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Pediatrics 2005;116;156-173; originally published online Jun 15, 2005;

DOI: 10.1542/peds.2005-0874

This information is current as of July 8, 2005

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://www.pediatrics.org/cgi/content/full/116/1/e156>

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American Academy of Pediatrics

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The Pediatrician Workforce: Current Status and Future Prospects

ABSTRACT. The effective and efficient delivery of children's health care depends on the pediatrician workforce. The number, composition, and distribution of pediatricians necessary to deliver this care have been the subject of long-standing policy and professional debate. This technical report reviews current characteristics and recent trends in the pediatric workforce and couples the workforce to a conceptual model of improvement in children's health and well-being. Important recent changes in the workforce include (1) the growth in the number of pediatricians in relation to the child population, (2) increased numbers of female pediatricians and their attainment of majority gender status in the specialty, (3) the persistence of a large number of international medical graduates entering training programs, (4) a lack of ethnic and racial diversity in pediatricians compared with children, and (5) the persistence of marked regional variation in pediatrician supply. Supply models projecting the pediatric workforce are reviewed and generally indicate that the number of pediatricians per child will increase by 50% over the next 20 years. The differing methods of assessing workforce requirements are presented and critiqued. The report finds that the pediatric workforce is undergoing fundamental changes that will have important effects on the professional lives of pediatricians and children's health care delivery. *Pediatrics* 2005; 116:e156–e173. URL: www.pediatrics.org/cgi/doi/10.1542/peds.2005-0874; *child health workforce, diversity, family medicine, female pediatricians, geographic distribution, health manpower, internal medicine-pediatrics, international medical graduates, nonphysician clinicians, physician workforce, pediatrics, pediatric medical subspecialists, pediatric surgical specialists.*

ABBREVIATIONS. AAP, American Academy of Pediatrics; FOPE II, Future of Pediatric Education II; ABP, American Board of Pediatrics; AMA, American Medical Association; GME, graduate medical education; IMG, international medical graduate; med-peds, internal medicine-pediatrics; FTE, full-time equivalent; HMO, health maintenance organization; GMENAC, Graduate Medical Education National Advisory Committee; GDP, gross domestic product.

INTRODUCTION

Our common mission to attain the optimal physical, mental, and social health and well-being for all infants, children, adolescents, and young adults (mission statement of the American Academy of Pediatrics [AAP]) depends on the pediatrician workforce. The improvement of chil-

dren's health occurs through the efforts of these professionals who draw on their training and experience to deliver within a medical home the best possible pediatric care and to serve as child advocates. How, then, can we ensure that the right number of qualified clinicians are located where needed to provide pediatric care that is effective and efficient? Market forces alone are insufficient to meet these public and professional workforce goals given the inherent imperfections in the market for health care labor and health care services.^{1–6} With a continuing need to influence the number and characteristics of child health professionals, this technical report seeks to inform pediatricians and child health policy makers of the status of the child health workforce and the public policies that will influence its future.

The last AAP policy statement on the pediatric workforce, prepared by the Committee on Pediatric Workforce and published in 1998,⁷ combined a status report of the workforce with policy recommendations. In this current effort, the technical report provides the background to recommendations included in the separate but companion policy statement "Pediatrician Workforce Statement."⁸ To accomplish this, the report draws mostly on published sources, many of them from the AAP or the Future of Pediatric Education II (FOPE II) Project, to identify salient trends, possible future challenges to the profession, and critical domains of underdeveloped information. When published sources of data were not available, unpublished data have been cited from the Center for the Evaluative Clinical Sciences at Dartmouth Medical School (data sources and methods are available on request). The focus of the report is on general and medical subspecialty board-certified (by the American Board of Pediatrics [ABP]) pediatricians and the 99 million patients younger than 21 years whom they serve. Surgical and non-ABP-boarded pediatricians also provide essential services to children, but a detailed discussion of their status is beyond the scope of this report.

HEALTH WORKFORCE TRENDS

A full understanding of recent trends and current challenges facing the pediatric health workforce requires an examination of 4 general workforce themes.⁹ First, the number of physicians in the United States continues to grow in both absolute and per-capita numbers.^{10,11} In 2001 (December 31), the number of total patient-care physicians (defined by the American Medical Association [AMA] Masterfile as >50%

doi:10.1542/peds.2005-0874

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of professional time spent in clinical care) was 668 939, reflecting a 28% absolute and 18% per-capita increase during the decade. The number of residency or graduate medical education (GME) positions, the best predictor of entry into practice, was virtually unchanged at 93 674, with an 11% decrease in per-capita numbers. The per-capita decrease in the number of residency positions is slow enough that the physician workforce will continue its per-capita growth for another 20 years before decreasing. These figures do not include osteopathic physicians, who increased by 41% per capita during the decade and are a particularly important provider of primary care in many regions (Center for the Evaluative Clinical Sciences, unpublished data, 1998).

The second notable trend was the continued growth in the number of female medical students.¹² Although men continued to outnumber women in some specialties in both residency programs and practice,¹³ most specialties have experienced a shift in their gender mix. Overall, the per-capita number of female physicians increased 53% during the decade, reflecting an increase from 100 024 to 173 254.^{10,11}

Third, the physician workforce still fails to reflect the growing racial and ethnic diversity of the nation despite efforts to broaden medical school opportunities for individuals of traditionally underrepresented minority groups (black, Hispanic, and American Indian/Alaska Native). From information primarily collected by medical schools and residencies, in 2001 the AMA Masterfile listed 20 738 black (2.5%), 28 626 Hispanic (3.4%), 73 849 Asian, (8.8%) and 504 American Indian/Alaska Native (<1%) physicians of 836 156 physicians.¹¹ The system of racial/ethnic designation is presumably self-designation from a list of mutually exclusive categories, a type of categorization that has limitations.¹⁴ It is notable that race/ethnicity was missing for 256 995 physicians (31%) in the Masterfile. More complete data are known for physicians in residency programs; in 2000, 6% of all residents in programs approved by the Accreditation Council for Graduate Medical Education were black, 5.5% were Hispanic, and 22% were Asian (see Appendix II in ref 15). The racial/ethnic makeup of physicians is in contrast to the US population, of which in 2000, 12.2% were black non-Hispanic, 11.8% were Hispanic, 3.8% were Asian, and 0.7% were American Indian/Alaska Native.¹⁶

Physicians trained in other countries represent a fourth trend. The number of international medical graduates (IMGs) increased by 38% during the past decade, from 118 531 to 164 097.^{10,11} IMGs include US citizens who graduated from medical schools outside of the United States or Canada, citizens of other countries emigrating to the United States, and those planning on returning to their native country after completing residency. The most common country of citizenship of those issued Educational Commission for Foreign Medical Graduates certificates in 2001 was the United States (25.6%), followed by India (19.6%), Pakistan (6.2%), China (2.5%), Philipines (2.5%), and Iran (2.5%).¹⁷ Despite their ethnic diversity, IMGs leave unaddressed the need for a

physician workforce reflective of and culturally competent to care for growing US minority populations.

A final important characteristic of the medical workforce is its uneven geographic distribution. Regional variation in physicians per capita, whether measured by state, county, or health service areas,^{18–20} exceeds threefold for all specialties. Although the term “geographic variation” is typically used to refer to maldistribution associated with physician shortage in rural and inner-city communities, most regional variation occurs in a range of supply above that considered adequate.^{21,22} To date, studies that have examined the relationship between physician supply and population health needs have found a tenuous association.^{19,20,23–25} Similarly, the limited research on the association between the per-capita numbers of physicians in regions and health outcomes has found diminishing returns of improved health with higher levels of physicians per capita.^{24,26–35} It should be noted that this type of research is methodologically challenging.

A MODEL OF THE CHILD HEALTH WORKFORCE

There are many factors that can influence the size and composition of the child health workforce. The workforce is not, of course, an end in and of itself but exists to provide medical services to children. Parents, the public, and pediatricians, in turn, expect that pediatric services delivered within a medical home will lead to better health and well-being for children. To bring clarity and cohesiveness to workforce-related factors discussed in this report, we present a conceptual framework that is referenced throughout (Fig 1). As complex as the model may appear at first glance, it provides a simplified map of the elements that influence the number and characteristics of pediatricians and their relation to the production of improved children’s health outcomes. The model presents a sequence of “steps” using common economic and health services concepts. The medical education system (sometimes referred to by others as “the pipeline”) produces pediatricians who, in turn, produce pediatric services, leading to the production of improved child health outcomes. The model severely abbreviates some critical health influences that are beyond the scope of this report. For example, the many important genetic, environmental, and social factors that bear on health outcomes are summed by the component “relative need” in box 17 of the model.

COMPOSITION AND RECENT TRENDS IN THE CHILD HEALTH WORKFORCE

The per-capita growth rate in pediatricians during the past decade has exceeded that of the overall physician supply. The total number of active patient-care pediatricians (including medical subspecialists but excluding those in residency) increased from 33 691 to 51 675 (53%) over the past decade (January 1, 1992, through December 31, 2001), and the number of children younger than 18 years increased 11%; on a per-child basis, this represents a 38% increase. The numbers of general pediatricians increased at a slightly slower pace, from 29 931 to 42 214, a 41%

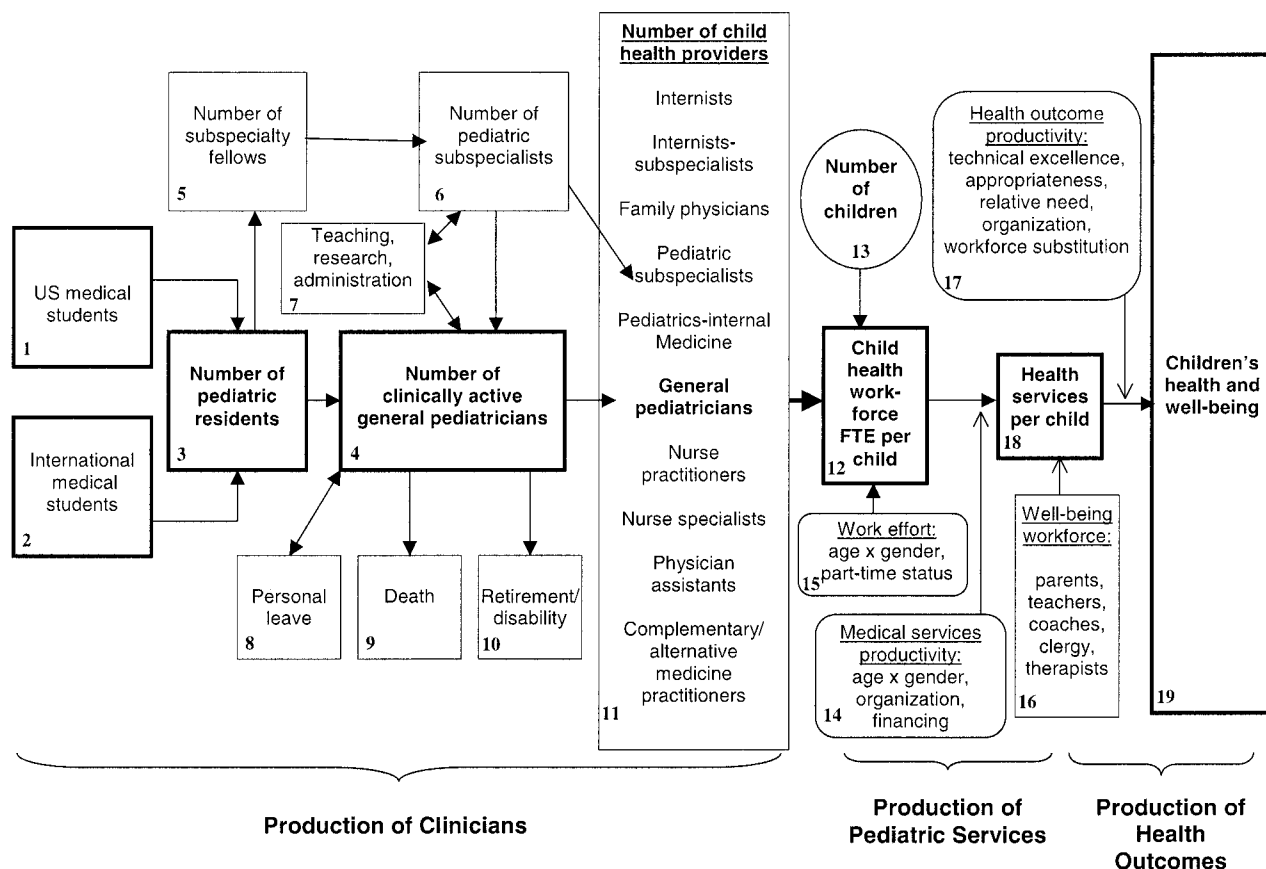


Fig 1. The child health workforce and the production of improved health outcomes.

increase or a 27% per-child increase. This increase in general pediatricians is higher than the per-capita (total population) growth in general internal medicine (20%) and family medicine (11%).^{10,11} Although concerns remain that the current number of pediatric residency positions is insufficient to meet patient and research needs for certain subspecialties,³⁶ the overall per-capita number of pediatric medical subspecialists increased by 127% during the past decade.

Gender

The most notable change in the composition of the child health workforce has been the accelerating entry of women into pediatric residency programs. Women constituted 65.2% of the 7629 pediatric residents in 2000, a proportion exceeded only by few other specialties such as obstetrics and gynecology (69.6%).¹⁵ In the past decade, the number of women in patient-care pediatrics increased from 17 219 to 31 276 (82% increase), and now women constitute 50% of all pediatricians.^{10,11} By the time this report is published, women will represent the majority of pediatricians, a historic first for any specialty in the United States. Information specific to pediatrics is lacking, but generally a woman's choice to enter a primary care specialty is influenced by children and other family responsibilities, volunteer or clerkship experiences with the underserved, personal social values, and factors related to marriage and spouse. In contrast, men are more influenced by income po-

tential, parental preferences, and role models before medical school.³⁷

There are many implications of this gender shift for pediatric health care delivery. The pediatrician workforce has begun to approach the gender mix of pediatric patients, better meeting the preferences of female adolescents for a clinician of the same gender. If the current gender mix of residents continues, male pediatricians will eventually make up approximately one third of the workforce. This trend is unlikely to stimulate increased demand for male clinicians. Although 50% of girls prefer a female clinician, only 23% of boys prefer a male clinician.³⁸

Another implication of more female pediatricians is that, all else held equal, additional physicians will be needed as more women choose to work part-time, particularly when their children are young.³⁹ The most useful source of information to assess these factors is the AAP Periodic Survey of Fellows, administered to 6400 active members annually. An excellent analysis of gender differences in 1993 was published by Brotherton and colleagues,⁴⁰ which this technical report will briefly summarize. First, the proportion of women practicing as general rather than subspecialty pediatricians was higher (61.4% female vs 55.4% male) and was particularly low for some subspecialties such as cardiology (0.9% of all pediatricians were female cardiologists vs 4.3% male); the proportion of female residents in 2000 remains less than 40% in pediatric cardiology and

gastroenterology.¹⁵ Male physicians, compared with female physicians, work more hours per week (average: 57 vs 48 hours, respectively) and spend more time delivering direct patient care (average: 42 vs 35 hours, respectively); thus, female physicians work, on average, 17% fewer patient-care hours than do male physicians over the course of their work lives. These figures include overall hours of both part-time and full-time pediatricians and are similar to data from the most recent AAP Periodic Survey of Fellows as well as previous reports.⁴¹

Analysis of the AAP Periodic Survey of Fellows has shown that the gender differences in work hours is explained by more women working part-time. The work hours of full-time men and women were similar, but 26% of women worked part-time, compared with 4% of men (Table 1). Pediatricians in part-time employment worked, on average, 15 fewer hours per week than did full-time pediatricians.

These data contradict any notions that women are less productive than men (productivity defined as "medical services productivity" and discussed later in the report [Fig 1, box 14]). More pediatricians will be needed as the proportion of female pediatricians increases, because women choose to work part-time or not at all during certain periods of their life but not because they do not work as hard as men when they are working full-time. Differing retirement rates by gender could also affect the numbers of pediatricians required, but no published studies are available to date.

Other gender differences merit mention. Overall, male and female pediatricians both spend approximately 17 minutes with patients for preventive care visits from birth through 11 years of age. However, female pediatricians spend 22 minutes with patients 12 years and older, compared with male pediatricians, who spend 19 minutes with patients 12 years and older.⁴⁰ In a study of a university-based pediatric primary care practice, female pediatrician visits were 29% longer than those with male pediatricians.⁴² These findings differ from those reported by McMurray et al⁴³ in data from the Physician Work Life Study. In this study, women and men allocated similar time for patient visits, but a discrepancy was reported between perceived and actual time needed by female physicians for complete physical examination/consultation.

Frank and Meacham⁴⁴ found that female pediatricians worked less and had lower incomes compared with other female physicians but also reported less

stress and career dissatisfaction. Female physician income was also reported to be consistently lower for both generalists and subspecialists compared with men, a difference that persists even when controlling for employment status. McMurray et al⁴³ also found a similar disparity when studying the combined specialties of pediatrics, family medicine, and internal medicine. Female pediatricians also face significant barriers in achieving advancement in academic medicine.⁴⁵ These disparities are troubling and have not been explained to date, although it would not be surprising if the gender discrimination in income and advancement that is pervasive in other professions was also found in pediatrics.^{46,47}

International Medical Graduates

Approximately one third of practicing pediatricians attended medical schools outside of the United States and Canada,^{10,11} a proportion that has changed little during the past 10 years. US medical students generally fill residency positions first and constitute a higher proportion of pediatric residency positions than most other specialties. In 2003, 28.7% of offered first-year pediatric residency positions were filled by IMGs, a lower proportion than for internal medicine (44.8%) or family medicine (58%).⁴⁸ IMGs remain an important and relatively stable part of the pediatrician workforce.

IMG residents and practicing physicians are heterogeneous in their national origin and their intentions to remain in the United States. The majority (58%) of first-year pediatric IMG residents are either US citizens, native or naturalized, or are permanent US residents with the right to apply for citizenship.¹⁵ The remaining IMGs hold a variety of visas that usually require a return to their country of origin after residency unless they accept employment in an underserved area of the United States. Their stay in the United States can be prolonged as long as they are in Accreditation Council for Graduate Medical Education–approved residency programs, including subspecialty education. This is a strong incentive to enter pediatric subspecialty residency programs, but when this training is completed, the final choices are still to practice primary care in an underserved area for several years or return to their country of origin. For example, an analysis of New York State IMGs by citizenship and visa status shows that IMGs with temporary visas were more likely to initially enter a primary care residency but that they planned to continue on to subspecialty education. Most planned to

TABLE 1. Mean Number of Hours and Part-time Status of Pediatricians According to Age and Gender: 2000

Age, y	Hours per Week (SD)		Percentage Working Full-time	
	Female	Male	Female	Male
≤35	42.6 (14.3)	46.9 (17.3)	77.1	91.1
36–45	38.8 (16.9)	46.0 (17.2)	66.9	99.0
46–55	36.2 (19.8)	47.3 (15.8)	70.9	97.9
≥56	45.5 (16.0)	43.1 (16.7)	93.3	92.2

Values represent the average work of post-GME clinical general pediatricians.

Source: AAP Periodic Survey of Fellows, unpublished data, 2000.

remain in the United States for additional education or by working with underserved populations.⁴⁹ In the end, a majority of IMGs remain in the United States.⁵⁰

The social value of the continuing flow of IMGs into residency positions, and ultimately into practice, is one of the most contentious issues among health workforce policy leaders. The debate is largely centered on the services they provide for indigent patients while in residency and the care they provide in practice to patients who are medically disenfranchised for geographic, cultural, or financial reasons.^{50–52} Some have argued that IMGs exacerbate an existing relative surplus of physicians, particularly specialists, and that in some instances they seem to add to regional disparities in the workforce. There are also concerns that international workforce migration of foreign-born physicians exacerbates health problems in developing countries by draining the supply of their physicians.^{53,54} Mullan⁵⁵ makes a similar point and argues that IMGs deny opportunities to US citizens aspiring to a career in medicine. In truth, many of the US citizens denied medical school admission in this country do travel overseas and return as one tributary of the IMG river. A fair reading of the policy research in this area does not support any simple conclusions. Foreign-born IMGs preferentially locate in areas with established IMG physicians, and IMGs of Hispanic and Asian descent tend to settle in areas with a higher proportion of these populations.⁵⁶ IMGs also disproportionately locate in high-need and underserved counties, and community health centers depend on them; at the same time, the data also indicate that they tend to locate in states with large numbers of physicians.^{57–60} In some instances, the presence of IMGs seems to exacerbate regional disparities in physician supply.⁶¹

IMGs receive their medical education in varied settings. The differences in education and training have raised concerns about the technical and cultural competencies of IMGs. Although data are incomplete about practicing IMGs, training-examination results provide some limited information. US IMGs and non-US IMGs have comparable pass rates in steps 1 and 2 of the US Medical Licensing Examination, but both fall short of US medical graduates. In the Clinical Skills Assessment Examination, overall pass rates of non-US IMGs are 79.7%, compared with 88.6% for US IMGs.⁶² ABP scores of first-time takers reveal a bimodal distribution with more low and high scores compared with US medical graduates (G. McGuinness, MD, ABP, written communication, January 16, 2003). These differences in scores may have implications for patient care; a recent study from Canada found a strong association between certification scores of primary care physicians and subsequent practice performance.⁶³

The number of foreign-trained physicians is a critical variable that affects growth in the physician workforce. Although the total number of residency positions, largely supported by funds from Medicare and the Health Resources and Services Administration, determines the GME maximum training capacity,⁶⁴ filling these positions depends on IMGs. The

number of physicians entering practice, therefore, is not determined by a national workforce policy linked to the need for physicians but by the vagaries of visa regulations, federal GME funding, and the perceived needs of teaching hospitals. Together, these factors, which determine the size of the GME pipeline, remain the most salient example of an absent national workforce policy in the United States.

Racial/Ethnic Diversity

The more general issue of people of minority groups in medicine is explored extensively in the 12th report of the Council on Graduate Medical Education.⁶⁵ The Committee on Pediatric Workforce has also published 2 relevant policy statements, “Enhancing the Racial Diversity of the Pediatric Workforce”⁶⁶ and “Culturally Effective Pediatric Care: Education and Training Issues,”⁶⁷ that are essential reading for those concerned with child health workforce policy issues. Although this technical report is partly duplicative of these efforts, the pressing nature of this topic warrants, at the very least, a summary of the factual basis of the policy recommendations. Additional information can also be found in 2 recent papers.^{68,69}

The overall racial/ethnic composition of pediatricians little resembles the populations they seek to serve. In 1996, for example, the number of black pediatricians per black children was less than one third that of white pediatricians per white children.⁶⁸ The proportion of third-year residents from underrepresented minority groups (black, Hispanic, or American Indian/Alaska Native) increased from 6% in 1997 to 12% in 2002.⁷⁰ Still, the disparity in race and ethnicity is anticipated to grow substantially by 2025,⁶⁸ reflecting the combination of high minority-population growth rates and an assumption of slow increases in enrollment rates of individuals of minority groups in medical education.

Given that physicians are never likely to be completely reflective of their patients, why should racial/ethnic diversity be a particular concern in planning the workforce for children? The disparities in health status and health services by race and ethnicity are well documented and incontrovertible.⁷¹ These disparities can only be partly attributed to an associated income gradient.^{72,73} Ronsaville and Hakim⁷⁴ found in a recent analysis of the 1991 National Maternal and Infant Survey that 35% of black infants and 37% of Hispanic infants obtained adequate well care, compared with 58% of white infants; these findings persisted after controlling for socioeconomic status.

Greater minority representation in the workforce seems to be one important way of improving health outcomes in children of minority groups. Physicians from underrepresented minority groups are known to preferentially provide care for patients from minority and underserved groups.^{75–79} Furthermore, many individuals of minority groups prefer physicians of similar racial or ethnic background and are more likely to seek care when such a clinician is available.⁸⁰ Other necessary measures to improve the delivery of care include the development of greater

cultural competence in current and new physicians⁸¹ and better identification of health system-specific disparities.⁸² Neither of these measures addresses the reasons for low rates of minority entrance into medical education, which in and of itself is a fundamental issue of societal equity.⁸³

Internal Medicine-Pediatrics

Although internists have assumed a relatively minor role in the care of children, the combined specialty of internal medicine-pediatrics (med-peds) has emerged in the past 30 years as an important alternative to family medicine for physicians interested in providing primary care to all age groups.⁸⁴ At present, there are 109 approved programs with a total of 1558 residents.⁸⁵ Growth in residency positions was rapid in the 1990s but has now slowed. In 1999, 432 positions were offered in the match and 88.4% were filled, 80.3% of them by US medical graduates. In 2003, 385 positions were offered and 82.3% were filled, 67% of them by US medical graduates.⁴⁸ After completing the 4-year program, approximately 90% achieve board certification in one discipline, and 80% achieve board certification in both. Fifty-four percent of med-peds physicians practice in community office settings, usually in primary care serving adults and children.⁸⁶ Med-peds is an important component of the pediatrician workforce, but its implications for projecting the workforce supply are less clear. Similar to family physicians, med-peds physicians can adjust their practices to the availability of patients without additional training. As the US population continues to age, med-peds physicians may accommodate a relative decrease in the local pediatric population by seeing more adults.

Nonpediatrician Providers of Pediatric Care

Pediatricians provide only a portion of the care received by pediatric patients. The extent of future pediatric primary care that is delivered by pediatricians will not be determined solely by the pediatrician's extensive education and training in children's health, the fact that they are the largest group of clinicians exclusively caring for children, or that their professional competency and availability may be preferred by families. Influential market forces that will shape the role of pediatricians include the (1) availability and rates of growth of other clinicians, particularly nurse practitioners and physician assistants, (2) salaries and productivity of all pediatric clinicians, (3) practice independence of nonphysician clinicians, and (4) hiring practices of health plans and existing pediatric practices, which hire nonphysician clinicians in increasing numbers.

The number of family physicians (post-GME clinically active) increased from 63 209 to 76 409 in the past decade (1992–2002), a per-child (younger than 18 years) increase of 9%.^{10,11} These numbers overstate the growth of family physicians who, unlike pediatricians, care for a rapidly growing population: the elderly. The number of first-year residency positions in family medicine was unchanged in the later part of the decade, and the number filled by US

medical graduates decreased.¹³ Family physicians view themselves as the primary care providers for families, including children, and their important role in this regard is evidenced by their providing 17% of primary care office visits for children younger than 5 years, 28% for children 5 to 9 years of age, 43% for children 10 to 14 years of age, and 61% for adolescents 15 to 17 years of age (Table 2). The fact that family physicians provide the majority of primary care office visits for older adolescents may translate into new opportunities for pediatricians as the aging population creates additional demand on family physician services. Recent trends indicate that pediatricians are, in fact, providing an increasing proportion of children's primary care visits.⁸⁷

Family physicians currently have a high interest in children's health care,⁸⁸ as demonstrated by a recent search of the Web site of the American Academy of Family Physicians. Twenty pediatric policy statements were identified, including clinical recommendations for breastfeeding and otitis media with effusion (see www.aafp.org/x6595.xml). Family physicians are vigorous advocates for the further expansion of their residency programs and are active in all aspects of workforce public policy.⁸⁸

Nurse practitioners and physician assistants have emerged as a health workforce larger than many physician specialties, including pediatrics. Precise figures for the total number of nurse practitioners are not available, but estimates of those practicing in primary care vary from 52 000 to 71 000.^{90–92} Approximately 90% of all nurse practitioners deliver primary care services,⁹⁰ and others such as neonatal nurse practitioners provide highly specialized tertiary care.⁹³ Approximately 46% of physician assistants (42 000), in contrast, work in primary care settings, including 14 734 in family practice and 1110 in general pediatrics.^{90,94,95}

Nurse practitioners and physician assistants have a particularly important role in rural underserved communities, the setting least likely to attract or support a pediatrician. In 1977, the Rural Health Clinics Services Act (Pub L No. 95-210) established rural health clinics to improve primary care availability in rural underserved areas through favorable Medicare and Medicaid reimbursements. The 2 most salient criteria for rural health clinic designation are location within a health profession-shortage area or

TABLE 2. Number of Primary Care Office Visits According to Specialty of Physician

Age of Patient, y	Primary Care Specialty, No. of Visits (%)	
	General Pediatricians	Family Physicians
0–4	40 480 000 (83)	8 163 529 (17)
5–9	15 960 000 (72)	6 058 195 (28)
10–14	10 660 000 (57)	8 073 828 (43)
15–17	3 422 674 (39)	5 327 585 (61)
Total	71 860 000 (72)	27 620 000 (28)

Office visits by internists are excluded because of the small number of observations.

Source: National Ambulatory Medical Care Survey, unpublished data, 1999.

medically underserved area and the employment of a nurse practitioner or physician assistant. Although the clinic must be under the supervision of a physician, the physician needs to be on site only once every 2 weeks. It is not surprising that many physician assistants and nurse practitioners who practice underserved areas seem to serve as physician substitutes.^{96–98} The proportion, however, of nonphysician clinicians located in underserved areas is small, and the overall location of nurse practitioners measured across states has been shown to be correlated closely with that of physicians.⁹⁹

The growth in training programs for both physician assistants and nurse practitioners greatly exceeds primary care physician residency growth, and therefore the availability of nonphysician clinicians will also grow faster than that of pediatricians.^{90–92} The growth in numbers has also been accompanied by an expansion of practice independence and prescription authority.^{100–102} Both greater numbers and practice autonomy are likely to lead to much larger roles of nonphysician clinicians in pediatric medical care.

Geographic Variation in Child Health Clinician Supply

The study of geographic variation in health care resources and utilization, termed “small-area analysis,” emerged in the late 1960s and remains one of the most active and provocative areas of health services research.^{103,104} Whether measured at a state, county, or health-market area level, the per-capita numbers of physicians and the use of medical care vary substantially from place to place. There is now an extensive literature of small-area variation in health care resources, although few studies are concerned with children and their clinicians.^{19,105}

The study of regional variation in child health clinicians, and pediatricians specifically, remains today an underdeveloped field of research. Almost without exception, pediatrician-workforce analysts have viewed the variation phenomenon as an aspect of underservice in rural and inner-city areas.^{7,61,106–108} Some of these locales are underserved in terms of all primary care clinicians (ie, health profession shortage areas¹⁰⁹), and others have an adequate number of primary care clinicians per capita but no pediatrician. For example, more than 7 million children live in 2935 primary care service areas (of a total of 6102) without a pediatrician. A small but important number of children (290 000) live in 313 primary care service areas without either a pediatrician or a family physician (Primary Care Service Area Project, Dartmouth Medical School, unpublished data, 1999).¹¹⁰ A recent study by Cull and colleagues⁷⁰ found a decreasing number of third-year residents accepting positions in rural areas.

There are myriad public programs that seek to address low clinician availability,^{109,111–113} including state and federal programs that run the gamut from subsidizing physicians to practice in designated areas (eg, National Health Service Corps), to providing incentives for nonphysician clinicians (eg, rural health clinics), to selectively recruiting medical students from rural areas.¹¹³ By and large, these pro-

grams have increased the availability of primary care physicians, although less is known about the availability and quality of clinicians for children.

Recently, a few studies have examined the geographic variation in child health clinicians across the full distribution of supply, ranging from areas of underservice to areas of perceived high supply.^{20,25,30,31,61} Although not without controversy, these studies challenge several long-held assumptions. All these studies demonstrate that the regional per-capita (ie, per-child or per-newborn) supply of general pediatricians or neonatologists varies more than fourfold. Chang and Halfon²⁰ examined pediatrician-to-child populations across the 50 US states between 1982 and 1992 and found a range of 18.5 (Idaho) to 84.3 (Maryland) clinical pediatricians per 100 000 population (children younger than 18 years). Pediatricians were the least well-distributed primary care specialty in relation to the child population and had the smallest reduction in regional variation between 1982 and 1992. LeBaron et al³⁰ found a similar degree of state variation in pediatrician supply for 1997. Politzer et al⁶¹ used county aggregates as units of analysis and found a similarly high relative degree of geographic variation in pediatricians compared with other primary care physicians and no decrease in regional disparities between 1989 and 1994. A recent study examined the per-newborn supply of neonatologists across 246 market-based neonatal intensive care regions and also observed a greater than fourfold variation. These differences in neonatologists could not be explained by the substitution of nonphysician clinicians or the presence of academic medical centers.¹¹⁴ Although capturing only a fraction of the total pediatrician workforce, the studies of neonatologists offer important methodologic advantages: geographic accuracy in physician enumeration and in the ascertainment of patient health care needs.

None of these studies provide evidence that areas with a higher supply of general pediatricians or neonatologists have populations with greater health needs. Across states, the supply of pediatricians, but not family physicians, is positively correlated with median household and per-capita income.^{20,30} Higher supply is associated also with the presence of pediatric residency programs²⁰ and minority populations.³⁰ State-based analyses are limited methodologically, because important within-state variation of physician supply and population risk are obscured. No work has been published examining the relation of general pediatricians to child health needs in health-market-based areas. Analyses of neonatologists and newborn risk address a narrower population but with greater measurement accuracy. By using vital record data to measure newborn risk and neonatal intensive care regions to measure supply, virtually no relationship was observed between the regional supply of neonatologists and low birth weight rates or any other commonly used measure of perinatal risk.^{25,31} Additional study is needed on the relation of supply and child-population needs, but these initial efforts do not suggest that current market forces and public policy lead to

an equitable distribution of child health physicians with respect to their health needs.

The final aspect of regional variation in pediatrician supply that has received some recent attention is the relation between the supply of pediatricians and the outcomes of infants and children. To date, no study has examined health outcomes of children in relation to the supply or availability of general pediatricians, and substantial methodologic challenges would confront any such research effort. These difficulties are evident in cross-sectional studies examining adult populations, which have shown a weak association between higher primary care physician supply and lower mortality. The analyses rely on large-area summations of population characteristics (ie, states, metropolitan statistical areas, or counties) and limited measures for controlling population health-risk differences (eg, income, race).^{28,35} Causal direction is also ambiguous. Do more physicians lead to lower mortality, or do physicians tend to locate in areas with healthier and wealthier populations? A recent study showing an association between the supply of pediatricians, but not family physicians, and immunization rates using states as the units of analysis had similar limitations.³⁰

A retrospective cohort study of the 1995 birth cohort found higher neonatal mortality in neonatal intensive care regions with a very low supply of neonatologists compared with those with a low supply but no difference in mortality between regions with low and very high supply. These findings suggest that there is indeed a threshold of supply beneath which poorer newborn outcomes are evident. On the other hand, the absence of any additional mortality decrease as supply increases suggests that many areas have more neonatologists than required for minimizing neonatal deaths. This study did not examine whether neonatologist supply was associated with decreased morbidity or better quality of care.³¹

Pediatric Subspecialists

Using the broadest criteria, there are 19 areas of pediatric medical subspecialization,¹¹⁵ 16 of which offer certification through the ABP.¹¹⁶ On the basis of physician report to AMA surveys on December 31, 2001, there were 9461 post-GME clinical (>50% of professional time spent directly caring for patients) pediatric subspecialists and an additional 740 researchers, 331 teachers, and 260 administrators

(Table 3).¹¹ Many of these pediatricians, of course, have more than one professional role.

AMA data are also likely to undercount subspecialists, because physicians will retain their initial GME specialty in the database until updated by a response to a survey. The alternative to AMA data has its own weakness. The ABP reports granting 14 699 subspecialty diplomas since 1961,¹¹⁶ but the current practice status of these pediatricians is not known.

Pediatric subspecialists are a heterogeneous group of pediatricians that eludes generalizations with respect to their type of practice, workforce size, and future opportunities. Some subspecialists such as neonatologists provide services not offered by other specialties, and others such as pediatric allergists provide care for conditions that are within the scope of practice of general pediatricians, pulmonologists, or internist-allergists. New specialties continue to develop and establish their role in caring for children before formal fellowships and board certification are established. Hospitalists are the most recent example. Certain subspecialists may have decreased the patient load of general pediatricians (neonatologists and hospitalists, for example) as they assume care for infants and children that were formerly central to the practice of many general pediatricians. Most important are the differences in the sizes of the subspecialties. At one extreme are neonatologists and pediatric cardiologists, who number 2847 (post-GME clinically active) and 1310, respectively, using AMA data, and at the other extreme are pediatric endocrinologists and rheumatologists, which, by the AMA system of enumeration, number less than 100 each in full-time clinical practice.¹¹ The number of board-certified subspecialists is higher.¹¹⁷ The ABP has certified 828 infectious-disease subspecialists and 192 rheumatologist subspecialists,¹¹⁶ but these figures do not identify those returning to general pediatrics and those with research, teaching, or administration as their primary focus. The proportion of professional time devoted to academic work also varies across these specialties, adding another factor to be considered in workforce planning.

The heterogeneity in pediatric subspecialists has 2 important implications. The first is that workforce statistics, forecasting models, and health services studies that report the general experience of pediatric subspecialists will be driven by the largest subspe-

TABLE 3. Professional Activities of Allopathic Pediatricians: December 31, 2001

	Total	Patient Care		Other Professional Activities			
		Post-GME Patient Care	Resident/Fellows	Administration	Medical Teaching	Research	Other
Pediatricians	66 636	51 675	10 924	1270	1128	1435	204
Generalists	52 888	42 214	8006	1010	797	695	166
Subspecialists	13 748	9461	2918	260	331	740	38
Nonfederal	65 622	50 868	10 876	1207	1108	1370	193
Federal	1014	807	48	63	20	65	11
US medical graduates	48 522	35 917	8964	1075	930	1166	170
IMGs	18 414	15 758	1960	195	198	269	34

Source: AMA Masterfile.¹¹

cialties. These generalizations may lead to policies that suit no particular group of children's health services needs. Pediatric subspecialists, as a whole, have already suffered this fate by being subject to the same policy brush as have adult subspecialists, an extremely large group of physicians who, unlike pediatricians, are largely nonacademically based and more highly remunerated. The second implication is that workforce analysts must recognize, from a measurement viewpoint, that many pediatric subspecialists qualify in epidemiologic terms as "rare events." Enumeration, workforce models, and measures of local availability have relatively low precision and, for the smallest subspecialties, great uncertainty. The geographic variation in subspecialists can lead to additional confusion about the overall adequacy of supply.

Pediatric subspecialists are more likely to be based academically than as general pediatricians or adult subspecialists,^{118,119} although this differs by specialty. Most pediatric subspecialists, nevertheless, spend most of their professional time in patient care. Pediatric departments have difficulty recruiting subspecialists, at the same time that subspecialists interested in nonacademic practices have trouble finding positions, and those in practice may experience significant competition.^{117,120} Failure to differentiate the academic and community labor markets for pediatric subspecialists perpetuates shortages of academic subspecialists who have unique roles in education and research. These shortages may be exacerbated in the future if there is a decrease in the number of IMGs and a greater number of female pediatricians, trends that are likely to lead to fewer pediatricians seeking subspecialty education.¹²¹ Notwithstanding these possible future influences, the recent trend is toward a greater interest in subspecialty education by third-year residents.⁷⁰ It is the pediatrician-scientist supply that remains at highest risk, facing particularly long training periods and shrinking clinical revenues while competing with PhD-trained investigators for research funding.

For these reasons, subspecialty workforce policy and planning need to occur by specialty, with an eye to finding commonality when it is present and rejecting it when it is not. Although the recommendations of the recent FOPE II report are not universally accepted,³⁶ FOPE II has produced an important literature about pediatric medical subspecialists and surgical specialists through the review of primary literature and surveys of pediatricians.^{117-120,122-126}

FORECASTING THE CHILD HEALTH WORKFORCE SUPPLY

The 2 fundamental questions in any consideration of the child health workforce are: How many will we have in the future, and will that number be enough or too many? As the previous discussion suggests, future child health workforce supply and requirements are related to many factors, each with their own uncertainties (Fig 1). Methods of projecting the number of pediatricians are on safest ground. Using simple actuarial models with assumptions about training (box 3), retirement (box 10), and death rates

(box 9 [the last 2 are sometimes combined as a separation rate]), the models have finite solutions. The robustness of forecasting models using these 3 rates can be tested with simple sensitivity analysis.

Training rates depend on the number of pediatric GME positions (Fig 1, boxes 3 and 5). Changes in the size of US medical schools (Fig 1, box 1) alter the makeup of the workforce but not the number of pediatricians. Positions unfilled by US medical school graduates^{48,127} are filled by physicians trained in other countries (Fig 1, box 2). Since 1997, the number of categorical pediatric residency positions offered in the match has increased by 11% and the number filled has increased by 6%.⁴⁸ ABP data indicate a 5% increase in the number of categorical first-year positions from 1997 to 2002.¹¹⁶ Changes in GME funding could quickly alter the size of this pipeline, although none are on the immediate horizon.

We can expect that death rates will continue their downward drift for physicians, but these rates are already low in the preretirement years and a further decrease will not appreciably alter supply-projection models. There are many opinions about trends in retirement rates,¹²⁸ but there is no dominant a priori direction that can be asserted. Much has been made of physician frustration with managed care, greater administrative tasks, and increasingly litigious families. Without a doubt, these are less attractive sides of the medical profession. On the other hand, health care professionals are retiring later, not earlier, as they follow a general labor trend to a longer work life. Pediatricians and their employers are also faced with the same dramatic short-term challenges of decreasing financial markets that devalue pension funds and 401(k) accounts alike. This inevitably will lead to postponed retirement, at least in the short run. By the time this report is published, it is hoped that the country's economic health along with the rate of return of financial investments will have improved. Still, no credible economist predicts a return to the "irrational exuberance" of the 1990 equity markets, as attractive as that might be for retirement expectations.

In a model forecasting the number of clinically active pediatricians, 2 additional gender-related variables are of increasing importance: personal leave (Fig 1, box 8) and part-time employment (Fig 1, box 15), typically for child care responsibilities. The former affects the number of clinically active pediatricians employed at any given time, and the latter modifies the full-time equivalence of those physicians. The dominant influence on these event rates will be the number of women entering pediatric residencies. Current rates are known and can be added to actuarial models with assumptions about future changes in these rates.

Forecasting becomes increasingly complex as we incorporate additional parameters into the model. Many of the desired variables are difficult to measure, requiring the substitution of proxies. Other measures lack a theoretic or definitional consensus within the health policy and medical community. Even with perfect measurement, simply adding

more variables to the model introduces additional uncertainty to the results.

One domain that bedevils child health workforce-supply forecasting is workforce productivity, how it is defined and measured.^{12,129–132} For the moment, we will restrict productivity to its common measures that are more aptly named medical services productivity (Fig 1, box 14). Examples include visits or hours of clinical activity per week per physician full-time equivalent (FTE). These measures are not equivalent. As previously discussed, the hours worked per week are not strongly related to pediatrician gender. Full-time female and male pediatricians work similar clinical hours.³⁹ Data are not available about gender differences in patient visits per week.

Organizational factors are increasingly important in medical productivity as pediatricians continue to shift from solo and partnership practice to employee-based work arrangements. Employee pediatricians work an average of 6.4 fewer hours per week compared with those practicing solo or in partnerships.¹³³ Financial incentives related to patient insurance types or the compensation plans by physician employers can also affect the number of medical services delivered per physician FTE.^{134,135} For all of these factors, the consistent trend is for pediatricians to work fewer hours and provide fewer visits per week. In 1989, pediatricians (those working at least 20 hours per week in patient care) worked an average of 53 hours per week in patient-care activities; by 1999, they worked 50 hours. During the same period, the average number of office visits decreased from 102 visits per week to 95 (Table 4).^{136,137} The numbers indicate a decrease in the medical services productivity of pediatricians but do not account for possible but still unmeasured changes in patient complexity. It is also not known if these trends stem from fewer patients, lifestyle choices of pediatricians, or both.

How will medical services productivity change in the future? Answers offered to this question are highly speculative.

Medical services productivity ignores the very purpose of the profession. The difficulty becomes obvious when one is reminded that the unit of production (in an economic sense) in health care is improvement in health outcomes (Fig 1). Therefore, a strict measure of productivity would be the labor input required per unit of greater health outcomes. In this instance, "health outcomes" is defined broadly to include the maintenance of health, the care and cure of illness, and the restoration of a sense of well-being in children and families through education and counseling. Although operationalizing the theory of health outcomes productivity with actual measurements is difficult, it should at least be understood that the number of hours worked or patients seen per week is not always related to the health status, reduction of risk, or sense of well-being of a physician's patient population.

Many workforce-supply models have been developed,^{138–140} but few have been for pediatrics and only one is recent. Shipman and colleagues¹⁴¹ developed an interactive general pediatrician-supply model using software developed for modeling scientific and business systems. The actuarial model estimates future pediatrician FTEs by using parameters for GME output, gender mix, and retirement patterns. Other parameters incorporated into the model include rates of subspecialization, mortality, and the proportion of IMGs returning to their home countries. Although not intended to fully represent workforce requirements, the model also calculates pediatrician-to-child ratios by using low-, middle-, and high-census projections. The supply projections are compared with a user-selected benchmark or reference value, the default being the current supply of

TABLE 4. Characteristics of Allopathic Pediatricians (General Pediatrics, Pediatric Cardiology, and Pediatric Allergy Included): 1989 and 1999

Pediatrician Characteristic	1989	1999	Percent Change 1989–1999
Net income	\$93 000	\$126 000	35.5
Adjusted for inflation*	—	\$93 750	0.8
Professional activities			
Weeks of practice per year	47.4	47.6	0.4
Hours of professional activities per week	58.0	54.5	–6.0
Hours of patient care per week	53.4	49.5	–7.3
Office hours per week	31.8	29.8	–6.3
Office visits per week	101.8	95.0	–6.7
Revenue sources			
Medicaid	—	20%	—
Private insurance	—	65%	—
Patients	—	10%	—
Time spent in primary care activities	—	95%	—
Wait for new patient appointment	—	2 days	—
Employment type	—		—
Self-employed solo	—	19.2%	—
Self-employed group	—	27.5%	—
Employee	—	50.5%	—
Independent contractor	—	2.1%	—

Physicians working <20 hours/week in patient care are excluded. Mean values are presented unless otherwise specified. — indicates that data were not available.

* Information was obtained from the US Department of Labor, Bureau of Labor Statistics (www.bls.gov/cpi).

Source: AMA Socioeconomic Monitoring System.^{136,137}

49.0 per 100 000 population. The benchmark can also be adjusted for the different future demand as the age structure shifts (infants require more visits than do adolescents) as well as the greater need for pediatricians if family physicians see fewer children. The program has a simple-to-use interface, and the user can adjust the default values. The effects of varying model parameters can be tested quickly by comparing projection curves of the number of pediatrician FTEs. The model is available at www.dartmouthatlas.org/workforce_model.php, and AAP members are encouraged to test their own assumptions about the relative importance of the factors discussed in this report.

By using default assumptions, the model forecasts a 36% increase (from 38 457 to 52 169) in general pediatricians in 10 years and a 64% increase (62 952) in 20 years. Using middle-census estimates, the number of general pediatricians per 100 000 children will increase 31% in 10 years and 50% in 20 years. Adjusting the number of future pediatricians for age and gender productivity will require 4% more pediatricians in 20 years, in large part to compensate for part-time status. This assumes that the current gender mix of residents continues into the future. Sensitivity testing included retirement rates, ranging from a 20% decrease to a doubling of current rates within all age and gender strata, decreased productivity of at least 30% for pediatricians older than 50 years, GME downsizing to 110% of US medical graduates, increase in pediatric residency positions by 1% per year, and substituting low- or high-census child-population estimates. At 20 years, these resulted in differences from the default model pediatrician-to-child ratio of less than 16%. This model demonstrates that the growth in the pediatrician-to-child ratio is robust to varied alternative-forecasting scenarios.

PEDIATRICIAN-WORKFORCE REQUIREMENTS

Workforce analyses usually run aground when forecasting the physician requirements of populations. The most important parameter is simply the size of the population or its age definition, in this instance the number of children (Fig 1, box 13); from this, future FTEs per child (or per capita) are calculated. Population projections may seem straightforward, but there are uncertainties in both the number and composition of the future population, leading to contentious and seemingly arcane arguments among forecasters.^{138,139,142}

Requirements for general pediatricians are also related to substitution within the broader child health workforce (Fig 1, box 11). As discussed in this report, the number of child health professionals includes a complex mix of physicians and nonphysician clinicians with differing training and education, skills, and knowledge that provide, at times, similar services. Two examples come to mind. Within pediatrics, subspecialists such as neonatologists and hospitalists provide care that once was part of nearly every pediatrician's daily professional life. For whatever factors that may increase the need for pediatric services in the future, rearrangement of clinical work within pediatrics decreases the need for general pediatricians. Similarly, the growth in numbers of non-

physician clinicians may spare the efforts of pediatricians within a practice while decreasing the need for pediatricians in aggregate.

More difficult to measure, and usually ignored, are the rich and complex factors that relate the number of health services delivered per child to children's health and well-being, termed health outcome productivity (Fig 1, box 17). A short list of factors includes the technical excellence and appropriateness of the service and the division of labor across the many possible clinicians (Fig 1, box 11) or even across the nonmedical workforce—parents, teachers, coaches, clergy, and therapists (Fig 1, box 16). Relative health needs are also of central importance (Fig 1, box 17). All else held equal, we would also expect a greater production of health (ie, improvement in health status or well-being) when care is delivered to a less healthy child. The organizational and community milieu can also modify the efforts of the child health workforce (Fig 1, box 14). When these factors are considered together, it becomes apparent that successful health outcomes might occur with a widely differing number of pediatricians. Workforce forecasters have accounted for these factors through 5 different models.^{130,139,143,144} Each model requires particular theoretic assumptions and data, and none of these methods should be viewed as mutually exclusive of the others. The acceptance of a particular framework partly depends on the definition of "requirement" and the policy goal of the forecasting process. Another way of looking at the task of assessing requirements is that it is not a science in the traditional sense but is intertwined with the values expressed in the assumptions. Is the goal to optimize health or the perception of access to physicians or to maximize employment opportunities for physicians? Is reducing disparities in the access and use of medical services one goal? What level of public funding in education and payment of health services is assumed, and what is the rationale for public funding at all if it is thought that markets will drive the health care system to desirable outcomes? Although the values inherent in different requirement models may not be explicitly stated, the careful reader will find them implicit in the models' assumptions.

Employment Opportunities for Pediatricians

The most basic approach to assess the requirements for pediatricians is to determine their employment opportunities and competition for patients. Both measures are indicative of the pediatrician's short-term prospects, although no forecasting models have been constructed that formally incorporate these economic signals.

Studies from the mid- to late 1990s show that although there were wide employment opportunities for general pediatricians, there was also significant competition for jobs and patients. In 1996, 17% of residents finishing training had difficulty finding a position, 15% received only 1 job offer, 9% accepted positions that were not their first choice, 17% accepted a position in a location that was not their first choice, and 18% accepted a job with a salary that was less than expected. Although discouraging at first

glance, pediatricians had less difficulty finding a position than did physicians in 25 of the 32 specialties examined. The specialty with the most favorable employment prospects was family medicine; job prospects in general internal medicine were slightly less favorable than in general pediatrics. The specialties with the poorest job prospects were pathology, adult pulmonary disease/critical care medicine, and adult infectious disease.¹⁴⁵ Another study found that between 1990 and 1995, the number of employment ads for pediatricians decreased, and ads for pediatric subspecialists remained nearly constant. At the same time, the number of ads for family physicians grew close to 25%.¹⁴⁶ Perhaps the most pessimistic view of general pediatrics was reported to the Council on Graduate Medical Education by the Center for Workforce Studies in Albany, NY.¹⁴⁷ In exit surveys of residents completing training in New York State and Texas, 6 measures were used to assess relative demand by specialty; general pediatrics was second to last of the 28 specialties studied.

The most recent information comes from Cull et al,⁷⁰ who used survey data from third-year pediatric residents. Over a 5-year period ending in 2002, the proportion of residents with a general pediatrics goal without a position increased from 5% to 15%, and the proportion reporting that their position was their first choice decreased from 86% to 80%.

Our information about the competition experienced by practicing pediatricians is limited to subspecialists. Competition is highest for pediatric allergy/immunology, cardiology, pulmonary medicine, and critical care medicine; lower levels of competition were perceived by infectious disease, genetics, and adolescent medicine pediatricians. The strongest predictors of competition were working in solo, group, or medical school practices in contrast to staff- or group-model health maintenance organizations (HMOs) or community hospitals. Pediatricians working in the Midwest or southern regions also experienced the strongest competition. Less competition was felt by IMGs, those working in rural areas, and female physicians.¹²⁰

Salary information also indicates a weak demand for pediatricians compared with other primary care specialties. In one nationally representative survey conducted between 1996 and 1998, general pediatricians reported an average income of \$126 000 compared with \$144 000 for general internists; pediatric subspecialists reported an average salary of \$156 000, whereas the average salary of internal medicine subspecialists was \$192 000.¹⁴⁸ When adjusted for inflation, the salary of pediatricians changed little between 1989 and 1999 (Table 4).^{136,137} Starting salaries for graduating residents entering general pediatric practices decreased (in 2002 dollars) from \$103 161 in 1997 to \$99 123 in 2002.⁷⁰

Data from the National Resident Matching Program indicated that pediatric residency positions are among the most highly sought by medical students. At its peak in 1998, 98.9% of pediatric positions offered through the match were filled, with 82.2% filled by US medical graduates; these match rates exceeded internal medicine and family medicine. By

2002, the overall pediatric match rate had fallen to 90.5%, with 70.7% filled by US medical graduates, and then increased slightly in 2003 to 93.8%, with 71.3% filled by US medical graduates. Other primary care specialties experienced similar decreases, particularly with respect to the proportion of US medical graduates matching: 55.2% for internal medicine and 42.0% for family medicine in 2003. For all first-year positions in 2003, 89.9% were match-filled, 63.9% by US medical graduates.^{48,127,149,150}

Despite these marketplace signals, it is worth noting that once in practice, general pediatricians have higher satisfaction with their job, career, and specialty than do general internists. Satisfaction, job stress, and burnout for pediatric subspecialists were less favorable and similar to general and subspecialty internal medicine physicians. These findings show a lack of correlation with salary levels and attitudes about practice and also identify stress experienced by pediatric subspecialists.¹⁴⁸

Needs-Based Models

One formal model for forecasting future physician requirements was that developed by the Graduate Medical Education National Advisory Committee (GMENAC).¹⁵¹ GMENAC estimated physician requirements in the late 1970s through a complicated process of defining the need for efficient medical services to optimize health. For each specialty, clinicians and epidemiologists estimated the future disease burden, the necessary treatments, and the workforce required to provide those services. The GMENAC report predicted a physician surplus for both generalists and specialists, pediatricians included. From the standpoint of physician employment, this obviously did not occur, and in the absence of unemployed physicians, GMENAC predictions have generally been rejected.^{9,152}

What went wrong with GMENAC? First, the data requirements of the models were unrealistic. Needs-based planning assumes that the disease burdens of populations are measurable and that it is known which medical interventions can most effectively and efficiently improve health today and in the future.¹⁵³ In actuality, the measurement of health status in populations is imperfect, and knowledge of medical care effectiveness is incomplete and likely to remain so as technologic developments outpace effectiveness studies.^{154,155} Second, there was an assumption by the readers of GMENAC that as physician supply approached levels needed for populations to be healthy, demand would attenuate. In this instance, surplus would be evidenced in unemployment or, at the very least, pressure on physician salaries. Populations with higher health status, however, do not consume necessarily less health care, as might be expected, but continue to demand (in an economic sense) services to address an ever-elusive definition of "health." With most health care costs borne by third parties and the general sense that more medical care always leads to better health, physicians continue to be fully employed even as health status improves. This would be of little public policy interest except that societal resources for medical care

reimbursement are not without limits, and many populations remain with unmet health care needs, even as the healthy seek more care. The lesson learned from GMENAC is that in the complex market for medical care and physician labor, population needs are poorly related to demand for physicians.

Demand-Based Models

Demand-based forecasting uses current medical services utilization as an indication of medical need and projects future utilization to determine the required number of physicians under different conditions of productivity. In its most elegant form, utilization is measured for many different combinations of population characteristics such as age, gender, and race and for different medical care settings and financing. These include the mixture of fee-for-service or managed care penetration and patient insurance status. Once these are measured in the present, then populations for each of these characteristics are projected into the future, and the number of required pediatricians can be calculated.

Demand-based models are the most common type of forecasting.^{138,139,156} Medical service utilization data are available for many populations and types of service delivery. The model assumes that current delivery patterns are rational and desirable and that similar populations in the future will require utilization rates close to those delivered today. The acceptance of current utilization patterns as normative measures also assumes that the current market for health care services maximizes the well-being of children.

The 2 merits of demand forecasting are the availability of data and the simple assumption that the medical marketplace reasonably delivers health care consistent with societal values and expectations. Among the many criticisms that can be leveled, the most obvious is that the supply of physicians, as seen with general pediatricians and neonatologists, is not located where child health needs are greater^{20,114} and that medical utilization similarly varies widely across regions without detectable population differences. Current demand for health care cannot be used as a normative standard when the location of resources is idiosyncratic. The health services literature is replete with studies that show the irrationality of health care delivery.^{18,157–160} Critics of demand-based planning ask: Why would we want to perpetuate these delivery patterns into the future?

Trend Analysis

Recently, a new method of projecting physician requirements was proposed: trend analysis.^{144,152} The method uses a macroeconomic conceptual framework that asserts that growth in physician requirements is tightly linked with increases in the gross domestic product (GDP). In addition to long-term trends in GDP, 8 “macro” trends are emphasized in the model, some that can be reasonably measured and others that are highly speculative. The model attempts to separate trends that are “the natural evolution of the current fiscal and organizational characteristics of the health care system and

the societal fabric in which it exists” (attrition, productivity, substitution, geographic distribution, technology, demographics, health systems, and economic dependency) from trends that are “value judgments” (technology controls, specialist controls, volume controls, and cost controls).¹⁶¹ The developers of this model have used it to advance the idea of an “impending” physician shortage. Although the method forecasts physicians in aggregate, they have interpreted trends as indicating a future shortage in specialists and an “abundance of generalists.”^{162,163}

Trend analysis has been criticized for its view that the macroeconomic association of GDP and the workforce is causal, inevitable, and a self-evident expression of societal wants. Many other criticisms have also been vigorously advanced.^{164–170}

When this model is applied to the pediatrician workforce, a contradiction emerges. Just as Cooper et al¹⁶² have observed a correlation between the growth of GDP per capita and total physicians per capita, Freed et al¹⁷¹ have presented a similar correlation with pediatricians per 100 000 children. Projecting this trend into the future, Freed et al¹⁷¹ find, instead of Cooper et al’s “abundance of generalists,” that “the current net inflow of pediatricians will not be sufficient to meet future demand as expressed by the trend line.” These conclusions need to be considered in the context of the estimate of Shipman et al¹⁴¹ that the per-child number of pediatricians will grow more than 5 times faster than the per-capita number of internists or family physicians. One interpretation is that there is an impending shortage of primary care as well as specialist physicians. Another interpretation is that macroeconomic correlations are an overly simple estimator of workforce requirements. A potential weakness with these models is that the number of physicians per capita has increased over time and will correlate highly with any other upward trend. Bivariate time-series analyses are subject to the same limitations as any other observational study, with the added problems of a small number of observations (n = number of time periods) and difficulty in identifying and measuring time-dependent confounders. When the models are technically correct,¹⁷² health care planners still must decide whether previous patterns of physician growth should be used as the primary guide of the child health workforce in the future.

Benchmarking

Benchmarking is a final method of determining workforce requirements. Benchmarking exploits natural experiments in workforce levels by using physician-to-population ratios found in regions of the United States or within health care systems as indications of real life and attainable physician levels.^{19,139,143,173,174} Benchmarking seeks to find regions in which workforce deployment is efficient and effective in delivering health care. A slightly different approach is to use the staffing levels in efficient capitated health systems that deliver high-quality care as measured by medical care processes, family satisfaction, and health outcomes. Benchmarking rejects the notion that the current national physician

labor or health services markets have any particular normative value in terms of optimizing health outcomes and offers a variety of available reference points to help guide physicians' employment decisions. In the short term, benchmarks can caution a health plan about adding additional specialists to an area with a high per-capita number or point to areas with a low supply that may be an opportunity for expanded services. As the marginal effects of physician supply on patient satisfaction and outcomes are better understood, benchmarks may provide a means of improving systems of care for populations enrolled in health plans or residing within regions. To the degree we fall short of the need or desire to develop effective delivery systems with constrained resources, benchmarking will fail to predict physician employment opportunities.

Requirements for Pediatricians

In Table 5 we present published projections of pediatrician supply and requirements. It is evident from this list that relatively little work has been done in this area. The supply of general pediatricians forecasted by Shipman et al¹⁴¹ for 2010 is similar to the earlier predictions of Kletke et al.¹⁷⁵

The current supply (53 general pediatricians per 100 000 children younger than 18 years) exceeds the requirement suggested by GMENAC in 1980 (49 per

100 000) and by Abt Associates in 1991¹⁷⁶ (41 per 100 000). The only other estimates of requirements that are available are from the AAP Pediatric Research in Office Settings Network (71 per 100 000) and various group and HMO practices (49–89 per 100 000). These figures assume that children receive care only within pediatrician-dominated practices with staffing levels observed in practices serving largely employer-insured populations.^{107,177} Even with these assumptions, Shipman et al¹⁴¹ and Kletke et al¹⁷⁵ forecast a supply in 2010 (72 per 100 000) that exceeds staffing levels observed in most of these groups.

As discussed elsewhere in this report, a level of supply judged sufficient for the United States as a whole still leaves pockets of underservice or possible pediatrician excess. In addition, the effects of the growing supply of pediatricians on employment opportunities will depend on both the financing and organization of health care. General pediatrician unemployment would most likely occur if pediatric care were delivered entirely under the organizational systems that carefully manage panel size, the mix of physicians and nonphysician clinicians, and utilization, such as staff- or group-model HMOs. To the extent that pediatric care is less explicitly planned and financed, there are likely to be substantial regional differences in future opportunities for pediatricians.

TABLE 5. General Pediatrician Current Supply, Projected Supply, and Requirements

Supply	Date	Children per General Pediatrician*	General Pediatricians per 100 000 Children*	No. of General Pediatricians
Current				
Shipman et al ¹⁴¹				
Population age <18 y	2000	1886	53	38 457
Population age <20 y	2000	2041	49	38 457
Kletke et al ¹⁷⁵ (estimated)	2000	—	—	41 600
Projected				
Shipman et al ¹⁴¹				
Population age < 18 y	2010	1390	72	52 169
Population age < 20 y	2010	1555	64	52 169
Population age < 18 y	2020	1293	77	62 900
Population age < 20 y	2020	1362	73	62 900
Kletke et al ¹⁷⁵ (ratios assume age <18 y)	2010	1408	71	51 500
Estimated Requirements				
Population-based				
GMENAC ¹⁵¹	1980	2034	49	NA
Abt Associates and the Bureau of Health Professions ¹⁷⁶	1991	2430	41	NA
Practice-based†				
AAP PROS Network ¹⁶⁶				
Managed care staffing	1996	1400	71	NA
Group Health Association of America ¹⁷⁸				
(age not stated)	1993	2222	45	NA
New England IPA (0–17 y)				
33 HMOs (0–14 y)	—	1300	77	NA
Group-model HMO 1 (age not stated)	1992	1157	86	NA
Group-model HMO 2 (age not stated)	—	1125	89	NA
Group-model HMO 3 (age not stated)	—	1750	57	NA
Group-model HMO 3 (age not stated)	—	1200	83	NA
FOPE II "ideal" ¹⁰⁷				
High	2000	1200	83	NA
Low	2000	1400	71	NA

PROS indicates Pediatric Research in Office Settings; IPA, independent practice association; NA, not applicable.

* Assumes middle-US estimates.

† These practice-based measures need to be viewed cautiously. They assume that all children are cared for exclusively by pediatric practices and that most have employer-based insurance.

Which Supply of Pediatricians Is “Right?”

This report does not recommend a particular supply of pediatricians but instead challenges the reader to consider the values worth promoting through workforce policy. Much of the disagreement about physician requirements is seen as a consequence of uncertainty in the data and analytic methods when, in fact, these debates are driven by fundamental, and often unstated, conflicts in values. The differences in values are embedded in both the means and ends of the pediatrician workforce.

With respect to the “means,” there are significant disagreements among pediatricians, health care planners, and families about the appropriate and effective mix of market-based and publicly funded programs in the education and deployment of the workforce. Should public funding of medical education (eg, GME Medicare and Health Resources and Services Administration monies) be accompanied by an obligation to care for underserved populations? Who should decide on the size of the pediatrician pipeline? Should it continue to be residency programs or a quasi-public entity? How much of medical education should be funded publicly if markets are considered the best arbiter of workforce supply?

As far as the “ends” of workforce policy, should the workforce be equitably available to children? If not, how much disparity is acceptable, and who should pay the associated uneven costs? How much should workforce policy be influenced by the interest in tempering pediatric competition and thereby ensuring practice opportunities and stable incomes? If this is ignored, will we be able to attract the best and the brightest of rising medical talent to pediatrics? These are only a few of the questions that need to be considered in developing workforce policy, including the target supply. The answers are linked to the values held as individuals and jointly as a profession.

If producing better health and well-being of children remains the goal of pediatricians and associated workforce policy, there are still areas in which sound policy is hindered by inadequate data. The 2 related and unanswered questions in pediatrician-workforce research are: How much of an improvement in child health outcomes is derived from a given increase in the number of pediatricians, and would an equal investment in an alternative input provide a greater benefit? Past investments in pediatricians have brought good value in children’s health outcomes improvement. At the same time, there is a need to evaluate the effectiveness of additional growth in pediatrician supply.

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The Pediatrician Workforce: Current Status and Future Prospects
David C. Goodman and the Committee on Pediatric Workforce
Pediatrics 2005;116;156-173; originally published online Jun 15, 2005;
DOI: 10.1542/peds.2005-0874

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