	4,322	4,439	710	1,054	918	1,305	453	620
Other nonmetropolitan	4,721	4,768	862	1,298	1,848	2,446	986	1,289
Metropolitan (SMSA) counties	31,221	31,327	10,461	15,801	24,872	30,552	10,970	13,254

1978 AMA County Classification	Patient Care MDs (Other Specialties)							
	General Surgeons		OB-GYN		Opthalmologists		Psychiatrists1/	
	1975	1979	1975	1979	1975	1979	1975	1979
Nonmetropolitan counties								
under 10,000 inhabitants	124	151	13	33	8	7	27	37
10,000 to 24,999 inhabitants	791	898	175	250	140	139	186	221
25,000 to 50,000 inhabitants	1,423	1,560	607	787	389	477	423	491
Other nonmetropolitan	1,761	2,369	1,062	1,655	665	988	627	1,073
Metropolitan (SMSA) counties	24,129	25,256	17,636	20,452	9,023	10,062	19,620	22,960

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6/1/83

Table 9: Relative Numbers and Percentages of Active, Non-Federal MDs in the Least Populous County Groups, for All Counties in the Group and for Counties Having a Whole or Part County Shortage Area Designation: 1975 and 1979

Physician Specialty and County Type	Counties with under 10,000 population				Counties with 10,000-25,000 population				Counties with 25,000-50,000 population			
	MDs under 35		Percent of all MDs		MDs under 35		Percent of all MDs		MDs under 35		Percent of all MDs	
	1975	1979	1975	1979	1975	1979	1975	1979	1975	1979	1975	1979
Active Non-Federal MDs												
All counties	252	343	13	15	1105	1651	13	17	1568	2424	12	15
Shortage counties[1]	107	166	11	15	618	905	14	18	642	1034	12	16
Active Non-Federal GP/FPs												
All counties	116	195	9	15	379	708	9	16	356	699	8	15
Shortage counties[1]	46	93	8	15	189	343	8	15	153	322	8	16
Active Non-Federal IMs												
All counties	9	27	14	27	95	226	23	34	140	354	14	24
Shortage counties[1]	2	14	8	33	61	135	31	42	62	147	17	26
Active Non-Federal Peds												
All counties	6	8	13	26	40	76	26	32	104	182	22	26
Shortage counties[1]	1	4	20	27	20	44	31	38	36	79	22	33
Active Non-Federal GS												
All counties	9	11	7	7	64	89	8	10	87	116	6	7
Shortage Counties[1]	6	6	10	8	39	54	10	12	41	50	7	8

[1] Shortage counties include all counties where there was a whole or part county designation as of March, 1980.

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6/1/83

FORECASTS OF POPULATION-TO-PRIMARY CARE
PHYSICIAN RATIOS IN U.S. COUNTIES, 1982-1994

FORECASTS OF POPULATION-TO-PRIMARY CARE PHYSICIAN RATIOS IN U.S.COUNTIES, 1983-1994

Introduction

This report provides forecasts to 1994 of the number of counties in the U.S. having population to primary-care physician ratios greater than certain levels and the number of additional primary care physicians needed to reduce the ratio in those counties to these levels. The primary ratio examined in this report is 3500-to-1, the basic criterion that most areas must meet to be considered for designation as a Primary Care Health Manpower Shortage Area (PCHMSA). Also provided are forecasts for ratios of 3000-to-1 (the criterion used for areas with high needs and for eligible population groups), 2500-to-1, and 2000-to-1.

The first section of the report describes the econometric model used to generate the forecasts, as developed in the Bureau of Health Professions by the Modeling and Research Branch of the Office of Data Analysis and Management. The second section describes the assumptions underlying the forecasts, i.e., the judgements made in projecting the exogenous variables which are used in the solution of the model for estimating the future geographic distribution of primary care physicians. These exogenous variables are the annual numbers of new primary care physicians, and year-by-year forecasts of county population and income. The forecasts themselves are presented and discussed in the third section of the report.

The final section of this report discusses the relationship of these forecasts to the number of designated primary medical care shortage areas. The forecasts are quantitative estimates of the geographic diffusion of physicians. That is, they quantify the degree and speed of diffusion across counties in the U.S. expected over the next decade. They do not represent projections of the future number of designated primary care health manpower shortage areas (PCHMSAs); i.e., they are not "shortage area" projections. A subsequent report provides projections of needs in shortage areas based on the results of the forecasts presented in this report.

The Econometric Model of Primary Care Physician Location

The econometric model used for the forecasts presented here was originally developed to investigate the effect of market forces on the geographic distribution of general practice physicians. The model successfully detected the presence of market forces as a major determinant of the geographic distribution of general practice physicians and yielded a provisional estimate of the speed of adjustment to the disequilibrium in local markets for physician services caused by such events as deaths of local practitioners and demographic or economic changes in the local area. For the present project, the econometric relationships were re-estimated for "Primary Care" physicians.

Because of the level of disaggregation of the model (which uses the county as the unit of geographic definition), it could not previously be utilized for

forecasting physician location since input forecasts of county level population and personal income were not available. Recent commercial availability of such forecasts has allowed a micro-simulation model to be constructed for the present report, with the econometric relationships estimated in the earlier diffusion research as its core. Although the econometric relationships had successfully passed a number of tests for specification errors during their initial development, their forecasting properties were unknown until the current project was undertaken. Fortunately, the model using these relationships does exhibit acceptable forecasting properties.

The econometric relationships used model the process of physician location as one of dynamic adjustment to imbalances between supply and demand at the county level. Specifically, supply and demand equations that were fit to county data for the period 1975-1979 provide estimates of the rates of movement of primary care physicians into or out of counties in response to annual changes in supply relative to demand or demand relative to supply. Changes in supply are represented by changes in the number of primary care physicians. Changes in demand are represented by changes in population and personal income. County areas are distinguished by the State that they are in and according to whether they are metropolitan or nonmetropolitan counties. The theoretical considerations involved in specifying alternative forms of the equations and the empirical methods used in estimating the relationships and choosing the final version of the model are described in a separate paper.[1/]

These econometric relationships have been incorporated in a micro-simulation forecasting model which makes a number of calculations to estimate the distribution of new primary care physicians to each county each year. For these forecasts, the initial conditions of the micro-simulation are the number and age distribution of the active primary care physicians in each county in 1979 (the last year of the period for which the econometric relationships were estimated), and the population and per-capita personal income in each county in 1980. Given the values of these three variables, a supply/demand gap is first calculated for each county using the econometric relationships described earlier. The gap is the difference between the number of primary care physicians in 1979 and the predicted number which will be demanded in 1980 based on changes in population and per-capita personal income over the year.

In the second calculation, the current year's new primary care physician supply is allocated among counties. The allocation is based on the size of each county's gap calculated in the first step, and a component related to the size of each county's share of the total primary care physician supply. This calculation thus generates the beginning number of primary care physicians for the current year and their age distribution. Another calculation then ages the current supply one year to the end of the current year; the relevant distribution of age-specific death rates and retirement rates are then applied

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1/L. Jackson Brown and Jack Reid, "Equilibrium and Disequilibrium in Markets for General Practitioners: New Evidence Concerning Geographic Distribution of Physicians," in Advances in Health Economics and Health Services Research, Vol. 4, edited by Richard M. Scheffler and Louis F. Rossiter, JAI Press, Inc., Greenwich, Connecticut, 1983.

to calculate the number of active primary care physicians in each county at year's end. This figure then becomes one of the initial conditions, together with the next year's population and per-capita personal income, for a repetition of the cycle of calculating the gap between supply and demand, allocating new additions to the total primary care physician supply, and the aging, death, and retirement process.

Because the econometric relationships of the model were derived from historical data, objective criteria of validity can be applied to their specification. In fact, the relationships employed were chosen from among several alternatives on the basis of specification error tests designed to detect a number of problems which would have led to biased estimates of the model parameters. The research was able to reject a number of competing hypotheses regarding the structure of local markets for physicians' services and to successfully identify a model of market adjustment that was essentially free of systematic error.

Assumptions Underlying the Forecasts

This section describes the assumptions underlying the projections of the supply of physicians at the national level and the county level projections of population and income which serve as input data to the econometric model.

The projections of total annual new additions to the U.S. supply of primary care physicians, which are allocated to individual counties by the model's econometric relationships, were obtained from the BHPr physician supply projection model. The current version of this latter model is fully described in the Third Report to the President and Congress on the Status of Health Professions Personnel,[2] and in the Current and Future Supply of Physician and Physician Specialists.[3] However, the projections presented in Table 1 are somewhat different than the ones previously published. The major source of these differences was the necessity to use a definition of primary care physicians which matches the HMSA criteria.

Although various definitions of primary care are found in the literature, for the purposes of this study primary care physicians are defined as they are used in the HMSA criteria, namely including general and family practice, internal medicine, pediatrics, and obstetrics-gynecology. This definition of primary care is also the one used by the American Medical Association. Furthermore, internal medicine and pediatrics here are defined consistently with definitions used in the American Medical Association's Physician Characteristics and Distribution in the U.S. Thus, internal medicine excludes cardiology; gastroenterology, pulmonary disease, and allergy, but includes all of the other internal medicine subspecialties. Pediatrics excludes pediatric cardiology

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2/ Third Report to the President and Congress on the Status of Health Professions Personnel in the United States. DHHS Publication No. (HRA) 82-2, February 1982.

3/ The Current and Future Supply of Physicians and Physician Specialists. DHHS Publication No. (HRA) 80-60, September 1980.

and pediatric allergy but includes other pediatric subspecialists.[4]

As used in the forecasting model, the total active physician supply under the above definition is projected to be 640,000 by 1994, with about 50 percent practicing in the primary care specialties. The specific assumptions underlying the projections of additions to the primary care physician supply, which are presented in Table 1, are as follows:

1. First year enrollments in U.S. allopathic and osteopathic schools are assumed to decline 5 percent over the 5-year period beginning in 1983 and to level off at 16,800 MDs and 1,600 DOs in 1987, remaining at the 1987 level through the end of the projection period. U.S. graduates (USMGs) thus peak at 17,400 MDs and 1,600 DOs in 1985-86, decline to 16,500 and 1,500 respectively in 1987, and then level off.

2. The supply of physicians who are trained in Canadian schools (CMGs) is projected to remain at 7,200 over the full projection period, with additions assumed to equal losses through death, retirement, and emigration.

3. Graduate additions from schools outside the U.S. and Canada are projected to decline from about 4,700 in 1981 to about 3,300 by 1987 and remain at that level throughout the projection period.

4. The specialty distribution of the USMG and CMG additions is determined by projecting historical trends in adjusted first year residency (FYR) choices. Unadjusted FYR distributions were altered based upon historical patterns to reflect subsequent losses and gains to each specialty during the residents' training. The resulting distribution places 49.6 percent of the 1976-77 US/CMGs in primary care practice in 1980, which is projected to rise to 60.5 percent of the 1983-84 graduates in practice in 1987, the level at which it is projected to remain throughout the projection period.[5]

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[4] The inclusion of certain internal medicine and pediatric subspecialties in the definition of primary care may overstate the actual supply of these physicians. However, if all subspecialties were excluded, only 10 percent or about 15,000 fewer new primary care physicians would be added to the pool over the forecasted 14-year period. Forecasting growth rates for the subspecialties is a difficult task, and a wide range of growth rates is possible. Nevertheless, the impact of excluding these physicians on the diffusion process is likely to be negligible.

[5] This adjustment process, based upon data from the Directory of Approved Residencies for selected years, identifies specialty changes of residents into and out of primary care, and, for the primary care specialties, lags their actual entry into practice for three years after graduation. Nevertheless, specialty changes that occur after completion of training are not incorporated. The net effect of such adjustments would be to reduce the number who designate practice in a primary care specialty. For a further discussion of post training mobility see The Current and Future Supply of Physicians and Physician Specialists, Appendix VI, DHHS Publication No. (HRA) 80-60.

5. Similarly, FYR distributions for FMGs (including USFMGs), adjusted for historical FMG residency distributions and movement patterns, allocate 36.5 percent of FMGs to primary care practice in 1980. This is projected to rise to 36.9 percent in 1984 and remain at that figure throughout the projection period.

6. Ninety percent of the DO graduating class are assumed to enter practice in the primary care specialties, with a one year time lag. This figure is based on the only source of data on DOs, i.e., the historical distribution of board certified osteopathic specialists.

7. Physicians in graduate medical education, i.e. residents, are excluded from the projections.

There are several sources of uncertainty associated with the assumptions on which these projections are based. The national supply of physicians is significantly influenced by the immigration of foreign medical graduates which is dependent on overall U.S. immigration policy and on restrictions placed on entry into graduate medical education which is essential for an FMG to establish practice in the U.S. There is also uncertainty regarding the number of U.S. citizens studying abroad. Various sources have estimated this group of students at 8,000 to 20,000. Although this group does not face immigration barriers, their eventual re-entry into the U.S. medical care system will depend on how difficult it is to enter the graduate medical education system. It is assumed that the more difficult Foreign Medical Graduate Examination in the Medical Sciences will be in place by 1985.

Predicting the number of primary care physicians is even more difficult because physicians are able to change specialties at any point in their careers. Differentiating between general internists and subspecialists is especially difficult within the constraints of currently available data and no historical data exist to forecast future rates of growth. Although the HMSA criteria exclude subspecialists the extent to which this instruction is actually followed in the designation process is unknown. This is due to both the variation in local input to the designation process and the lack of detailed specialty statistics at the subnational level, and until recently, even at the national level.

It was decided to use the same definition of internal medicine in the national projections as was used in the estimation of the parameters of the econometric model. This series may actually be fairly close to the number of internists in primary care practice since the inclusion of certain non-primary care subspecialists is offset by the exclusion of other subspecialists who do provide considerable primary care. For example, hematologists are included but cardiologists are not. The category of internists included in the econometric model is more likely to consist of general internists in rural counties than in urban areas because subspecialists tend to be located in more densely populated market areas.

Projections of the other variables required for the forecasts (annual population and per-capita personal earnings in each county) were obtained from the National Planning Association, Washington, D.C. These projections are benchmarked to the 1980 census, and are produced by disaggregating national and regional forecasts generated by two interractive economic and demographic

long-term growth models. Disaggregation to the county level is based on the relationship of historical trends in each county with national and regional growth rates.[6] A few discrepancies in definitions of some geographic areas were found when the historical data were merged with the population/earnings projections. For example, New York City was defined as five counties in the historical data and as a single geographic unit in the projected data. Reconciliation of these differences resulted in the simulated number of counties being slightly less than the actual. However, the implications of the simulation for changes in the overall distribution of physicians should not be affected by the differences.

Forecasts to 1994

As may be seen in Tables 2-5, the model forecasts a continuation of the diffusion process over the forecast period. Based on the rate of diffusion measured in the recent past, it shows that increasing numbers of new primary care physicians will gradually locate in lower-ratio counties as time goes on. The forecasting model predicts that the number of counties with ratios above 3500-to-1 will decline from 895 to 388 between 1982 and 1994, a 57 percent decline. The number of primary care physicians needed to bring the primary care population-to-physician ratio in each county below 3500-to-1 (the basic HMSA criterion) will decline by about the same percentage over the period, from 2161 to 969. The counties that will have ratios above 3500-to-1 at the end of the forecast period (1994) are among those currently above that ratio; virtually all counties in the U.S. will experience significant declines in their population-to-primary care physician ratios. This indicates that market mechanisms will force the increased numbers of primary care physicians to gradually "diffuse" into lower-ratio counties as time goes on.

The process of diffusion predicted by the model can also be illustrated using the numbers of counties that move into lower population-to-physician ratio groups over time. Table 6 shows, for 1982, the number of counties in particular population-to-physician ratio groups; for each succeeding year of the forecast period, it shows the number of these counties remaining in those groups.

Table 7 shows the annual numbers of physicians needed to bring the counties still in each group down to the next group ratio. For example, these tables indicate that the number of counties with ratios between 3500 and 3000-to-1 in 1982 was 271, and that 340 physicians would be required to bring all of the counties in that group down to a ratio of at least 3000-to-1. The forecasts indicate that none of the counties that were in that particular group in 1982 will remain there by 1994. They will all have attracted enough physicians to reduce their ratios below 3000-to-1. This same pattern prevails for each of the groups of counties in Table 6, with the sole exception of the group of

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6/ The technique is described in U.S. Regional Projections 1981-2000, NPA Report No. 81-R-1, by Martin K. Holdrich.

counties with ratios originally above 3500 to 1. However, by 1994, only 388 counties would be left in this group, with 969 physicians required to bring them down to 3500-to-1.

Tables 8 and 9 display the same type of process but from a slightly different perspective. In Table 8, when a particular county attracts enough physicians to move to the next lower group of counties (e.g., from the group with ratios above 3500-to-1 to the group with ratios between 3500 and 3000-to-1), it is then included in the latter group. Thus, the number of counties in each group reflects the changes both as counties move out to the next lower group and as counties move in from the next higher one. Table 8 shows, year-by-year, the number of counties in each group; Table 9 shows the number of physicians needed each year to move each county to the next lower-ratio group of counties.

Relationship Between County Population-to-Physician Ratios and HMSA Designations

One criterion often employed to judge a model's forecasting accuracy is its tracking performance in the historical period beyond that within which the model was estimated, provided that estimation of the model did not use up all of the available historical data. In the case of the present model, which was fit over the period 1975-1979, no actual counts of physicians for subsequent years by county (1980-82) were readily available for comparison. However, predictions of the number of counties with population-to-physician ratios above the 3500-to-1 shortage area designation criterion and the number of physicians needed to bring these counties below this "shortage" threshold can be compared with actual shortage area designation program data through Calendar Year 1982. As of December 31, 1982, a total of 888 whole counties were designated as Primary Care Health Manpower Shortage Areas (PCHMSAs). Using the data from the HMSA data base, it was calculated that a total of 1741 primary care physicians would be needed to bring the population/primary care physician ratios in these counties below the designation criterion of 3500-to-1 (i.e. off the official list of shortage areas). This result compares with the model's forecast of 895 counties and 2161 primary care physicians, respectively, in these categories in 1982. Thus, three years out from the end of the period over which the econometric model was estimated, the forecasts are estimating accurately the number of designated counties but overestimating the number of physicians needed.

Deviations of the forecasts from the shortage area program data can be ascribed primarily to differences in the definition and the measurement of population and primary care physicians and to additional designation criteria, rather than to forecast error. Specifically, the data on physicians employed in calculating the population-to-primary care physician ratio for purposes of determining shortage area designation eligibility are often adjusted from straight "head counts" to full-time-equivalents, as provided for in the criteria, by local applicants or by designation program officials. This process tends to increase the number of designated counties. On the other hand, counties with population-to-physician ratios meeting the ratio criterion are not eligible for designation if adequate supplies of services are accessible in contiguous counties. This accessibility is determined on a case-by-case

basis and tends to decrease the number of designations. Furthermore, in the shortage area data base, a multiple-county designation would be identified as a single Medical Service Area rather than as several whole-county designations. The forecasting model, on the other hand, deals only with whole counties and does not take into account contiguous-county resources.

As was indicated earlier, this report deals only with whole county forecasts. However, there are nearly 1,100 designated part-county primary care (PC) HMSAs (including service areas that cross county lines) over and above the nearly 900 whole-county PCHMSAs. Since this report does not deal with the major component of shortage areas, these forecasts of population-to-physician ratios should be viewed as basic input material for projecting actual HMSAs, including sub-county areas, just as population and physician counts should be viewed as the basic input material for the actual designation process. A subsequent report provides shortage area projections based on information from the HMSA data base together with the results presented in this report.

Table 1

Projected Distribution of Graduate Additions to Allopathic and Osteopathic Primary Care Physician Supply, 1980-1994

	Allopathic Physicians			Osteopathic Physicians			All Physicians
	Total MDs	Percent MDs in Primary Care	Total MDs in Primary Care	Total DOs	Percent DOs in Primary Care	Total DOs in Primary Care	Total MDs and DOs in Primary Care
1980	18,931	46.0	8,708	1,004	90.0	904	9,612
1981	16,497	50.0	8,249	1,068	90.0	961	9,210
1982	18,374	50.7	9,307	1,145	90.0	1,031	10,338
1983	18,985	52.0	9,866	1,276	90.0	1,148	11,014
1984	20,236	52.7	10,669	1,032	90.0	929	11,598
1985	20,855	53.2	11,096	1,416	90.0	1,274	12,370
1986	20,495	52.9	10,839	1,484	90.0	1,336	12,175
1987	21,307	55.7	11,869	1,564	90.0	1,408	13,277
1988	21,807	55.5	12,110	1,547	90.0	1,392	13,502
1989	20,378	57.1	11,633	1,532	90.0	1,379	13,012
1990	20,598	56.7	11,681	1,517	90.0	1,365	13,046
1991	20,312	56.8	11,540	1,502	90.0	1,352	12,892
1992	20,131	56.8	11,438	1,485	90.0	1,337	12,775
1993	19,934	56.8	11,332	1,486	90.0	1,337	12,669
1994	19,766	56.8	11,233	1,486	90.0	1,337	12,570

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Table 2

Number of Counties with a Population-to-Primary Care Physician Ratio Above 3500-to-1 and Number of Primary Care Physicians Needed to Bring Those Ratios to 3500-to-1, 1982-1994

Year	Number of Counties with a Ratio Greater than 3500-to-1			Number of Physicians Needed for All Counties to Have a Ratio No Greater than 3500-to-1		
	Total	Non-Metro	Metro	Total	Non-Metro	Metro
1982	895	761	134	2,161	1,441	721
1983	851	724	127	2,070	1,371	699
1984	794	678	116	1,967	1,296	671
1985	744	635	109	1,867	1,221	646
1986	687	585	102	1,748	1,139	609
1987	635	538	97	1,601	1,040	561
1988	586	500	86	1,457	962	495
1989	530	453	77	1,317	869	448
1990	506	431	75	1,255	828	427
1991	475	405	70	1,172	778	393
1992	432	370	62	1,083	723	360
1993	417	360	57	1,030	698	332
1994	388	343	45	969	661	308

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Table 3

Number of Counties with a Population-to-Primary Care Physician Ratio Above 3000-to-1 and Number of Primary Care Physicians Needed to Bring Those Ratios to 3000-to-1, 1982-1994

	Number of Counties with a Ratio Greater than 3000-to-1			Number of Physicians Needed for All Counties to Have a Ratio No Greater than 3000-to-1		
Year	Total	Non-Metro	Metro	Total	Non-Metro	Metro
1982	1,166	982	184	3,358	2,216	1,142
1983	1,108	935	173	3,213	2,115	1,098
1984	1,040	881	159	3,034	1,984	1,050
1985	975	826	149	2,836	1,843	993
1986	897	760	137	2,626	1,703	923
1987	807	688	119	2,375	1,536	839
1988	723	614	109	2,164	1,396	768
1989	658	557	101	1,953	1,259	695
1990	621	528	93	1,824	1,179	645
1991	577	491	86	1,699	1,105	594
1992	537	458	79	1,562	1,018	544
1993	512	436	76	1,467	961	506
1994	475	404	71	1,374	904	470

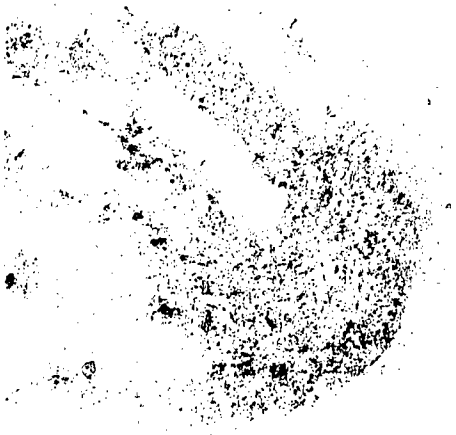

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Table 4

Number of Counties with a Population-to-Primary Care Physician Ratio Above 2500-to-1 and Number of Primary Care Physicians Needed to Bring Those Ratios to 2500-to-1, 1982-1994

Year	Number of Counties with a Ratio Greater than 2500-to-1			Number of Physicians Needed for All Counties to Have a Ratio No Greater than 2500-to-1		
	Total	Non-Metro	Metro	Total	Non-Metro	Metro
1982	1,560	1,300	260	5,882	3,767	2,115
1983	1,497	1,249	248	5,559	3,585	1,974
1984	1,413	1,181	232	5,227	3,379	1,848
1985	1,311	1,101	210	4,854	3,135	1,719
1986	1,225	1,033	192	4,432	2,874	1,558
1987	1,094	924	170	3,971	2,569	1,402
1988	993	837	156	3,557	2,277	1,280
1989	888	754	134	3,148	2,008	1,140
1990	814	693	121	2,945	1,876	1,069
1991	745	633	112	2,726	1,740	986
1992	692	587	105	2,485	1,588	897
1993	638	542	96	2,314	1,481	833
1994	600	511	89	2,150	1,383	767

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Table 5

Number of Counties with a Population-to-Primary Care Physician Ratio Above 2000-to-1 and Number of Primary Care Physicians Needed to Bring Those Ratios to 2000-to-1, 1982-1994

Year	Number of Counties with a Ratio Greater than 2000-to-1			Number of Physicians Needed for All Counties to Have a Ratio No Greater than 2000-to-1		
	Total	Non-Metro	Metro	Total	Non-Metro	Metro
1982	2,094	1,737	357	11,910	7,194	4,716
1983	2,018	1,672	346	11,291	6,873	4,418
1984	1,934	1,606	328	10,570	6,492	4,078
1985	1,815	1,506	309	9,737	6,035	3,702
1986	1,701	1,414	287	8,811	5,526	3,285
1987	1,545	1,291	254	7,771	4,936	2,835
1988	1,401	1,175	226	6,853	4,377	2,476
1989	1,259	1,058	201	6,010	3,850	2,160
1990	1,164	986	178	5,528	3,540	1,988
1991	1,081	914	167	5,055	3,218	1,837
1992	987	836	151	4,557	2,889	1,668
1993	929	786	143	4,236	2,685	1,551
1994	842	718	124	3,883	2,459	1,424

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Table 6

Number of Counties Remaining in the same Population-to-Primary Care Physician Ratio Grouping, 1982 to 1994 1/

Year	Number of Counties with Ratios Greater Than 3500-to-1	Number of Counties with Ratios between 3500-and 3000-to-1	Number of Counties with Ratios between 3000-and 2500-to-1	Number of Counties with Ratios between 2500-and 2000-to-1
1982	895	271	394	534
1983	850	212	331	458
1984	792	144	247	374
1985	742	82	145	255
1986	685	37	72	142
1987	635	13	20	35
1988	586	7	9	13
1989	530	5	4	6
1990	506	4	3	2
1991	475	3	2	2
1992	432	1	2	2
1993	417	0	1	2
1994	388	0	1	2

1/ A particular group of counties is followed over the forecast period. Once a county makes the transition to a lower ratio group, it disappears from the table.

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Table 7

Physicians Needed to Bring Population-to-Physician Ratios of All Counties Remaining in Original (1982) Group to the Lower Boundary of That Group, 1982-1994

Year	Number of Physicians Needed for all Counties Remaining from Original over-3500-to-1 Group to have a Ratio no greater than 3500-to-1	Number of Physicians Needed for all Counties Remaining from Original Group between 3500-to-1 and 3000-to-1 to have a Ratio no greater than 3000-to-1	Number of Physicians Needed for all Counties Remaining from Original Group between 3000-to-1 and 2500-to-1 to have a Ratio no greater than 2500-to-1	Number of Physicians Needed for all Counties Remaining from Original Group between 2500-to-1 and 2000-to-1 to have a Ratio no greater than 2000-to-1
1982	2,161	340	758	1,622
1983	2,070	243	539	1,227
1984	1,966	150	351	835
1985	1,866	74	182	461
1986	1,747	37	74	184
1987	1,601	13	15	35
1988	1,457	6	6	10
1989	1,317	5	3	4
1990	1,255	4	2	2
1991	1,172	3	2	2
1992	1,083	1	2	2
1993	1,030	0	1	2
1994	969	0	1	2

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Table 8

Number of Counties Grouped by Population-To-Physician Ratios
Each Year From 1982 Through 1994 1/

Year	Number of Counties with Ratios Greater Than 3500-to-1	Number of Counties with Ratios between 3500-and 3000-to-1	Number of Counties with Ratios between 3000-and 2500-to-1	Number of Counties with Ratios between 2500-and 2000-to-1
1982	895	271	394	534
1983	851	257	389	521
1984	794	246	373	521
1985	744	231	336	504
1986	687	210	328	476
1987	635	172	287	451
1988	586	137	270	408
1989	530	128	230	371
1990	506	115	193	350
1991	475	102	168	336
1992	432	105	155	295
1993	417	95	126	291
1994	388	87	125	242

1/ Counties are regrouped each year over the forecast period. Once a county makes the transition to a lower ratio group, it appears in the lower group until it makes another transition when it will appear in yet another group.

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6/1/83

Table 9

Physicians Needed to Bring Population-to-Physician Ratios of All Counties in a Group to the Lower Boundary of That Group, 1982-1994

Year	Number of Physicians Needed for all Counties to have a Ratio no greater than 3500-to-1	Number of Physicians Needed for all Counties with Ratios between 3500-to-1 and 3000-to-1 to have a Ratio no greater than 3000-to-1	Number of Physicians Needed for all Counties with Ratios between 3000-to-1 and 2500-to-1 to have a Ratio no greater than 2500-to-1	Number of Physicians Needed for all Counties with Ratios between 2500-to-1 and 2000-to-1 to have a Ratio no greater than 2000-to-1
1982	2,161	340	758	1,622
1983	2,070	314	702	1,521
1984	1,967	321	648	1,542
1985	1,867	275	568	1,476
1986	1,748	246	486	1,272
1987	1,601	171	455	1,183
1988	1,457	139	395	980
1989	1,317	164	299	837
1990	1,255	143	260	773
1991	1,172	128	238	712
1992	1,083	115	233	587
1993	1,030	100	203	547
1994	969	111	192	448

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PROJECTIONS OF PRIMARY CARE PHYSICIAN NEEDS IN HEALTH MANPOWER SHORTAGE AREAS 1982-1994

PROJECTIONS OF PRIMARY CARE PHYSICIAN NEEDS IN HEALTH MANPOWER SHORTAGE AREAS, 1982-1994

Summary

Forecasts developed by the Office of Data Analysis and Management of the Bureau of Health Professions indicate a significant decline in U.S. counties with population-to-primary care physician ratios above 3500-to-1 between 1982 and 1994. Sub-county shortage area projections indicate a significant, although smaller, reduction as well. However, the method used to project primary care physician needs in sub-county shortage areas is less satisfactory than the model used for the county forecasts due to the lack of historical data on the population and number of physicians in such subcounty areas. Nevertheless, utilization of certain assumptions about the relationship of future changes in population and number of physicians at the subcounty level to projected changes in these variables at the county level made it possible to develop estimates of physician needs in subcounty shortage areas over the projection period that are believed to be reasonable.

The number of primary care physicians needed to reduce the population-to-primary care physician ratio below 3500-to-1 in all medical service areas (MSAs) is projected to decline by 25 percent between 1982 and 1994. When these subcounty needs are combined with the whole-county forecasts, the total number of physicians needed declines by 37 percent, from 5,076 in 1982 to 3,204 in 1994. Thus, diffusion of primary care physicians is expected to reduce overall shortage area needs in the coming years, although needs will persist in many currently designated shortage areas.

Introduction

This report presents estimates of needs for primary care physicians in health manpower shortage areas over the 1982-94 period. The previous report presented forecasts of the number of U.S. counties with population-to-primary care physician ratios above 3500-to-1 (the basic shortage area criterion) over the period from 1982 to 1994 and the number of primary care physicians that would be needed to bring all county ratios below that level. That report also included similar forecasts for a ratio of 3000:1, the level used in designation of high need shortage areas. As stated in that report, those forecasts were aimed at quantifying the degree and speed of diffusion of primary care physicians into less well-served areas that can be expected over the next decade, but did not represent projections of the future numbers of designated primary care health manpower shortage areas (PCHMSAs) or their physician needs; i.e., they were not "shortage area" projections.

There are several reasons why the county forecasts developed in the earlier report could not be directly interpreted as estimates of primary care physician needs in designated "shortage areas." Briefly, these are:

(1) The numbers of physicians analyzed in the county forecasts represent "head counts" rather than the full-time-equivalents used in the

shortage area designation criteria. This tends to underestimate both the number of counties whose ratios satisfy the shortage criteria and the numbers of physicians needed in those counties to reduce the population-to-primary care physician ratio to a given target level.

(2) The county forecasts include all counties with ratios worse than a certain level, without regard to resources in contiguous counties. Since the Health Manpower Shortage Area (HMSA) criteria provide that areas will not be designated where resources in contiguous areas are available, accessible, or not overutilized, this tends to overestimate the number of shortage counties and physicians needed.

(3) In addition to whole counties, medical service areas within counties are designated by the HMSA program. In fact, about half of all currently-designated primary care HMSAs are non-whole-county MSAs. These include subcounty portions of a large county having two (or more) population centers; subcounty areas isolated by natural barriers from the rest of the county; and areas whose population is isolated from resources available in contiguous areas by economic, language, or cultural barriers. Similarly, supercounty areas containing two or more whole counties (or one whole county plus a portion of another) may be designated if their centers are close to each other. It is not possible to project needs in subcounty areas directly from a county-level model. However, because of the number of these areas that are designatable and have been designated under the criteria, a projection of needs in shortage areas which did not include those in subcounty areas would clearly be incomplete.

(4) Migrant populations, tourists, Native Americans, prisoners, developmentally disabled persons, and other special populations or facilities are considered in the designation process but are not incorporated in the county model forecasts.

Although direct evidence is not available, it is possible that the tendency to underestimate noted in (1) above and the tendency to overestimate noted in (2) above approximately cancel each other out, leaving the results of the county forecasts in the previous report as reasonable approximations of physician needs in whole-county shortage areas. However, projections of needs in subcounty MSAs clearly are essential to the estimation of overall future shortage area needs.

Despite intensive efforts and examination of a number of alternative approaches, no single approach to the development of such subcounty projections proved completely satisfactory. Nevertheless, by utilizing the county-level forecasting model together with data on currently-designated MSAs and assumptions about the relationships of changes at the subcounty level to changes at the county level, estimates of future shortage area needs at the subcounty level were developed that are believed to be reasonable and the best that can be obtained with the data that are available. Combining these sub-county projections with the county-level forecasts presented in the earlier report results in what are believed to be reasonable projections of the overall needs in shortage areas over the period of interest.

This report describes the approach used in developing the subcounty projections and combines those figures with the county projections to arrive at estimates of the total number of primary care physicians needed to satisfy shortages in designated areas in each year of the 1982-1994 period.

Technique

The subcounty projections presented here are consistent with the previous county-level forecast of population-to-primary care physician ratios. They use the same allocation of new primary care physicians among counties over the forecast period and the same county population forecasts.

To develop the subcounty forecasts, all of the current MSAs in partly designated counties were first individually identified. Secondly, the population and the number of full-time-equivalent primary care physicians in each of the MSAs in a partly-designated county, obtained from the Primary Care Shortage Area Designation file, were summed to obtain the total population and the total number of full-time equivalent physicians in all designated portions of each partly designated county. On the basis of this information, a portion of the changes in population and number of physicians forecast by the county model for each year of the projection period was then explicitly allocated to the designated portions of each partly designated county.

The allocation from county to subcounty required an assumption regarding the relationship between the rate of diffusion occurring in each county and the rate of diffusion occurring in its subcounty MSAs. After examination of several possible assumptions, the assumption finally adopted was that the rates of diffusion for each county and its subcounty MSAs would remain equal. This meant that physicians would be allocated to subcounty areas in sufficient numbers to keep the rate of growth of the physician supply for those areas the same as was forecast for the parent county; it also meant that the rate of change of the population of the MSAs would be the same as the rate of change in the parent whole county.

The above assumption was not adopted without serious reservations, however. The rates of population growth and physician diffusion could very well be different between subcounty MSAs and their parent counties, just as the rates of population growth and diffusion are different, on average, between whole-county HMSAs and non-designated counties. Unfortunately, there were no data available for MSAs upon which to base estimates of differential rates. As a result, it was decided to adopt the assumption of equality in the rates between MSAs and their parent counties, and then to conduct an analysis of the sensitivity of the results to variations in that assumption. (The results of the sensitivity analysis are described later in this section.)

The objective of these projections was to calculate the number of physicians needed to bring the population-to-physician ratio in HMSAs down to 3500-to-1. Therefore, subcounty areas which had ratios below 3500-to-1 but greater than 3000-to-1 and were designated because they exhibited high need for primary care manpower were not included. All of the partly designated counties that were in the county forecast file and that were not already included in the

comparable county-level forecasts (i.e., those counties with ratios below 3500-to-1) were included in the analysis. (The five counties of New York City were treated as a single county.) These selection criteria excluded from consideration those MSAs that were not part of a U.S. county (e.g., trusts or territories), those entire counties that were part of a designated MSA, and those MSAs that were part of a county having a whole county population-to-physician ratio of greater than 3500-to-1. Including the latter two groups of MSAs, which had already been accounted for in the county-level forecast, would have resulted in double counting.

After the results of this specific method were produced, a sensitivity analysis was conducted to identify the impact of modifying the assumption of equal population rate changes and physician diffusion between each county and its subcounty MSAs. This sensitivity analysis showed that the output estimate of needs for primary care physicians in subcounty MSAs varied much less in percentage terms than the variations made in the input rates of population change and diffusion. For example, variations of 20 percent in the population and diffusion assumptions produced an overall change of only 8 percent in estimated needs. It was thus concluded that the projections were not overly sensitive to moderate variations in the basic assumptions employed, and the assumptions were consequently accepted as being reasonable.

Results

Table 1 displays the subcounty projections generated as discussed above. The table shows a total of 606 counties in 1982 that contain subcounty MSAs with a population to full-time-equivalent primary care physician ratio of greater than 3500-to-1. According to the table, to bring those ratios down to the 3500-to-1 level would currently require 2915 full-time-equivalent physicians.

By 1994, the number of counties having designated subcounty portions with population-to-physician ratios above 3500-to-1 is projected to decline to 422, while the number of physicians needed in those areas would decline to 2235. Thus, with the assumptions discussed above, the projections suggest that, over the next decade, designated subcounty MSAs will attract a proportion of the primary care physicians they need.

Although the subcounty projection was developed under the assumption that the rate of population growth and the rate of diffusion of physicians for each subcounty area would be equivalent to those of the parent county, the resulting projected rate of diffusion for all part-county MSAs is substantially slower than the overall rate predicted for all counties. The earlier whole-county forecast indicated that the number of whole counties with population-to-primary-care-physician ratios above 3500-to-1 would decline by almost 60 percent from 1982 to 1994. In contrast, the subcounty forecast indicates that the number of partly-designated counties having subcounty areas with such ratios would decline by only 30 percent over the same period. The difference in the rate of diffusion is even more pronounced when stated in terms of the number of physicians needed. That number declines by almost 60 percent in whole counties, while it declines by only about 25 percent in part counties.

Although the subcounty forecast employs input data on the number of full-time-equivalent primary care physicians at the beginning of the projection period instead of the simple "head count" of primary care physicians used in the county forecast, that difference affects only the absolute numbers of physicians needed, not the rate of diffusion. A more likely explanation for the different rates is that the partly-designated counties are themselves attracting physicians at a slower rate than other counties. In the original econometric model that was the basis for the forecasts, there was also a slight but discernable difference in the rates of diffusion between urban and rural counties. Since the partly-designated counties are large and more "urban" than a typical county, it is likely that they are attracting physicians at a slightly slower-than-average rate; this, of course, was reflected in the subcounty forecasts.

Table 2 repeats the projection for whole counties with ratios greater than 3500-to-1 from the earlier report, while table 3 combines the results of both the whole county and part county forecasts. Table 3 thus shows the aggregate number of counties that have a county ratio above the 3500-to-1 level or that contain subcounty MSAs with a ratio above that level. The total number of primary care physicians that would be needed to bring the ratios in these whole counties and subcounty areas down to the 3500-to-1 level is also presented.

As Table 3 shows, there was a total of 1,501 whole- and part-counties with population-to-physician ratios above 3500-to-1 in 1982. To bring their ratios down to the 3500-to-1 level, 5076 primary care physicians would currently be needed. By 1994, the projection indicates that an aggregate of only 810 such counties would continue to have ratios above 3500-to-1, with 3204 physicians needed to bring their ratios down to that level. This represents a 46 percent decline in the number of counties and a 37 percent decline in the number of physicians needed. The decline in the number of counties with ratios above 3500-to-1 is very similar between metropolitan and non-metropolitan counties (43 percent and 47 percent respectively), but the number of physicians needed declines more rapidly in non-metropolitan than in metropolitan counties over the forecast period (45 percent as compared with 31 percent).

Table 1

Number of Partly Designated Counties Having a Population-to-Primary Care Physician Ratio for Designated Portions Greater than 3500-to-1, and Number of Full-Time-Equivalent Primary Care Physicians Needed to Reduce the Ratio in Designated Subcounty Areas to 3500-to-1, 1982-1994

Year	Number of Partly Designated Counties having a Population-to-Primary Care Physician Ratio in all Designated Portions Greater than 3500-to-1			Number of Full-Time-Equivalent Primary Care Physicians Needed to Reduce the Ratio in Designated Subcounty Areas to 3500-to-1		
	Total	Nonmet	Met	Total	Nonmet	Met
1982	606	365	241	2,915	657	2,258
1983	595	358	237	2,813	647	2,166
1984	579	355	224	2,729	646	2,083
1985	567	350	217	2,658	638	2,020
1986	541	337	204	2,582	621	1,961
1987	530	327	203	2,513	602	1,911
1988	509	316	193	2,450	580	1,870
1989	483	297	186	2,402	555	1,847
1990	470	292	178	2,326	543	1,783
1991	461	290	171	2,283	541	1,742
1992	451	281	170	2,269	533	1,736
1993	437	271	166	2,242	511	1,731
1994	422	255	167	2,235	487	1,748

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Table 2

Number of Counties with a Population-to-Primary Care Physician Ratio Greater than 3500-to-1, and Number of Primary Care Physicians Needed to Reduce those Ratios to 3500-to-1, 1982-1994

Year	Number of Counties with a Ratio Greater than 3500-to-1			Number of Physicians Needed to Reduce Ratio in all Counties to 3500-to-1		
	Total	Nonmet	Met	Total	Nonmet	Met
1982	895	761	134	2,161	1,441	721
1983	851	724	127	2,070	1,371	699
1984	794	678	116	1,967	1,296	671
1985	744	635	109	1,867	1,221	646
1986	687	585	102	1,748	1,139	609
1987	635	538	97	1,601	1,040	561
1988	586	500	86	1,457	962	495
1989	530	453	77	1,317	869	448
1990	506	431	75	1,255	828	427
1991	475	405	70	1,172	778	393
1992	432	370	62	1,083	723	360
1993	417	360	57	1,030	698	332
1994	388	343	45	969	661	308

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Table 3

Number of Wholly or Partly Designated Counties Having a Population-to-Primary Care Physician Ratio Greater than 3500-to-1 and Number of Primary Care Physicians Needed to Reduce the Ratio in these Whole or Part Counties to 3500-to-1, 1982-1994

Year	Number of Wholly or Partly Designated Counties Having a Population-to-Primary Care Physician Ratio Greater than 3500-to-1 1/			Number of Primary Care Physicians Needed to Reduce the Ratio in Whole and Part Counties to 3500-to-1 2/		
	Total	Nonmet	Met	Total	Nonmet	Met
1982	1,501	1,126	375	5,076	2,098	2,979
1983	1,446	1,082	364	4,883	2,018	2,865
1984	1,373	1,033	340	4,696	1,942	2,754
1985	1,311	985	326	4,525	1,859	2,666
1986	1,228	922	306	4,330	1,760	2,570
1987	1,165	865	300	4,114	1,642	2,472
1988	1,095	816	279	3,907	1,542	2,365
1989	1,013	750	263	3,719	1,424	2,295
1990	976	723	253	3,581	1,371	2,210
1991	936	695	241	3,455	1,319	2,135
1992	883	651	232	3,352	1,256	2,096
1993	854	631	223	3,272	1,209	2,063
1994	810	598	212	3,204	1,148	2,056

1/ Counties identified in the county-level projection as having overall ratios greater than 3500-to-1 are combined with counties identified in the subcounty projection as containing designated portions having a population-to-physician ratio above 3500-to-1.

2/ Projected numbers of physicians needed in wholly-designated counties to reduce their ratios to the 3500-to-1 level combined with projected numbers of physicians needed in designated portions of partly designated counties to reduce their ratios to the same level.

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6/1/83