Forecasting the Need for Physicians in the United States: The Health Resources and Services Administration's Physician Requirements Model

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Objective. The Health Resources and Services Administration's Bureau of Health Professions developed a demographic utilization-based model of physician specialty requirements to explore the consequences of a broad range of scenarios pertaining to the nation's health care delivery system on need for physicians.
Data Source/Study Setting. The model uses selected data primarily from the National Center for Health Statistics, the American Medical Association, and the U.S. Bureau of Census. Forecasts are national estimates.
Study Design. Current (1989) utilization rates for ambulatory and inpatient medical specialty services were obtained for the population according to age, gender, race/ethnicity, and insurance status. These rates are used to estimate specialty-specific total service utilization expressed in patient care minutes for future populations and converted to physician requirements by applying per-physician productivity estimates.
Data Collection/Extraction Methods. Secondary data were analyzed and put into matrixes for use in the mainframe computer-based model. Several missing data points, e.g., for HMO-enrolled populations, were extrapolated from available data by the project's contractor.
Principal Findings. The authors contend that the Bureau's demographic utilization model represents improvements over other data-driven methodologies that rely on staffing ratios and similar supply-determined bases for estimating requirements. The model's distinct utility rests in offering national-level physician specialty requirements forecasts.

Key Words. Physician work force, physician requirements, physician utilization, physician demand, work force planning

Policymakers and analysts concerned with assuring an adequate supply of physicians in the United States must, like actors in an oversized theater, be able to project. They must be able to predict with reasonable accuracy how many physicians, in what specialties, will be needed decades into the twenty-first century. The ability to make such predictions on a specialty-specific basis is important for two reasons:

1. An oversupply of physicians in a given specialty inflates health care costs by introducing the possibility of provider-generated demand.
2. An undersupply increases the likelihood that population groups that are currently underserved will continue to lack access to the basic health care services needed to foster healthy babies and children, and attend to the disease prevention and health promotion needs of adults.

These are not idle concerns. Observers of the health care scene in the United States increasingly support the proposition that there are too many specialist physicians and not enough generalists and that, as a consequence, the nation is suffering in two respects: excessive health care costs for all and inadequate access for some (Rockefeller 1993; Wennberg et al. 1993; O'Neil 1993).

To address these concerns in a systematic manner, the Health Resources and Services Administration's Bureau of Health Professions (BHPr) has developed and applied computerized models for projecting physician supply and requirements decades into the future. Over the years, the BHPr supply model has been cited and described in a number of publications (Kindig, Cultice, and Mullan 1993; Politzer et al. 1992; Mullan et al. 1994; Mullan, Rivo, and Politzer 1993; Gamliel et al. 1995). The requirements model, although equally important, has received somewhat less attention (Politzer, Gamliel, Cultice, et al. 1995; U.S. Department of Health and Human Services 1992; Traxler

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1994). Recognizing that a broader understanding of the model may be helpful to health services researchers in assessing the adequacy of the nation's future physician supply, this article describes the requirements model and provides samples of the output it produces. Readers are cautioned that the illustrative forecasts presented here do not necessarily reflect the authors' view of the future. They are presented solely to demonstrate how the model may be applied to explore the consequences of conjectured future developments in such variables as physician productivity, HMO enrollment patterns, race-specific utilization rates, and so on. Users of the model are free to vary these and other variables virtually at will.

MODEL OPERATION

The BHPr Physician Requirements Model divides the world of patient care into three domains: population, physician specialty, and care setting. Subdivisions within each of these domains follow.

POPULATION

The population of the United States is divided, based on U.S. Census Bureau projections (U.S. Bureau of Census 1989), into 36 demographic groups: by gender (Male, Female) by race (White, African American, Other) by age (0–17, 18–34, 35–54, 55–64, 65–74, 75+). Each group is further subdivided, based on other data sources, into three insurance categories: fee-for-service insured, HMO enrollment, and uninsured. In all, the model accommodates 108 population segments–108 different combinations of gender, race, age, and insurance status.

PHYSICIAN SPECIALTY

Eighteen medical specialties are defined: (1) general/family practice, (2) general internal medicine, (3) cardiology, (4) other internal medicine subspecialties, (5) general surgery, (6) orthopedic surgery, (7) otolaryngology, (8) ophthalmology, (9) urology, (10) other surgical subspecialties, (11) emergency medicine, (12) obstetrics/gynecology, (13) pediatrics, (14) psychiatry, (15) anesthesiology, (16) radiology, (17) pathology, and (18) other specialties.

CARE SETTING

The spectrum of health care delivery is divided into five settings: (1) physician office visits, (2) emergency room/hospital outpatient visits, (3) short-term

hospital stays, (4) operating room (surgeries), and (5) long-term care/nursing home visits.

The projection process employed in the model involves three basic steps.

Step 1. Determine Base Year Utilization

The model begins by examining the past: the volume of services provided in a given base year, currently set at 1989. These calculations were performed by Vector Research, Inc. (VRI) and its subcontractor, Lewin-ICF, and resulted in comprehensive tables (Vector Research, Inc. 1993) showing the per capita utilization rates experienced in the base year by each population segment with respect to various combinations of physician specialty and care setting. The data used to support these determinations were taken from the following surveys conducted by the National Center for Health Statistics:[1]

- The 1989 National Ambulatory Medical Care Survey, for information on physician office visits;
- The 1989 National Health Interview Survey, for information on emergency room/hospital outpatient visits and ambulatory surgeries. A special Health Insurance Supplement conducted that year also provided data on HMO enrollment and the linkage between insurance status and utilization of services;
- The 1989 National Hospital Discharge Survey, for information on hospital stays and inpatient surgeries;
- The 1980 National Medical Care Utilization and Expenditure Survey, for specialty detail on inpatient hospital stays and surgeries;
- The 1985 National Nursing Home Survey, for information on long-term care/nursing home visits.

Data from these sources served to illuminate the overall utilization picture but did so unevenly. Not all data were from the same year, gathered in the same manner, or reported to the same level of detail. To sharpen the picture, VRI/Lewin–ICF utilized data from the 1989 American Medical Association Socioeconomic Monitoring System (AMA–SMS) survey (American Medical Association 1990), from which they derived "control totals," expressed in number of visits, for each specialty and setting. These totals were then apportioned among the various population segments, making use of relationships derived from the previously mentioned data sources, so that the sum of the parts equaled the whole–the whole being the specialty- and setting-specific totals reported by the AMA.

Step 1 produced two sets of output. The first is $V_{1989}(i,j,k)$, the estimated volume of services administered to population segment i by physicians of specialty j in care setting k, in 1989. The second is the corresponding utilization *rate,* defined as

$$R_{1989}(i, j, k) = V_{1989}(i, j, k) \div P_{1989}(i) \tag{1}$$

where

$R_{1989}(i, j, k) =$ the per capita utilization rate associated with population segment i, physician specialty j, and care setting k in 1989;

$P_{1989}(i) =$ the number of persons in population segment i in 1989;

and $V_{1989}(i, j, k)$ is as previously defined. These values, as noted, apply only to the base year (1989). Stored in the form of computerized files, they may now be used, with or without modification, to support the steps that follow.

Step 2. Project Future Year Utilization

For each combination of population segment, specialty, and setting, the projected number of units of service required in future years is determined by reconfiguring Equation 1:

$$V(i, j, k) = P(i) * R(i, j, k) \tag{2}$$

where the absence of a subscript denotes future, as opposed to base year, values. The quantities on the right-hand side of the equation are permitted to vary over time. $P(i)$, the number of persons in population segment i, varies as the population grows, undergoes shifts in demographic composition, and/or undergoes changes in the distribution of insurance coverage; the input tables that drive the model permit the user to vary any or all of these factors. $R(i,j,k)$, the per capita utilization rate associated with population segment i, specialty j, and setting k, is also permitted to vary. For each combination of population segment, specialty, and setting, users have the option of either retaining the base year utilization rate calculated in step 1 or, alternatively, modifying the rate to reflect anticipated changes in the nation's health care delivery system or in the utilization patterns of selected groups.

An illustration of how the latter feature might work is provided below:

Example. The base year utilization rates for physician office visits by females under the age of 18 with fee-for-service insurance coverage were estimated to be as follows (Vector Research, Inc. 1993):

	General/Family Physicians	Pediatricians	Other Specialties
		Visits per 1,000 females under age 18	
White	1,455	2,891	1,327
African American	663	2,138	1,246
Other	1,286	2,838	1,247

The dramatically lower rates associated with African American female children may be the result of increased use of emergency room facilities, less-than-optimal consumer education of their parents, limited availability of health care resources, or, more than likely, some combination of the above. In the health care system of the future, one would expect these gaps to narrow and ultimately close. It would not be unreasonable, therefore, to assign to all three race/ethnic groups utilization rates that are roughly, if not precisely, equal. The model, as noted, provides this capability.

Once values of $V(i,j,k)$ have been derived, based on Equation 2, for all combinations of i, j, and k, the model sums across population segments to derive the projected volume of services by specialty and setting:

$$V(j,k) = \sum_{i} V(i,j,k) \tag{3}$$

where the indexes i, j, and k are defined as before.

Step 3. Convert Future Year Utilization to Number of Full-Time Equivalent Physicians

This step is accomplished in three phases. The first phase is to convert the "apples and oranges" output of step 2 (the projected demand for physicians of a given specialty in five different settings) to a single measure: minutes. Expressing all services, regardless of setting, in the number of minutes required to perform them permits the model to sum across settings to derive a single unambiguous measure of the demand for any given specialty in any given year.

Estimates of physician productivity ("average number of minutes per service") were derived from 1989 data. Utilizing data from that year's AMA Socioeconomic Monitoring System (AMA–SMS) survey, VRI/Lewin–ICF initially estimated $M_{1989}(j,k)$, the total number of minutes devoted by physicians of specialty j to the delivery of care in setting k. Each of those numbers was then divided by the corresponding number of units of service derived in step 1, to produce the following estimate of physician productivity, expressed in minutes per service:

$$\overline{M}_{1989}(j,k) = M_{1989}(j,k) \div V_{1989}(j,k) \tag{4}$$

As in the case of patient utilization rates, these base year estimates may either be retained throughout the projection period or varied over time. In either case, the values assigned are applied to the output of step 2 to convert that output from "number of units of service" to "number of minutes." The equation that governs this operation is simply:

$$M(j,k) = \overline{M}(j,k) * V(j,k) \tag{5}$$

where $\overline{M}$ could be either the base year value of productivity or that value modified to reflect technological or other changes. Summing across settings then produces the projected demand, in minutes, for the specialty as a whole, that is:

$$M(j) = \sum_{k} M(j,k) \tag{6}$$

The second phase in this process is to inflate $M(j)$, the projected minutes of direct patient care for specialty j, to reflect the average percentage of time devoted by physicians of that specialty to indirect patient care, defined as telephone conversations with patients or their families, consulting with other physicians, interpreting laboratory results or x-rays, and so on. These indirect care percentages, again drawn from the 1989 AMA–SMS survey, range from a low of 7.0 percent for urologists (i.e., for every 100 hours devoted to direct patient care, an additional 7 hours are devoted to indirect care) to a high of 22.3 percent for pathologists. As in the case of utilization and productivity, these values may be varied over time.

The third and final phase is to convert the projected minutes of patient care, direct and indirect combined, to the corresponding full-time-equivalent number of physicians. To do this, use was made of data from the 1990 AMA publication *Physician Characteristics and Distribution in the U.S.* (American Medical Association 1992), concerning the number of physicians in each specialty who in 1989 reported that their major professional activity was patient care. For each specialty, the total minutes devoted to patient care in 1989, divided by the number of physicians who reported their primary activity as patient care, produces a full-time-equivalency factor, in minutes, for that specialty. The FTE factor for each specialty, divided into the projected minutes of patient care required of that specialty in any given year, produces the corresponding full-time-equivalent number of patient care physicians required that year:

$$FTE_{pc}(j) = M(j) * [1 + IPC(j)] \div FTE(j) \tag{7}$$

where $M(j)$, as previously defined, is the projected minutes of direct patient care associated with specialty j, and $IPC(j)$ and $FTE(j)$ are the corresponding indirect patient care and full-time-equivalency factors.

At this point, the model applies to the output of Equation 7 an upward adjustment factor to reflect physicians who are engaged in activities other than patient care (administration, teaching, research, etc.). The requirement for patient care physicians shown in Equation 7 is thus expanded as follows:

$$FTE_{phys}(j) = FTE_{pc}(j) * [1 + NPC(j)] \tag{8}$$

where $NPC(j)$ is the ratio of non-patient care to patient care physicians in 1989 for specialty j.

The non-patient care adjustment factors in Equation 8 are assumed not to change in the future. For allopathic physicians these factors were drawn from the 1992 *Physician Characteristics and Distribution in the U.S.*, and they range from a low of 2.2 percent for orthopedic surgeons to a high of 26.3 percent for "other specialties." The corresponding percentages for osteopathic physicians, drawn from the *1990 American Osteopathic Association Yearbook and Directory* (American Osteopathic Association 1992), are in the vicinity of 2 percent.

MODEL OUTPUT

As noted in the preceding section, the model produces the projected number of physicians, by specialty, required to handle the demand for health care in each of various projection years. It does so by taking into account changes in the demographic composition of the United States and in the percentage of Americans covered by fee-for-service insurance, enrolled in HMOs, and uninsured, respectively. Other changes, such as changes in basic utilization rates, physician productivity rates, and the percentage of time devoted to indirect patient care, are also permitted.

This form of projection differs from the simpler but less probing form in which physician-to-population ratios based on past experience are applied to future populations. The consequences of these differences are illustrated below.

PHYSICIAN-TO-POPULATION APPROACH

In 1989, the defined base year, the resident population of the United States was 248,249,000 (U.S. Bureau of Census 1989). The number of physicians that year was 588,000, consisting of 193,500 MDs in primary care (defined as general and family practitioners, general internists, and general pediatricians) specialties; 367,900 MDs in non-primary care specialties; and 26,600 DOs, about 60 percent of whom were in primary care. The corresponding physician-to-population ratios were as follows: MDs and DOs combined, 2.37 per thousand; MDs in primary care specialties, 0.78 per thousand; MDs in non-primary care specialties: 1.48 per thousand; and DOs, 0.11 per thousand.

By the year 2020, according to the Census Bureau's middle series projections (U.S. Bureau of Census 1993), the resident population will have grown to 325,941,000. Applying the ratios shown above to this increased population size would result in a requirement for 772,500 physicians, distributed as follows:

- 254,200 MDs in primary care specialties
- 482,400 MDs in non-primary care specialties; and
- 34,900 DOs.

Because of the proportionality inherent in this approach, the percentage of MDs engaged in primary care is precisely what it was in 1989: 34.5 percent.

MODEL APPROACH

Changes in the demographic composition of the American population, however, may reasonably be expected to affect both the total number and specialty distribution of physicians that would be required based on population growth alone. Changes in the percentage of Americans covered by various forms of health insurance may be expected to invoke further changes. To explore these possibilities, the following scenarios were defined for use in connection with the model:

Scenario A. No change will occur in existing managed care enrollment patterns.[2] Physician requirements will change only as a result of population growth and changes in the age, race, and gender composition of the population.

Scenario B. By the year 2020, in addition to population growth and the demographic changes postulated in Scenario A, everyone in the United States will be covered by fee-for-service insurance, with per capita utilization rates

equal to those experienced in the base year by individuals with fee-for-service insurance.

Scenario C. By the year 2020, in addition to population growth and the demographic changes postulated in Scenario A, everyone will be enrolled in a managed care organization, with per capita utilization rates equal to those experienced in the base year by individuals enrolled in HMOs, both group and Independent Practice Associations (IPAs).

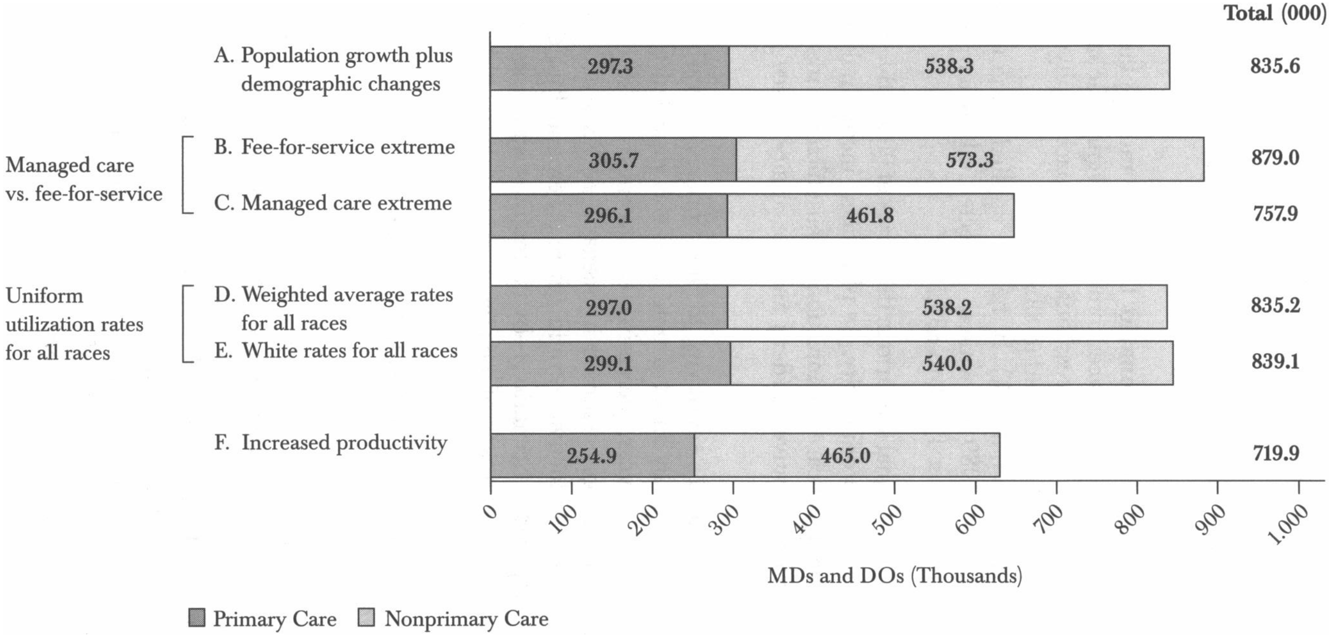
In addition to growth in managed care, profound changes in the age, gender, and racial composition of the United States are expected between now and the year 2020. The elderly component will have expanded considerably, the female component will have declined, and the percentage of racial/ethnic minorities, particularly those other than African Americans, will have undergone a substantial increase. Applying these population projections to Scenarios A through C produced the marked contrasts in projected physician requirements shown in Figure 1 (further on). In essence:

- **Scenario A** (population growth plus demographic change with no change in existing enrollment patterns) resulted in a projected requirement for 835,600 physicians in 2020. This represents an 8.2 percent increase above the requirement of 772,500 based on population growth alone. The percentage of MDs engaged in primary care remained essentially what it was in 1989: 34.6 percent.
- **Scenario B** (the fee-for-service extreme) produced an even greater (13.9 percent) increase in physician requirements, to 879,000. Concomitantly, the percentage of MDs engaged in primary care declined to 33.9 percent.
- **Scenario C** (the managed care extreme) produced a projected requirement for only 757,900 physicians, a 1.8 percent *decrease* with respect to that based on population growth alone. The percentage of MDs engaged in primary care *increased*, to 38.0 percent.

Changes in demographic composition and managed care are not the only changes to be expected. The lower-than-average utilization rates associated with racial and ethnic minorities in the past will surely rise through better access to and awareness of available health resources. To reflect that likelihood, two additional scenarios were defined:

Scenario D. This is similar to Scenario A, except that the utilization rate applied to all persons of a given age and gender is the weighted average in 1989 for persons of that age and gender of all races combined.

Figure 1: Projected Physician Requirements in the Year 2020–Six Scenarios



Source: Results from the BHPr/HRSA Physician Requirements Model.

Scenario E. Same as Scenario D, except that the utilization rate applied to minorities of a given age and gender is the 1989 rate for whites of the same age and gender.

The results of these scenarios, shown in Figure 1, are briefly summarized:

- **Weighted average (Scenario D).** If the rate applied is the 1989 weighted average for all races combined, assigning the same utilization rate to all races produces essentially no impact on physician requirements (835,200 as opposed to 835,600).
- **White rate (Scenario E).** If the rate applied is the utilization rate applicable in 1989 to whites, projected physician requirements increase by almost 4,000, to 839,100.

Scenario F. The final scenario in this series of illustrative runs explores the issue of physician productivity. As physicians increasingly provide services through managed care organizations, their efficiency may rise through reductions in administrative burdens and the ability to see more patients per year.

To test the model's sensitivity to the productivity variable, the productivity of physicians in direct patient care was modeled to grow at just under 0.5 percent per year, increasing 15 percent by 2020, in addition to the demographic changes assumed in Scenario A. As seen in Figure 1, a 15 percent rise in productivity would cut requirements by nearly 120,000 physicians compared to Scenario A–by far the most substantial reduction in requirements achieved in any of the scenarios.

INTERPRETATION OF RESULTS AND CONCLUSIONS

These results confirm what most observers believe: that the continued growth of managed care will have a sizable impact on physician requirements; that is, the number of physicians required will decline (compared to a continuation of the status quo) but the percentage of primary care specialists will increase. One might conclude from this that, from the standpoint of physician requirements, the impetus toward reduced utilization and increased productivity associated with managed care will effectively offset two major forces moving in the opposite direction: (a) the graying of America and (b) universal coverage. Any such

conclusion must be tempered, however, by the recognition that the managed care utilization rates used in Scenario C are reflective of the base year (1989) and not necessarily of the future. To the extent that HMO populations have tended in the past to be healthier on average than those that are uninsured or in the fee-for-service sector, applying prior year utilization rates to enrollees drawn over time from the other two sectors may not be appropriate. Another potential complication: the model does not currently distinguish between the productivity of physicians engaged in managed care versus those in non-managed care. Both of these complications require further study.

On the issue of race-specific utilization, applying prior year utilization rates to racial minorities is both ethically and logically indefensible. Those who, for reasons beyond their control, have underutilized health care resources in the past should not be condemned to do so in the future. There is nothing inherent in being a minority that ordains that an individual should receive a lower rate of health care than that received by whites.

In conclusion, the BHPr physician requirements model provides an effective and flexible analytic tool for projecting demographic–utilization-determined requirements for physician specialties. While the model described here is not suitable for generating normative or goal-directed requirements for policymaking purposes as was, for example, the Graduate Medical Education National Advisory Committee needs-based model (U.S. Congress 1980), it is useful as a framework for monitoring trends and economic factors that will likely affect the utilization of physician specialists.

Although the model is generally bound by the key assumption that recent trends will continue into the future and, as such, serves more as a benchmark or status quo estimator of requirements, we have shown that there is sufficient flexibility in the model's inputs to permit gauging the effects of a wide range of possible scenarios on physician requirements. At the least, this capability will be of interest and service to health policymakers and analysts now and in the foreseeable future.

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NOTES

1. Interested readers may contact James M. Cultice, Workforce Analysis and Research Branch, Office of Research and Planning, BHPr/HRSA, Room 847, 5600 Fishers Lane, Rockville, MD 20857 (301/443-6923) regarding additional background material on the model, including data used in the model.
2. All scenarios assume that in 1989, 14 percent of the population were enrolled in group HMOs and IPAs, 73 percent were covered under fee-for-service plans, and 13 percent were uninsured.

REFERENCES

American Medical Association. 1990. *Physician Marketplace Statistics*. Chicago: AMA (Fall).

———. 1992. *Physician Characteristics and Distribution in the U.S.* Chicago: AMA.

American Osteopathic Association. 1992. *American Osteopathic Association Yearbook and Directory*. Chicago: AOA.

Gamliel, S., R. M. Politzer, M. L. Rivo, and F. Mullan. 1995. "Managed Care on the March: Will Physicians Meet the Challenge?" *Health Affairs* 14 (2): 131–42.

Kindig, D. A., J. M. Cultice, and F. Mullan. 1993. "The Elusive Generalist Physician: Can We Reach a 50% Goal?" *Journal of the American Medical Association* 270 (9): 1069–73.

Mullan, F., R. M. Politzer, S. Gamliel, and M. L. Rivo. 1994. "Balance and Limits: Modeling Graduate Medical Education Reform Based on Recommendations of the Council on Graduate Medical Education." *The Milbank Quarterly* 72 (3): 385–98.

Mullan, F., M. L. Rivo, and R. M. Politzer. 1993. "Doctors, Dollars, and Determination: Making Physician Work-Force Policy." *Health Affairs* 12 (Supplement): 139–51.

O'Neil, E. H. 1993. "Academic Health Centers Must Begin Reforms Now." *The Chronicle of Higher Education* (8 September).

Politzer, R. M., C. E. Yesalis, C. H. Davis, and M. D. Segarra. 1992. "The Traditional Public Health Approach to Prevention and Risk Reduction–Can We Raise the Titanic?" *American Journal of Preventive Medicine* 8 (6): 395–98.

Politzer, R. M., S. R. Gamliel, J. M. Cultice, C. M. Bazell, M. L. Rivo, and F. Mullan. 1995. "Matching Physician Supply and Requirements: Testing Policy Recommendations." Draft, submitted for publication.

Rockefeller, J. D. 1993. "Primary Care: The Infrastructure for Healthcare Reform." *The Internist* 23 (April): 9–11.

Traxler, H. 1994. "Physician Supply Modelling in the United States of America and Its Uses in Assisting Policymaking." *World Health Statistics Quarterly* 47 (3/4): 118–25.

U.S. Department of Health and Human Services, Health Resources and Services Administration. 1992. *Health Personnel in the United States–Eighth Report to Congress, 1991*. Washington, DC: Government Printing Office.

U.S. Bureau of the Census. 1989. *Projections of the Population of the United States by Age, Sex, and Race: 1988 to 2080.* Series P-25, no. 1018. Washington, DC: Government Printing Office.

———. 1993. *Population Projections of the United States, by Age, Race, and Hispanic Origin: 1993 to 2050.* Series P-25, no. 1104. Washington, DC: Government Printing Office.

U.S. Congress, Office of Technology Assessment. 1988. *Forecasts of Physician Supply and Requirements.* Washington, DC: Government Printing Office.

Vector Research, Inc. 1993. *Refinements to BHPr Physician Requirements Forecasting Model, Volume II: Data and Methodology.* Prepared under contract to the Bureau of Health Professions by C. Roehrig, A. Turner, J. Brooks, and J. Hufford of VRI, and D. Kennel, L. Alecxih and A. Brooks of Lewin–VHI.

Wennberg, J. E., D. C. Goodman, R. F. Nease, and R. B. Keller. 1993. "Finding Equilibrium in U.S. Physician Supply." *Health Affairs* 12 (2): 90–103.