Final Report of the FOPE II Pediatric Subspecialists of the Future Workgroup

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ABSTRACT. The report of the Pediatric Subspecialists of the Future Workgroup of the Second Task Force on Pediatric Education reviews the critical changes of the past 2 decades that have affected the provision of pediatric subspecialty services, education of pediatric health care providers, and the acquisition and application of new knowledge. The report considers the future needs that will determine the ability of pediatric subspecialists to meet identified goals. Recommendations for change in the education, role, and financing of the pediatric subspecialist are reported together with those of other workgroups. ***Pediatrics*** **2000;106(suppl):1224–1244;** ***pediatric subspecialist, pediatric subspecialist workforce, education pediatric subspecialist, research pediatric subspecialist.***

ABBREVIATIONS. FOPE, Future of Pediatric Education; ABP, American Board of Pediatrics; AAP, American Academy of Pediatrics; AMSPDC, Association of Medical School Pediatric Department Chairmen; ABMS, American Board of Medical Specialties; CME, continuing medical education; IMG, international medical graduates; HMO, health maintenance organization; COTH, Council on Teaching Hospitals; NIH, National Institutes of Health; FY, fiscal year; NINR, National Institute of Nursing Research; NEI, National Eye Institute; NIGMS, National Institute of General Medical Sciences; NIDDK, National Institute of Diabetes and Digestive and Kidney Diseases; PSDP, Pediatric Scientist Development Program; NICHD, National Institutes of Child Health and Human Development; APS, American Pediatric Society; SPR, Society for Pediatric Research; RBRVS, Resource-Based Relative Value Scale; GME, graduate medical education.

Since the first report in 1978 on the Future of Pediatric Education (FOPE), workforce numbers as well as the activities of pediatric subspecialists have progressively increased. A major outcome of the 1978 Task Force was the requirement for longer periods of training for both the pediatric generalist and specialist. The mechanisms by which clinical services are provided, the manner in which pediatricians are educated, and research conducted into the prevention, cause, and treatment of childhood disease, have undergone metamorphosis. These changes accelerated during the 1980s and 1990s.

Changes were brought about by clinical factors such as the increasing survival of children with severe chronic illness and the development and application of new and expensive technology. These changes have been accompanied by economic delivery issues including: increased health care costs, entry of large business systems into health care, failure of governmental regulatory plans, the decision to limit health care costs via provider competition, new methodologies for determining physician reimbursement for clinical services, changes in government and foundation support for biomedical research, expansion of biomedical industries, and the emergence of a global market enabled by the Internet and other communication devices.

There has been an increase in the number of total physicians in the United States, from 153 medical doctors per 100 000 population in 1975, to 253 medical doctors per 100 000 population in 1997.[1] Between 1980 and 1997, the number of active internal medicine and pediatric subspecialists has increased from 14 949 to 39 315.

In contrast, the increase in pediatric subspecialty workforce has been modest. As of the end of 1998, the cumulative number of all subspecialists ever certified by the American Board of Pediatrics (ABP) was 11 823.[2] Calculated from US census values of 1996, there are no more than 4 ABP-certified pediatric subspecialists per 100 000 people. Although a few pediatric subspecialties, such as cardiology, neonatology, neurology, and psychiatry, have sometimes moved out of academic centers, the majority of pediatric subspecialists still practice primarily within academic medical centers and their integrated systems. This distribution is clearly different from that found in internal medicine. The percentage of internists pursuing subspecialties was almost the inverse of that which has occurred in pediatrics. Also, the majority of internal medical subspecialists practice in community settings. This growth, predominantly in adult subspecialty medicine as well as a parallel growth in size and number of health care facilities, is unlikely to be sustained under changing reimbursement systems and facility consolidation. As these changes occur, it is important to rationalize work-

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force needs separately for pediatric versus internal medicine subspecialties.

Academic health centers, in addition to providing complex clinical care, are uniquely charged with producing the health care professionals for the 21st century and extending the boundary of medical science. Since the publication of the first task force report on pediatric education, changes in public policy and health care delivery have had a profound effect on these centers. While the costs for education and research have increased, the level of fiscal support has decreased. University-derived fiscal support for faculty has either remained constant or decreased. Although patient care reimbursement has been an important source of financial support for the missions of education and research, many insurers of health coverage are no longer willing to cross-subsidize these activities.

Competition for patients by for-profit entities and the financial disadvantage of caring for chronically ill patients has further disadvantaged academic medical centers. For pediatric programs, these problems are accentuated because of the rare and complex nature of disease, the lessened political impact on health policy that results from the smaller incidence of childhood disease, and the lack of economic empowerment. In short, the financial underpinnings of the academic medical center that provides the major support for pediatric subspecialists have progressively eroded.

These extensive issues support the critical necessity of evaluating our present position as regards the missions of service, education, and research. Concurrently, a need exists to develop a strategic plan for the future of pediatric subspecialists to ensure that the comprehensive health care needs of children are appropriately met during the first quarter of the 21st century. The report is organized under the following headings: workgroup charge, report construction, definitions, history, current status, future issues, gender or diversity, conclusions, general recommendations, and specific recommendations.

WORKGROUP CHARGE

This report has 2 objectives:

1. To review the critical changes of the past 2 decades that have impacted the provision of pediatric subspecialty services, the education of pediatric subspecialists, and the development of new knowledge and its application to the care of children.
2. To offer recommendations about the needs and numbers of future pediatric subspecialists regarding the delivery of clinical services, their education, and involvement in conducting research.

Because the majority of pediatric subspecialists practice within academic medical systems, the major segment of this report focuses on the current status and future role of the pediatric subspecialists within this setting. It will also address their role in community, rural, and vertically integrated health care delivery settings.

REPORT CONSTRUCTION

Sources of Input

Data related to workforce and its distribution and the current scope of activity of pediatric subspecialists were obtained from surveys conducted by the American Academy of Pediatrics (AAP) and Association of Medical School Pediatric Department Chairmen (AMSPDC) of pediatric generalists and subspecialists, communications with one or more subspecialty organizations representing each pediatric subspecialty, published reports, consultants, data published by the ABP, and a series of meetings of the Future of Pediatric Subspecialty Workgroup with members of other workgroups of the Task Force.

Process of Report Formation

During and after data collection, a series of meetings, workshops, and conference calls was held by the Workgroup on the Pediatric Subspecialists of the Future of the Task Force on the Future of Pediatric Education II to review and interpret the data collected and to organize this report. Draft reports were circulated to members of the Workgroup for input.

DEFINITIONS

A medical subspecialty, as defined by the American Board of Medical Specialties (ABMS), is an identifiable component of a specialty to which a practicing physician may devote a significant proportion of time. Practice in the subspecialty follows special educational experience in addition to that required for general certification. The ABMS states that a medical specialty is a defined area of medical practice that connotes special knowledge and ability resulting from specialized effort and training.

A pediatric subspecialist is an individual who, as a result of training and experience, is qualified to provide patient care and education and to conduct research in a defined or organ-specific area of medical or surgical care. The Workgroup arrived at this definition by consensus to express the need for both training and experience in the pediatric subspecialty arena and to encompass the spectrum of pediatric subspecialties to include age-specific generalists (neonatologists and adolescent medicine subspecialists), acuity-specific generalists (intensivists), organ-specific subspecialists (cardiologists, nephrologists, etc), and disciplines that are nonorgan-specific (genetics, endocrinology, and infectious disease). As defined by the ABMS, a certified medical subspecialist is a physician who has fulfilled the requirements and received a certificate of qualification from a medical specialty board approved by the ABMS.

Some pediatricians who are not subspecialty board-eligible have developed through self-study or limited time spent with pediatric subspecialists a distinctive set of clinical skills that they use to care for a limited group of patients within the focus of a given subspecialty. Although many of these individuals routinely interact with pediatric subspecialists and/or participate in continuing medical education (CME) activities related to their area of special interest, others do not. Strong ongoing interactions with

full-time pediatric specialists should be encouraged so children can receive enhanced care through a network of interactive providers.

An academic medical center is an institution where the practice of medicine interfaces with teaching, and interaction with trainees at all levels and evidence of scholarship are requisites for the maintenance of appointment. Academic medicine also includes research and the translation of new knowledge into leading-edge clinical care.

For purposes of this report, it is recognized that the general pediatrician is considered a specialist by the American Board of Medical Specialists. To avoid confusion, the board-certified pediatrician will be referred to as a pediatrician. The term pediatric subspecialist refers to all pediatric subspecialists, medical, surgical, and others requiring specialized training in the health care of children. Although the majority of subspecialists are board-certified or have a certificate of added qualifications, some subspecialties do not yet offer such certification.

HISTORY AND CURRENT STATUS

Certification and Criteria

Pediatric subspecialists can be categorized by discipline or by the certification process. Pediatric subspecialists are board-certified by a number of different ACGME-approved boards or receive a certificate of special competence by institutions offering nonboard-approved programs.

The ABP certifies the majority of medical subspecialties. Subboards developed by the ABP since the Cardiology Subboard issued its first certificate in 1961 are: Hematology–Oncology (1974), Nephrology (1974), Neonatal–Perinatal Medicine (1975), Endocrinology (1978), Pulmonology (1986), Critical Care Medicine (1987), Gastroenterology (1990), Rheumatology (1992), Emergency Medicine (1992), Sports Medicine (1993), Adolescent Medicine (1994), Infectious Disease (1994), Medical Toxicology (1994), Developmental Behavioral Pediatrics (1999), and Neurodevelopmental Disabilities (1999). Since the 1978 Task Force Report, 3 major changes in the training of fellows have occurred. First, the period of training for most subboards was extended to or established as 3 years in duration. Second, documentation of a research experience is required. Finally, recertification at 7-year intervals has become standard.

General board certification is given by the American Boards of Allergy and Immunology (a conjoint board of the American Boards of Internal Medicine and Pediatrics), Medical Genetics, Human Genetics and Psychiatry, and Neurology. A board-approved general certificate exists in child neurology. Board-approved subspecialty certificates are given in child psychiatry, pediatric surgery, pediatric pathology, pediatric radiology, and pediatric otolaryngology, under their parent adult-specialty boards. The majority of approved boards issue time-related certificates requiring recertification.

A number of disciplines unconnected to any board offer training programs of their own and issue certificates to individuals in recognition of their time spent training in a particular area. Several of these areas, eg, pediatric urology, are actively represented in the council of subspecialties of the AAP.

PEDIATRIC SUBSPECIALTY WORKFORCE

A number of different approaches have been used over the past 5 years to explore workforce issues in the pediatric subspecialties. Some subspecialty organizations have conducted workforce surveys (gastroenterology and neonatology). A survey was conducted by a professional corporation for both adult and pediatric nephrology.[3] Workforce surveys were conducted by AMSPDC in 1997 and the American Pediatric Society in 1998. The ABP began a subspecialty-tracking program in 1995. As part of the FOPE II project, the AAP conducted a survey of its membership in the Council on Sections. The major factors determining workforce to be discussed in this section are: the number of individuals entering and completing subspecialty training, site of medical school education, gender, and subsequent career choice.

A 1996 survey of university-based pediatric medical subspecialty workforce in the United States was compared with the Canadian workforce (Table 1). Workforce estimates were obtained from 3 sets of data gathered during 1996: the Annual Report of the ABP[4]; the Canadian Department of Pediatric Chairs survey of medical school faculty; and an AMSPDC survey of US and Canadian department chairs by its president, Alan B. Gruskin. For purposes of calculation, the US population was estimated to be 260 000 000 and the Canadian population, 29 434 000. Separate computations assumed that 100% and 75% of certified subspecialists remained active in the field. The US ratios of pediatric subspecialists to population were similar or less than Canadian ratios in 4 of the 12 areas. When comparing medical school faculty to population ratios, US ratios were similar or less in 8 of the 12 pediatric subspecialties, including neonatology. This comparison does not address the fact that Canadian pediatric generalists have had 4 years of training before their general certifying examination. The ratios are remarkably similar despite differences in procedures for appointment and licensure of faculty, national research expenditures, population demographics, or health care economics.

The number of first-time candidates for the ABP generalist examination increased from ~2150 to 2900 per year from 1988 to 1999, while the fraction of trainees entering pediatric subspecialties has decreased from 32% to slightly less than 20%. Although the numbers of internal medicine-pediatrics residents who enter pediatric subspecialties is unclear, between 17% and 21% enter some type of subspecialty training.[5]

Since the ABP began to track subspecialty training in 1995, the absolute number of pediatricians entering fellowship programs remained stable until 1998 when it decreased for the first time. Compared with a high of 680 in 1988, only 580 pediatricians entered subspecialty training in July 1998. An unknown number of graduating pediatric residents who are AMGs are deferring subspecialty training for several years to repay educational debts; hence, the total

number of present graduates who will become subspecialists may be slightly underestimated.

The fellowship dropout rates for those entering fellowship training in 1995 and 1996 were 17.8% and 18.7%, respectively. The ABP sought reasons why fellows discontinued their training. Among trainees leaving the program in the 1998–1999 academic year, 33% were Canadian or international medical graduates (IMGs) who did not plan to certify, 16% desired only clinical training, 10% needed only 2 years to meet certification requirements, 8% were listed erroneously, 7% needed to move or take leave of absence for child rearing, 7% elected to leave training, 6% were terminated by the program, and 5% left for visa-related problems.

IMGs form a substantial portion of pediatric subspecialty workforce and trainees. As of July 1998, 44% of subspecialty fellows were IMGs, while only 22% of those receiving subspecialty certification in 1987 were IMGs. For several of the pediatric subspecialties, IMGs represent >50% of its workforce.

The number of women entering pediatric subspecialty fellowships has increased over the past decade and reached 49% in 1998. Women are more highly represented in the nonprocedural than in the procedural subspecialties.[6] While 62% of first-time test takers of the general pediatric certification examination were women, fewer than 45% of first-time examinees of the subboards of pediatric critical care, gastroenterology, hematology–oncology, neonatology, nephrology, pulmonology, and rheumatology were women. In 1998 significantly more men began fellowship training in cardiology, critical care, and gastroenterology, while more women entered training in endocrinology and pediatric emergency medicine.

Most importantly, the overall interest in subspecialty fellowship training has dramatically decreased in recent years. Between 1994 and 1998, the number of men choosing subspecialties fell by 22%. Although the number of women applying for subspecialty examination increased, it was 34% less than anticipated from the number of women entering pediatric training. A similar decrease from 34% to 22% of IMGs choosing subspecialty training has occurred during this same period. Thus, decreased interest in pursuing pediatric subspecialty training cannot be explained based on gender or nationality.

A number of reasons have been offered to explain reduced interest in subspecialty careers. They include an increased emphasis on primary care, a progressively increasing debt burden, increasing academic faculty dissatisfaction, decreased research support for pediatric faculty, increasing pressure on faculty to generate professional income, and the uncertainties created by managed care.

A lower percentage of graduates of subspecialty training programs are joining medical school faculties and an increasing number seem to be joining managed care organizations. Until the late 1980s, an estimated 80% to 85% of certified pediatric subspecialists (with the exception of neonatologists, allergists, neurologists, and psychiatrists) worked almost exclusively in academic medical centers. Since then,

TABLE 1. Comparison of US to Canadian Workforce and an Estimate of the Fraction of Pediatric Subspecialists Working at Medical Schools

	ABP 1996 Data*	Ratio Board-Certified per Million US Population¶	75% of ABP 1996 Data§	Ratio Board-Certified per USA Population of 260 000 000	Canadian Ratio 1996 Data‡	1996 Data 108 Schools†	1996 Data Corrected to 124 Medical Schools	ABP 1996 Total Board-Certified*	75% Active	Fraction Medical School to Total‖
Adolescent	209	1 244 019	157	1:1 656 051	1:1 667 649	176	202	209	157	1.28
Cardiology	1339	194 174	1004	1:258 964	1:567 129	494	521	1339	1004	.52
Critical care	714	364 146	535	1:485 981	1:717 902	264	303	714	535	.58
Emergency medicine	807	322 181	605	1:429 752	1:336 005	318	365	807	605	.6
Endocrinology	731	355 677	578	1:449 827	1:788 059	271	311	731	578	.54
Gastroenterology	489	531 697	367	1:708 447	1:863 167	264	303	489	367	.82
Hematology/oncology	1348	192 878	1011	1:257 171	1:464 625	456	523	1348	1011	.52
Infectious disease	501	518 962	375	1:693 333	1:693 380	254	292	501	375	.78
Medical toxicology	11	23 636 363	8.3	1:31 325 301	1:4 528 308					
Neonatology	3069	84 718	2301	1:112 994	1:269 049	736	845	3069	2301	.37
Nephrology	494	526 315	370	1:702 703	1:934 413	219	251	494	370	.68
Pulmonology	536	485 075	402	1:646 766	1:887 903	233	267	536	402	.66
Rheumatology	151	1 721 854	113	1:2 300 885	1:1 565 638	94	108	151	113	.95
Sports medicine	15	17 333 330	13.5	1:19 259 259						

* Total number of certified subspecialists.
† Survey of 108 medical schools.
‡ 1996 data collected by department chairs.
§ Numbers assume that only 75% of those board-certified currently active.
‖ Fraction of all subspecialists employed by a medical school (assumes all are certified).
¶ Assumes US population of 260 000 000.

TABLE 2. FOPE II: Comparative Analysis of Survey Findings, March 1999

Specialty	% Male	% Female	Average Age	Anticipated Retirement Age	% Medical School Main Work Site	% Specialty Group Main Work Site	% Multispecialty Group Main Work Site	% Community Hospital Main Work Site	% Solo Practice Main Work Site	% Other Main Work Sites
Adolescent medicine	49	51	48	65	29.9	2.5	9.0	5.0	10.6	43.0
Allergy/immunology	76	24	50	65	10.9	32.4	8.9	.7	35.6	11.5
Cardiology	80	20	48	65	56.8	19.1	6.2	3.4	6.6	7.9
Clinical genetics	59	41	48	66	65.9	5.3	4.3	6.4	2.7	15.4
Critical care medicine	75	25	42	63	59.5	10.0	4.9	13.3	2.3	10.0
Dermatology	51	49	47	65	32.3	19.1	9.1	1.8	26.4	11.3
Developmental behavioral	59	41	50	66	38.3	4.1	8.6	5.7	10.6	32.7
Emergency medicine	63	37	42	62	44.9	8.7	1.9	32.0	.7	11.8
Endocrinology	64	36	50	66	51.3	6.3	7.6	4.5	7.8	22.5
Infectious diagnosis	67	33	47	66	62.1	1.2	6.2	7.8	3.0	19.7
Neonatology	66	34	47	63	35.8	27.5	4.6	17.8	4.6	9.7
Neurology	75	25	51	67	47.4	17.5	7.1	2.4	18.1	7.5
Ophthalmology	77	23	48	64	14.9	41.5	7.4	1.3	29.8	5.1
Orthopedic surgery	94	6	50	64	29.0	35.3	6.9	1.2	15.9	11.7
Otolaryngology	90	10	47	64	26.8	33.5	7.9	.8	26.4	4.6
Plastic surgery	94	6	49	65	28.0	25.7	5.0	1.5	37.5	2.3
Pulmonology	72	28	45	66	58.0	10.9	6.4	6.2	8.0	10.5

NA indicates not applicable.

an increased number of pediatric subspecialists have practiced in full-time, nonacademic settings. Between 50% and 73% of those entering nonacademic practices in pediatric endocrinology, gastroenterology, or nephrology planned to work part-time as generalists.[7] Of all first-time-take pediatric subspecialty subboard candidates in 1999, 36% to 59% chose careers in academic settings, except for neonatology in which 45% of candidates chose to work in an academic center. When the fraction of currently active US medical school faculty was compared with the total number of active board-certified individuals (excluding neonatology), 52% to 95% of various groups of subspecialists were employed by medical schools. Although a number of subspecialists work or are closely aligned with teaching institutions, the percentage receiving significant financial support by these institutions is not known. Importantly, an estimated 75% of pediatric subspecialists are engaged in the teaching of future pediatricians.

The presidential address of Dr Ralph Feigin to the American Society of Pediatrics in 1998 presented the results of a 1998 survey of all US and Canadian medical school department chairs.[8] Fewer than 50% of pediatric departments offered fellowship training in any subspecialty, aside from neonatology, which was offered by 66% of departments. Only 900 of 1078 first-year fellowship positions (83%) were filled. None of the subspecialty disciplines filled all of the available positions. Fill rate varied from 53% in toxicology to 96% in allergy/immunology. Of the 2375 subspecialty trainees, 1473 indicated a desire to pursue an academic career. There were more trainees (excess numbers of trainees in parentheses) than projected academic positions in allergy/immunology (30), cardiology (102), critical care medicine (64), emergency medicine (33), endocrinology (16), hematology–oncology (32), gastroenterology (3), infectious diseases (49), neonatology (86), and toxicology (4). More faculty positions than trainees (excess faculty positions in parentheses) were projected to be needed over the subsequent 3 years in 7 of the 19 pediatric subspecialties surveyed: adolescent medicine (14), genetics (8), neurology (32), pulmonology (24), nephrology (2), and rheumatology (5). However, it must be emphasized that this survey addressed currently available salaried positions and did not address academic workforce needs.

A number of university pediatric departments are in the process of downsizing because of reduced professional income and increased competition from other health care providers within the region. This has the effect of reducing time for research and education by the remaining faculty.

Increasingly, pediatric subspecialists in some areas are having difficulty in finding full-time academic positions for a number of reasons: reduction in faculty positions under stress of competition and lowered reimbursement, unwillingness to move to areas with available jobs, and insufficient training to be grant competitive. Additional reasons believed to influence the choice of an academic career are increased debt burden, large discrepancies between salaries of investigators and practitioners, falling success rates in competing for grants, and lack of recognition of research accomplishments.

The amount of care being provided to children by adult-trained physicians is unclear and should be quantified for each subspecialty. The Pediatric Rheumatology Strategic Planning Document for the year 2000 points out that one third of children with known rheumatic diseases are cared for by internist rheumatologists and have never had their diagnosis or care plan reviewed by a pediatric rheumatologist. One third of medical schools do not have a pediatric rheumatologist on the faculty.

Seventeen pediatric and surgical subspecialties were surveyed by the AAP in 1998, with a response

% Time/ Week Direct Patient Care	% Time/ Week Teaching	% Time/ Week Administration	% Time/ Week Clinical Research	% Time/ Week Basic Science Research	% Doctors Believe They Face Competition for Pediatric Subspeciality Services	% Doctors Facing Competition Who Modified Practice in Response	% Believe No More Subspecialists Needed Next Three to Five Years	% Believe Need More Doctors in My Discipline Next Three to Five Years	% Believe Need More Doctors in Other Disciplines Next Three to Five Years
68.5	11.1	11.6	3.1	.1	56.0	49.0	54.0	35.0	19.0
83.2	4.6	4.9	3.5	1.1	85.0	38.0	75.0	14.0	14.0
66.3	11.3	10.0	5.4	3.2	84.0	54.0	75.0	13.0	16.0
50.7	10.9	13.4	8.1	11.5	50.0	35.0	55.0	39.0	15.0
56.0	14.4	14.5	5.4	5.0	71.0	39.0	59.0	27.0	25.0
77.8	9.2	5.9	2.7	1.2	64.0	24.0	70.0	25.0	8.0
66.7	10.1	11.9	4.8	3.5	63.0	37.0	34.0	48.0	20.0
68.3	14.1	17.0	6.9	3.8	53.0	42.0	48.0	46.0	17.0
61.3	10.9	10.2	8.3	5.0	69.0	39.0	60.0	30.0	20.0
44.4	15.5	13.7	12.8	6.6	53.0	32.0	69.0	15.0	24.0
63.6	10.2	13.1	4.3	4.1	68.0	43.0	NA	NA	NA
67.0	9.7	8.3	6.6	4.2	71.0	39.0	58.0	35.0	17.0
83.8	5.6	5.9	2.0	.4	80.0	32.0	85.0	9.0	8.0
74.8	9.5	7.7	3.3	.6	75.0	31.0	76.0	18.0	8.0
79.4	7.6	7.0	2.2	.7	82.0	39.0	75.0	18.0	12.0
76.8	8.2	7.4	2.4	1.1	70.0	25.0	95.0	5.0	3.0
59.7	10.9	11.0	7.5	6.5	76.0	50.0	61.0	30.0	19.0

rate of 55% to 60% (Table 2). In contrast to the survey by Dr Feigin, which focused primarily on academic positions, the AAP survey focused on clinical delivery issues related to principal practice site, distribution of effort, source of patient referral, and perception of competition and local workforce needs. Approximately 80% of specialists in allergy–immunology, cardiology, ophthalmology, and otolaryngology believed that they face significant competition in their geographic area, compared with only 50% of those practicing adolescent medicine, clinical genetics, emergency medicine, and infectious disease. Except for those in adolescent medicine, dermatology, and emergency medicine, pediatric subspecialists believed that their major source of competition was other pediatric or nonpediatric subspecialists. To deal with increased competition in cardiology and pulmonology, 50% have modified their practice patterns, while 25% of dermatologists and plastic surgeons have undertaken practice modifications. Modifications include increased office hours and increased numbers and responsibilities of support staff. The majority of respondents believed that there will not be a need for additional subspecialists in their area over the next 3 to 5 years. In otolaryngology, allergy/immunology, cardiology, orthopedics, and plastic surgery, 75% indicated no need for additional subspecialists. In contrast, 50% of behavioral medicine and emergency physicians and 35% of adolescent medicine, clinical genetics, and pediatric neurology subspecialists believe that more subspecialists are needed in their areas.

Over the past few years, several organizations representing pediatric subspecialties have obtained workforce data. The study performed by the North American Society for Pediatric Gastroenterology and Nutrition is the most complete and provides meaningful data in terms of breadth and extent of activity.[9] The surveyors attempted to contact all individuals involved in pediatric gastroenterology and the response rate was 90% ($n = 624$). The data collected revealed that 76% were board-certified. As regards employment, 55% worked in academic medical centers, 11% worked for hospitals, 21% were in private single subspecialty practice, 6% worked for multispecialty groups, and 3% for health maintenance organizations (HMOs). Clinical activities occupied 60% of their time, research 14%, teaching 6%, and administration 8%. Only 10% spent at least 50% in research, and only 39% of research effort was supported by an extramural grant or contract. Of the 56 training programs, 79% had less than 4 fellows per program; 28% of fellows were federally funded, 57% were supported by clinical revenue, and 6% by university sources. This report pointed out that if the current number of trainees completing fellowship ($n = 40$ per year) continues, there would be a significant surplus of gastroenterologists by the year 2006. The report recommended a reduction of 50% to 70% in the number of trainees. As regards the contribution of a fellow to the overall clinical mission of their fellowship program, it has been suggested that one third of their training be considered full-time clinical service and that during the time spent clinically, fellows should be viewed as being 65% as effective in time utilization as experienced faculty.[10] Compared with data obtained from Canadians ($n = 48$; 96%), there were twice as many US pediatric gastroenterologists per million population. Nearly all Canadian pediatric gastroenterologists work in academic health centers, whereas 55% of Americans work in a similar environment. The US and Canadian pediatric gastroenterologists spent 60% and 43% of their time, respectively, involved in clinical activities. One explanation for this difference might be in the referral pattern for patients with common digestive disorders by pediatricians in Canada, who function more as consultants than as primary care practitioners.

Workforce needs might decrease in the United States if general pediatricians develop more expertise in this area or if incentives to discourage referrals are applied. In contrast, proliferation of liver and small bowel transplantation centers would increase the need for transplant gastroenterologists.

In a study of those practicing pediatric cardiology, another technical pediatric subspecialty, pediatric cardiologists spent ~75% of their time in clinically related activities.[11] Assuming there are currently 1000 active board-certified pediatric cardiologists in the United States, the numbers of pediatric cardiologists per 100 000 children is similar when ratios per child throughout the United States are compared with those working in a managed care organization.[12] The same report commented that the length of training internal medicine cardiologists have had in pediatric cardiology is very limited; 87% of internal medicine cardiologists have had 1 month or less of formal training in pediatric cardiology. The degree to which internal medicine cardiologists compete with pediatric cardiologists for pediatric patients is difficult to access and varies geographically, but there is a common perception that they are referred older children with asymptomatic cardiac findings. This is an important population for generalist training and the evaluation of the larger volume of patients with asymptomatic findings by the pediatric cardiologist often subsidizes the care of the complex patient. Thus, competition from internal medicine subspecialists creates economic pressure for the pediatric subspecialist.

A survey of 420 neonatal practices (representing 60% of all those listed in the 1996 US Directory of Neonatologists) offers some insights into the workforce status and future needs in neonatology.[13] Seventy-five percent of listed neonatologists are board-certified. Approximately 18% in one of the districts of the AAP were not active. More than 80% were <50 years of age. Females, representing 34.2% of the total, were more likely to be university- and hospital-based rather than in private practice. The distribution of neonatologists was 36.9% university-based, 23.9% hospital-based, 35.7% in private practice, 1.7% and 1.8% HMO-based and in the military, respectively. The rate of utilization of nonphysician providers was greatest among university-based neonatologists (77.2%), followed by private practice (52.9%) and hospital-based (46.3%) neonatologists. Time allocation varied among the groups with clinical activity using 39%, 64%, and 62% of neonatologists based at a university, private practice, or being nonuniversity hospital-based, respectively. Research time for the 3 groups was 24%, 2%, and 5%, respectively, while the education component was 10%, 8%, and 9%, respectively. Administrative time averaged 10% for all groups. There were 102 neonatology fellowship-training programs graduating 150 to 160 individuals per year. One half of practices anticipated increasing their number of neonatologists; more planned to double their number of nonphysician providers.

Although neonatologists represent the largest number of pediatric subspecialists (3069 certified since the inception of the Subboard of Neonatal–Perinatal Medicine in 1975), there exists a vigorous job market for new graduates because of the number of community hospitals and professional organizations developing neonatal units. The same is true of emergency medicine specialists who are hired to provide clinical services at nonprimary academic medical centers. As a result, these subspecialties are a popular choice of pediatric residents. Fourteen percent (103 individuals) first-time takers of the 1995 General Pediatrics Certifying Examination entering subspecialty training planned careers in emergency medicine training and 24% (168 individuals) planned to enter programs in neonatology. In contrast, only 7 first-time examination takers planned careers in rheumatology and 28 planned to enter nephrology. A great disparity exists in the vigor of the different subspecialties, which probably relates to market value. In some cases, there is such an undersupply of specific pediatric subspecialists that training sites are affected. An example is pediatric rheumatology, which is represented in only 45 training centers.

In conclusion, the available workforce data support the conclusion that in 1999 there is an appropriate balance of pediatric subspecialists for provision of clinical services but that saturation of available funded positions will soon occur in many areas because of inadequate reimbursement for effort, restricted patient access, and a recent trend toward larger numbers of trainees. This differs sharply from the oversupply of many internal medicine subspecialists. Also, unlike internal medicine subspecialties, a majority of pediatric medical subspecialists are associated with Council on Teaching Hospitals (COTH) institutions. Among subspecialists entering community practices, a substantial number apparently plan to practice a combination of general and subspecialty pediatrics. Some subspecialties are in serious undersupply and depend on IMGs to sustain a skeleton workforce. These areas may be seriously threatened if the IMGs in the pipeline are drastically reduced without other actions taken to increase the number of AMG fellows. Finally, women are now entering subspecialty training in similar numbers, but not in similar percentages, as men. Women continue to prefer general pediatrics and nonprocedural subspecialties compared with men.

CURRENT ROLES OF PEDIATRIC SUBSPECIALISTS

Clinical Service

The principle clinical setting and type of clinical services provided by different subspecialties is heterogeneous and varies widely according to performance of procedures, the degree of consultative versus first line care, practice site (primarily in an office vs hospital), and the degree of overlap with general practice.

Ideally, pediatric subspecialists conduct their clinical activities in collaboration with other pediatric subspecialists both within their specialty and in relationship to other subspecialists to deliver optimal care. Subspecialists' educational and research activities are also being provided in an interdisciplinary manner.

A survey of the sections of the AAP, subboards of the ABP, and specialty organizations asking them to classify themselves supports the grouping of some subspecialties together. Subspecialists that have significant clinical overlap with general pediatrics are research-based and are nonprocedural (ie, infectious disease and endocrinology) remain based principally at COTH institutions. Subspecialties that are procedurally active and dependent on clinical income, such as cardiology, gastroenterology, and surgical subspecialties often practice in multiple sites including academic medical centers and community hospitals. Clinical services in rural settings are usually provided by periodic outreach clinics, telephone, and telemedicine consultation or referral to adult subspecialists because these areas have few pediatric subspecialists.

Ambulatory settings in which pediatric medicine is practiced includes private offices, group practices, multispecialty group practices, hospital outpatient facilities, and hospital system-operated ambulatory buildings. The majority of the medical, surgical, and imaging programs for children currently take place within an ambulatory setting. The majority of pediatric subspecialists spend most of their clinical time, over 65%, in ambulatory settings including community-based practices.

Approximately 200 chronic conditions and disabilities affect children. Three groups exist: first, children with developmental delays or disabilities, such as learning disabilities, sensory impairment, and mental retardation; second, children with ongoing medical disorders, such as diabetes, asthma, sickle cell disease, acquired immunodeficiency virus, chronic renal disease, congenital heart disease, cystic fibrosis etc; and third, children with emotional or behavioral problems, such as attention-deficit disorder and psychiatric illnesses. The development of many interdisciplinary programs to meet the multiple medical, nutritional, and psychosocial needs of children with special health care needs has improved the quality of life for affected children and their families. Most of these programs are based at academic pediatric health centers and their major affiliates. Estimates of the prevalence of children with special health care needs range from 2% to 31%.[14] Some pediatric subspecialists provide primary care services to their patients. This is particularly important for medically complex patients who presently may not have a medical home other than the subspecialty group.

Pediatric subspecialists currently provide the majority of education to trainees at all levels and generate the majority of new information related to their specialties. Since 1978, a number of advanced practice nurses, physician assistants, and generalist pediatricians have been trained to provide pediatric subspecialty services under the direction and supervision of the subspecialists. These nonphysician providers often share the management of high-acuity patients in the inpatient setting and deliver important transitional and home care in the outpatient setting. A team care setting offers the broadest, most comprehensive and efficient management of chronically ill patients.

The degree to which pediatric generalists and subspecialists overlap varies by problem-type and location but occurs least in procedural-based subspecialties. The degree to which interaction between generalists and subspecialists results in an improved quality of care has only recently began to be studied. In a managed care environment, facilitated asthma management by a subspecialist has been shown to result in reduced nocturnal problems and emergency department visits and a greater use of drugs that reduce relapse, compared with care by a generalist.[15]

Because pediatric generalists and subspecialists receive the most comprehensive and intensive period of supervised training before providing clinical services to children, it would be expected that they provide subspecialty care to all children requiring such services. Pediatric generalists also appropriately provide some subspecialty clinical services. However, there seems to be an increasing number of nonpediatric subspecialists providing pediatric subspecialty services. In general, nonpediatric subspecialists, when providing care for children, treat those with milder degrees of impairment and illness. Internal medicine and adult surgical subspecialists are more likely to see children in rural areas, where pediatric subspecialists may not be readily available. Because adult subspecialists have contracted for adult and pediatric services in some managed care organizations, patients must go out of their insurance plan to access pediatric subspecialists. The degree to which nonsubspecialty providers deliver subspecialty care to children varies with geography; with the intensity of the service (eg, neonatal intensive care unit vs the routine management of the diabetic); and with the level of integration of the health care system (eg, in some HMOs pediatric subspecialists serve as consultants to a large number of pediatric and nonpediatric generalists).

Because more care has been provided by nonpediatric subspecialists, it is likely that fewer children will be seen in settings where a critical mass of pediatric specialists practice. The availability of fewer patients could also impact on the pediatric specialist's ability to answer critical questions about causes and treatment of childhood disease. It could also decrease the ability to educate a generalist trainee by a concentrated exposure to a variety of conditions and a spectrum of severity.

An increasing number of studies comparing both the quality of care being offered as well as the cost of delivering that care support the conclusion that pediatric subspecialists, by virtue of their background and experience, are better able to provide services to pediatric patients than are internal medicine subspecialists. As a specific example, the majority of pediatric nephrologists view home-based peritoneal dialysis as a preferred modality area to that of in-center hemodialysis. Dialysis centers run by pediatric nephrologists were more likely to start children on peritoneal rather than on hemodialysis.[16] Also, it was observed that one third of children with end-stage renal disease requiring dialysis were managed at centers that provided very little care for children (<1% of the population served). Two thirds of these

children were adolescents. An explanation for referral to adult rather than to pediatric subspecialists may be related to the fact that in one survey only 10% of children 15 to 19 years of age use pediatricians as their primary care physicians.[17]

Available data support the conclusion that subspecialists are more likely to adopt new therapies and approaches more quickly than are generalists.[18] As regards pediatric subspecialists, for example, one study concluded that outcomes in adolescents with acute leukemia are better when treatment is provided by pediatric rather than by internal medicine oncologists because the children are treated by defined protocol.[19] Such findings support the general concept that greater experience with disease may be associated with improved outcomes, lower costs, and improved management strategies. It has also been demonstrated that children who sustained blunt trauma experienced better outcomes when they were cared for in a designated pediatric trauma center, compared with an adult trauma center.[20]

University-based or children's hospitals' programs currently provide nearly all of the comprehensive care team programs for children with subspecialty health care needs. Such teams consist of multiple caregivers such as advanced practice nurses, social workers, dieticians, and psychologists together with pediatric subspecialists and generalists. Four examples of the value of this type of care delivery follow. First, the organization of centers under the umbrella of the Cystic Fibrosis Foundation has grown from a small network in 1962 caring for ~7100 patients, to 114 centers caring for over 21 000 patients at the present time.[21,22] The availability of a large population of complex patients for the development of clinical management protocols has, in part, led to an improvement in median survival age from 14 years in 1969 to 28.9 years in 1993. Using body weight as a surrogate for disease status in cystic fibrosis, regionalized care in the United Kingdom was shown to have a better outcome than care centered at a general hospital. This form of organization has supported education and clinical research, which has significantly improved clinical care.

A second example is that of end-stage renal disease care for children. This program is the only federally funded patient care program for children and is Medicare-supported. The program provides support for team care. The cohorting of children with terminal renal failure has led to the development of national collaborative research programs in the area of pediatric dialysis and renal transplantation that have significantly improved patient outcomes.

Third, many pediatric departments collaboratively operate with their state team care programs for children with special health care needs, eg, meningomyelocele.[23] Many programs deal with small numbers of patients. These programs bring together critical masses of pediatric subspecialists and other pediatric health care providers from a number of disciplines. Such programs offer referral care to large geographic areas. Sometimes third-party payers have dictated patient movement from regional pediatric centers into organizations with team services provided by an adult-oriented staff. In some cases team care has not been offered. The degree to which this has occurred varies widely from region to region and is undergoing constant change and, therefore, is difficult to quantify.

Fourth, care provided in tertiary pediatric intensive care units is associated with improved outcomes.[24]

Educational Role

Since the Task Force of 1978, the majority of pediatric education has been provided by pediatric subspecialists functioning as specialists or as generalists. Traditional modes of education have included didactic lectures, small group workshops, and case study. The past decade has seen the expanded use of self-instructional materials and computer-assisted interactive educational experiences. Medical student education has occurred concurrently with that of housestaff, while fellowship training tends to be discipline specific. Since 1978, the period of training and training content of fellows have changed. Most medical subspecialty fellowships have increased from 2 to 3 years, and the completion of a research project has become a requirement of the majority. Most surgical pediatric fellowships last 1 year and are organized and focused on patient care. Some surgical programs have a research requirement, usually 1 year.

Since 1978, an increasing amount of subspecialists' teaching for the generalist takes place in ambulatory locations. Little, if any, training of pediatric medical subspecialists currently occurs in community-based practitioners' offices.

In addition to time spent educating pediatric trainees at various levels, including postgraduate teaching of pediatric generalists, pediatric subspecialists provide education to family practitioners, advanced practice nurses, physician assistants, and osteopathic physicians seeking both general and subspecialty training. Most pediatric osteopathic subspecialists have received their training in allopathic institutions. Teaching time of medical school-based faculty occupies 20% to 40% of total faculty time.

Family practice residencies offer limited exposure to pediatric subspecialists. Many training programs are based in institutions distant from academic medical centers. Family practitioners may work in rural environments where adult subspecialists are more accessible than are pediatric subspecialists, and referral patterns are well-developed. It follows that family practitioners are less likely to use the services of pediatric subspecialists because of unfamiliarity with their role.

Fellowship training is organized to meet Residency Review Committee guidelines. Many fellowship programs have 3 or fewer certified faculty members. Programs may be limited in their ability to provide access to appropriate expertise in study design, statistical analysis, epidemiology, scientific writing, grant preparation, and/or laboratory research. Most fellows have limited exposure to educational methodology and issues of management. Over the past 5 years, there has been an increasing

TABLE 3. FY 1994 NIH Extramural Support to Higher Education Institutions by Department

School and Department	Millions of Dollars	% of Higher Education Dollars
Total for higher education	$6634.3	100
Total for medical schools	$4576.5	69
Medicine	$1333.6	20.1
Psychiatry	$ 324.4	4.9
Pediatrics	$ 260.2	3.9
Biochemistry	$ 253.3	3.8
Pathology	$ 245.7	3.7
Physiology	$ 238.9	3.6
Microbiology	$ 230.1	3.5
Pharmacology	$ 211.0	3.2
Anatomy	$ 183.8	2.8
Surgery	$ 180.3	2.8
Other	$1115.2	16.8
Other than medical schools	$2057.6	31

emphasis in providing course work and in integrating the educational and research experience of fellows from multiple disciplines. A number of institutions offer introductory courses in research design and statistical analysis, while others offer such experiences throughout the fellowship. The primary outcome of fellowship training over the past decade has been the graduation of individuals who subsequently pursue clinical service with a secondary emphasis on education. Fewer graduates of fellowship programs have pursued careers as physician scientists with success in obtaining ongoing funding to support research programs. Reasons for the failure to pursue research careers include personal preference, work time required to be successful, accumulated debt, difficulty in obtaining grants, departmental emphasis on obtaining clinical revenue, lack of protected time, and lack of mentoring.

Research Profile

Virtually all physician-generated research related to childhood disorders has occurred in medical school-affiliated institutions. Grant-holding (National Institutes of Health [NIH]) pediatric subspecialists are not evenly distributed across medical schools. Support for pediatric related investigations comes from medical schools, hospital-based foundations, regional and national foundations, governmental agencies, and academic practice plans. Practice plan income has supported a significant amount of time devoted to research activities, particularly clinical research. Examples of clinical research in pediatrics include the recent increase in multicenter clinical trials (eg, neonatal network, North American Pediatric Renal Transplant Cooperative Study, Acquired Immune Deficiency Syndrome, Pediatric Oncology Group, and Children's Cancer Study Group trials). The pediatric cancer multicenter trials are examples of long-standing, successful, pediatric collaborative efforts.

Some support for clinical research in pediatrics has been developed by collaboration between managed care organizations and academic medical centers. One example of this is the Kaiser–University of California-Los Angeles Vaccine Study Group, which has performed studies on the safety, immunogenicity, and efficacy of bacterial and viral immunization. This type of collaboration has the capability of providing large populations of children for clinical studies.

The majority of support for pediatric research still derives from the NIH. In fiscal year (FY) 1994, 3.9% of the NIH funding for institutions of higher education or $260 200 000 went to departments of pediatrics (Table 3). For the same period, 20.1% or $1 333 600 000 went to departments of internal medicine. McCabe[25] found that this funding increased for FY 1996 to $270 600 000 for departments of pediatrics and $1 397 000 000 for departments of medicine (Table 4).

Although the total grant award dollars for departments of medicine was 5 times that for departments of pediatrics, McCabe[25] found that the success rates for funding were similar, 21.2% for pediatrics and 24.0% for medicine in FY 1994 (Table 5). Not only do success rates differ among departments, they also vary by institutes within the NIH, ranging from 12.3% for the National Institute of Nursing Research (NINR) to 39.5% for the National Eye Institute (NEI; Table 6). Success rates for MDs and MD/PhDs depend on the institute (Table 7). In FY 1994, only 7% of National Institute of General Medical Sciences (NIGMS) first-time awardees were MDs or MD/PhDs, while this rate was 58% in the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Stiehm[26] showed that success of pediatrician investigators varied among institutes in FY 1993 with a high of 19% for child health, then 16% for human genome, 8% for allergy, 7% for diabetes, 6% for dental, 6% for heart/lung, and 5% for drug abuse. Aging, arthritis, cancer, environment, eye, general medicine, mental health, and neurology all fell below 5%.

Stiehm[27] showed that funding for departments of pediatrics had increased dramatically in FY 1993, compared with his original report in FY 1983. In FY 1983, departments of pediatrics received 2.7% of NIH awards, with 390 awards for a total of $53 000 000 or 3.1% of NIH funding (Table 8). In FY 1993, there was an increase to 5% of NIH awards for 608 awards, $164 000 000 or 5.3% of NIH funding. McCabe found 875 awards for $246 200 000 in FY 1996. While the

TABLE 4. Comparison of FY 1996 NIH Grant Funding for Different Departments

Department	Total	Research	Training	Contract	Fellowship	Other
Family practice	$ 18.4 (61)*	$ 13.0 (53)	—	$ 5.3 (5)	$ .05 (2)	$ .07 (1)
Medicine	$ 1397 (4565)	$ 1246 (3898)	$56.3 (323)	$85.7 (125)	$6.1 (213)	$2.8 (6)
Obstetrics/gynecology	$ 70.7 (286)	$ 62.0 (252)	$ .7 (9)	$ 7.2 (12)	$ .3 (12)	$ .4 (1)
Pediatrics	$270.6 (963)	$246.2 (875)	$ 5.9 (41)	$17.5 (24)	$ .7 (22)	$ .3 (1)

* Amount in millions (number).

TABLE 5. FY 1994 Success Rates for NIH Competing Research Projects for Higher Education Institutions by Department

Department	Number of Awards	Success Rate (%)
Total for higher education	5252	25.7
Medical schools	3400	25.7
Medicine	749	24.0
Psychiatry	255	26.8
Pediatrics	148	21.2
Biochemistry	241	30.3
Pathology	211	24.4
Physiology	223	28.1
Microbiology	219	26.0
Pharmacology	221	28.3
Anatomy	192	29.4
Surgery	135	20.7
Other	806	26.2
Other than medical schools	1852	25.6

TABLE 6. Success Rates for NIH Competing Research Project by Institute FY 1994

Institute	Success Rate (%)
NEI	39.5
NIDR	36.7
NIGMS	33.4
NIDA	32.9
NIDCD	31.8
NIAAA	29.3
NHGRI	27.8
FIC	26.7
NINDS	26.0
NIEHS	25.6
NIDDK	25.3
NIA	24.6
NIAID	24.4
NHLBI	23.4
NCI	22.3
NIMH	20.7
NICHD	20.5
NIAMS	19.6
NCRR	18.2
NINR	12.3

NIDR indicates National Institute on Dental Research; NIDA, National Institute on Drug Abuse; NIDCD, National Institute on Deafness and Other Communication Disorders; NIAAA, National Institute of Alcohol Abuse and Alcoholism; NHGRI, National Human Genome Research Institute; FIC, Fogerty International Center; NINDS, National Institute of Neurological Disorders and Stroke; NIEHS, National Institute on Environmental Health Sciences; NIA, National Institute on Aging; NIAID, National Institute of Allergy and Infectious Diseases; NHLBI, National Heart, Lung, and Blood Institute; NCI, National Cancer Institute; NIMH, National Institute of Mental Health; NIAMS, National Institute of Arthritis and Musculoskeletal and Skin Diseases; NCRR, National Center for Research Resources.

number of awards increased, the percentage of awards (5.4%) and the percentage of NIH funding (5.5%) were similar to FY93 levels.

Stiehm[27] was concerned that because many departments of pediatrics had few grants, many medical students would have a limited opportunity to interact with a pediatrician scientist during their training. The data of Stiehm were from 1993, but McCabe[25] did not report appreciable improvement by FY 1996 (Table 9). Three programs had 30 or more grants in 1993, and 7 had 30 or more grants in FY 1996. In 1993, 43 departments had no awards, while 35 had no awards in FY 1996. In 1993, the top 15 departments had 393 awards (51%), and in FY 1996, the top 13 departments had 447 awards (51%). In 1993, the bottom 85 departments received 112 awards (14%), and in FY 1996 the bottom 85 departments received 147 awards (17%). In 1993, the mean number of awards per department of pediatrics was 6.2, and in FY 1996 this number was 6.9. The median was 2 awards in 1993 and 3 awards in FY 1996. McCabe[25] concluded that in FY 1996, NIH grants remained concentrated in a limited number of departments; accordingly, trainee exposure to pediatrician investigators was limited.

TABLE 7. Number of Competing Research Project Grants to First-Time Awardees for FY 1994

Institute	All Degrees	PhDs	MDs and MD/PhDs	Others
NCI	235	146	86	3
NIGMS	175	162	13	0
NIDDK	172	70	99	3
NHLBI	167	95	69	3
NIAID	162	99	60	3
NINDS	136	85	50	1
MIMH	111	91	20	0
NICHD	109	77	32	0
NIDA	93	71	20	2
NEI	63	47	16	0
NIA	61	46	12	3
NIDR	48	34	6	8
NIAMS	45	26	19	0
NIAAA	40	30	9	1
NIDCD	38	32	3	3
NIEHS	29	24	4	1
NHGRI	21	15	5	1
NINR	16	11	1	4
NCRR	9	9	0	0
FIC	2	1	1	0

See Table 6 for abbreviation definitions.

The constant dollar change in research grant funding for each of the NIH institutes between the years of 1985 and 1994 is summarized in Table 10. With the exception of one institute, funding has increased. There was essentially no change in funding levels for NIH training grants or fellowships from FY 1994 to FY 1996. NIH funding for pediatric training grants has not increased significantly during the past decade. McCabe[25] found for FY 1996 only $5 856 967 in NIH training grants and $687 022 in NIH fellowships for all departments of pediatrics (Table 3). Departments of medicine held $56 327 457 in NIH training grants and $6 145 474 in NIH fellowships for the same time period. While Medicine had 5 times the NIH research grant funding of pediatrics, support for NIH training grants and fellowships was 10 times greater. These results raise serious concerns about the training of future pediatrician scientists.

The concern over a diminishing number of physician scientists led AMSPDC to establish an AMSPDC research issues work group. One outcome was the development of a set of guidelines for fellowship training, which has been published.[28] A second outcome of this effort was the creation of the Pediatric Scientist Development Program (PSDP) and the Annual Frontiers in Science Program. The former provides fellowship funding for beginning physician scientists to complete the research component of

TABLE 8. NIH Research Project Support to Academic Clinical Departments Update of Stiehm (1996)[25]

Department	FY 1983[25]*†	FY 1993[25]*†	% Increase[25] FY 1983–FY 1993	FY 1996*†	% Increase FY 1993–FY 1996 (%)
Anesthesiology	69* (.5%)†	128 (1.0%)	85%	151 (.9%)	18
Dermatology	76 (.5%)	90 (.7%)	18%	121 (.7%)	34
Family practice	22 (.2%)	22 (.2%)	0	53 (.3%)	141
Medicine	2040 (14.2%)	2740 (21.8%)	42%	38 998 (23.9%)	42
Neurology	190 (1.3%)	330 (2.6%)	95%	501 (3.1%)	52
Obstetrics/gynecology	169 (1.2%)	173 (1.4%)	2%	252 (1.5%)	46
Ophthalmology	332 (2.3%)	284 (2.3%)	−14%	437 (2.7%)	54
Orthopedic surgery	49 (.3%)	58 (.5%)	—	78 (.5%)	34
Otolaryngology	48 (.3%)	71 (.6%)	47%	127 (.8%)	79
Pediatrics	390 (2.7%)	608 (5.0%)	56%	875 (5.4%)	44
Psychiatry	111 (.8%)	746 (5.9%)	680%	1202 (7.4%)	61
Radiology	261 (1.8%)	332 (2.6%)	27%	395 (2.4%)	19
Surgery	384 (2.7%)	515 (4.1%)	52%	643 (3.9%)	25
Total all awards	14 370	12 785	−12%	16 285	27

* The numeral preceding the parentheses indicates the number of grants; †, the number in the parentheses (%) indicates the percent of grants throughout the table.

TABLE 9. NIH Awards to Departments of Pediatrics Update of Stiehm (1996)[25]

Number of Awards	1993 Number of Departments[25]	FY 1996 Number of Departments
70 or more	1	0
31–69	1	6
26–30	4	4
21–25	3	8
16–20	6	3
11–15	11	11
6–10	15	15
4–5	13	15
1–3	29	29
0	43	35
Total awards	775	875

TABLE 10. Constant Dollar Change in Research Grants From FY 1985 to FY 1994

Institute	Change in Millions	Percent Change
NIAID	$209	82
NIMH	$160	120
NIDA	$158	301
NIA	$121	124
NCI	$116	16
NIGMS	$103	25
NIAAA	$ 56	149
NIEHS	$ 48	70
NIDDK	$ 46	14
NICHD	$ 36	16
NHLBI	$ 34	6
NINDS	$ 32	11
NIAMS	$ 30	33
NEI	$ 19	13
NIDR	$ 13	20
NCRR	−$100	−33

See Table 6 for abbreviation definitions.

their fellowship with involvement of a steering committee in a leading research program whose research program ranges from bench to outcome. The latter program, whose goal is to increase interest in academic medicine, supports attendance at a meeting immediately preceding the annual meeting of AMSPDC of pediatric residents selected by department chairs to a yearly 2-day meeting during which presentations by PSDP trainees and leading research scientists occur. Individuals participating in both programs have been tracked. Those completing the PSDP program have been highly successful in obtaining external funding, while a significant fraction of those attending the Frontiers meeting have pursued academic careers. Finally, the increasing complexity, together with a greater span of activities of many specialties, some of which require the development of procedural skills as well as the increasing breadth of research activities, has led some to question the rigidity of subboard requirements, particularly the research requirement, and suggest more recognition of individual ability and preference.[29]

Current training programs include the 19 Child Health Research Centers for junior pediatric faculty, courses such as the National Institutes of Child Health and Human Development (NICHD) perinatal course in research for neonatologists and private foundation supported programs for fellows and junior faculty members. The American Pediatric Society/Society for Pediatric Research (APS/SPR) sponsors workshops on grants, manuscripts, abstracts, and presentations at scientific meetings for fellows and junior faculty. APS/SPR also supports summer research experiences in departments of pediatrics for medical students. The PSDP supports research fellowship training for pediatricians.

Increased research emphasis on childhood diseases and normal development will occur. The AAP and NICHD convened a workshop on June 18 to 19, 1996 on the Inclusion of Children in Research. The rationale for this conference was similar to that which led to requirements for inclusion of women and minorities in NIH research—medical treatments applied to children are often based on testing performed only on adults and scientifically proven treatments are less available to children because of barriers to their inclusion in research. The NICHD Advisory Council endorsed the conclusions of the workshop at its September 19 to 20, 1996 meeting and forwarded them as recommendations to the NIH Director. Beginning in October 1998, NIH research applications were required to include the pediatric population wherever appropriate.

Financial Issues

Support of Trainees

Residency training positions have traditionally been supported by hospitals funds, whereas support for subspecialty fellowships has been obtained from multiple sources. They include practice plans, hospital funds, foundations, and government-supported grants. Over the years, only 12% of pediatric subspecialty fellowship training has been funded by the NIH. Whereas the level of funding has remained constant, the value in absolute dollars has dropped. The majority of support comes from clinical dollars with scant and variable funding from hospital sources. Recent changes in support for graduate medical education (GME) have markedly reduced support for training beyond the core years of primary training. This change, which is aimed primarily at decreasing the number of adult subspecialists, has simultaneously reduced support for training pediatric subspecialists. The total number of NIH training grants held by pediatric departments is 157. More than one training grant is held by only 27 departments; 13 had more than 3; and 7 had more than 5.

Faculty Support

Financial support for faculty involved in education is derived from medical schools, hospitals, foundation and governmental agencies, and practice-generated revenues. Medical student tuition provides <5% of medical school costs. Increasingly, medical school faculty support has been obtained by practice plan-generated dollars. Hospital support of faculty, which during the 1980s increased significantly, has stabilized and/or is currently decreasing because of government or third-party reductions. HMOs have traditionally not paid for education. Since 1978, practice plan-generated dollars have supported an increasing fraction of medical school faculty and teaching staffs of COTH. There has been a cross-subsidization of teaching and research time by practice revenues. It has been estimated that practice-generated income, which supports the teaching and research missions of Academic Health Center, exceeds 2 billion dollars annually. Debate continues over how best to account for teaching time when faculty provides oversight to many learners while providing direct or indirect patient care. Noteworthy, the NIH over the past few years has instituted both intramural and extramural programs of loan reimbursement up to $35 000 per year. While exciting, this program is not yet available to junior pediatric faculty.

Significant reductions in support for medical education as well as support for clinical services have led to a large number of academic health centers experiencing financial losses and challenges previously not experienced. A few health care systems have filed for bankruptcy, while a number of others are faced with making severe reduction in personnel and programs.

Reimbursement for Clinical Services

Multiple methods of reimbursement for professional services exist. They include fee-for-service, discounted fee-for-service, and multiple capitated schemes. Increasingly, traditional fee-for-service payment is being replaced by managed care approaches, including preferred provider organizations and HMOs. Although reimbursement paid by many third-party payers for more complex care is based on Resource-Based Relative Value Scale (RBRVS), the RBRVS system, which is based on adult health care, does not place appropriate value on the amount of time and effort required in the intense care of complex pediatric patients. Moreover, these codes were not created to deal with the inherent inefficiency of caring for neonates, infants, and young children, where developmental factors, such as fear of pain, the requirement for sedation before performing procedures, and the inability to communicate easily and directly with patients dictate an approach entirely different from that involved when caring for adult patients. Despite attempts by a number of pediatric groups to modify the RBRVS system, there has been only a limited degree of acceptance.

An additional challenge to the financial stability of many pediatric subspecialty programs stems from competition for care of the patient with less acute or complex conditions. It is reimbursement for these patients that is best matched for effort and real costs. Therefore, many pediatric subspecialists cross-subsidize the care of complex problems with reimbursement from less complex care. As these patients are increasingly managed by generalists or internal medicine subspecialists, support for pediatric subspecialty programs is being destabilized. Unless there is reimbursement for the true costs of care for complex and serious problems, the pediatric subspecialist is at risk for losing sufficient income to provide services for children with special health care needs.

Clearly, children with special health care needs are known to require more resources than are presently available. Data derived from the state of Washington Medicaid database demonstrate that the average cost per year is in the range of 3 to 4 times higher.[30] Yet, it is possible systems that provide uninterrupted long-term care for children can offer the possibility of reducing costs.

There exist only a few studies comparing costs of services provided by pediatric subspecialists with those of other providers. When the costs of evaluating a child with a murmur were compared with the pediatric generalist, the pediatric cardiologist saved 33%. Moreover, direct and/or self-referral to subspecialists may be less expensive and more efficient than the more traditional gatekeeper model.[31] As well, hospital stays tend to be shorter when pediatric subspecialists are directly involved in the management of children.[32]

The federal government has provided financing for health care to fill those gaps not well-covered by voluntary, primarily employment-related systems. Government has provided both age-related (Medicare and Medicaid) and disease-specific financing (end-stage renal disease). Medicare is nationally funded and, therefore, is uniform throughout the United States, whereas Medicaid depends on both federal and state funding and is operated on a state-

by-state basis. Most states have financing programs for children with special health care needs. A recent review of the Medicaid program again pointed out the major differences in reimbursement for health care services between Medicare and Medicaid.[33] The fraction of total expenditures to professional fees between the 2 systems differs by nearly fourfold (5.9% Medicaid, 25%–40% Medicare). In 1993 when data were last available, Medicaid reimbursement to physicians was 73% of Medicare payments and 47% of private fees. Because of the relatively large number of children receiving clinical services supported either by Medicaid or state-based programs for children with special health care needs, pediatric subspecialists have been disproportionately underreimbursed for their efforts. To the extent professional fees for such services are used to support the academic mission of pediatric departments, the financing of the academic mission in comparison to other clinical departments has been compromised.

A large amount of time is spent by pediatric subspecialists in providing informal and telephone consultation. Most subspecialists currently receive no compensation for these activities. It is not known how much similar advice is given by internal medicine providers. It is known that many lawyers charge for telephone consultation but that concept has not found acceptance in American medicine and is not generally reimbursed by our current fee-for-service or capitated systems. Noteworthy, the *1999 American Medical Association Current Procedural Terminology* code book contains codes for telephone consultation.

FUTURE TRENDS

Impact of New Technologies, New Biology, and New Specialties on Pediatric Subspecialty Care

Molecular genetics and molecular biology will continue to have a major and increasing impact on the practice of medicine. Subspecialists in a broad range of disciplines will feel the influence of advances in molecular biology. This information is having effects well beyond the specialty of genetics and is influencing the way all physicians approach their patients. Therefore, in addition to training subspecialists who will be able to incorporate the new biology into their various areas of medical diagnosis and management, it will be necessary to have a high level of understanding among the generalists in order for them to answer the questions of their patients related to these advancements. To meet this basic requirement for advanced literacy in molecular biology, medical schools, residency and fellowship training programs, and CME for pediatricians must update their knowledge in these areas.

The specialty of genetics is at the epicenter of these developments. Many of the dysmorphic syndromes are recognized to represent "inborn errors of development," a recognition that has spawned the new field of molecular dysmorphology. Because of the rapid advances in genetics, physicians require a constant updating of diagnostic information. The field of biomedical informatics is assisting us in this information explosion and computerized databases must become more accessible to both pediatric subspecialists and generalists. The goal of molecular diagnostic testing is not simply to arrive at a diagnosis but to improve the quality of life for the individual patient. Many adult disorders are genetically determined and have their origin during the childhood years. Physician and nonphysician counselors who are able to translate this basic science information are needed to counsel so as to change behaviors. For example, new advances in our understanding of obesity, heart disease, and cancer indicate the need for the ability to intervene in a sociobehavioral fashion. On the horizon looms a genetic understanding of risk for association disorders including behavioral psychological abnormalities.

Gene therapy will have a broader effect outside of genetics, as in the area of oncology. It will become necessary for the subspecialists in other areas to have a thorough understanding of molecular biology as it applies to this new treatment modality. Generalists must be able to provide the translation of this technology for the family.

Infectious disease is likely to see the most broad reaching influence of molecular biology on the daily practice of general pediatrics. The speed and sensitivity of the polymerase chain reaction is already beginning to transform our approach to the diagnosis of *Mycobacterium tuberculosis* from a culture-based technology to one that relies on DNA analysis, because DNA-based approaches take a matter of hours to days and have specificity equal to routine microbiologic analysis with improved sensitivity. Methods under development are likely to convert current diagnostic algorithms such as the routine approach to the infant with rule-out sepsis, to a molecular biological strategy.

Neurosciences

The developments in neuroscience and market forces are changing the nature of the delivery system for a variety of pediatric neurologic, psychiatric, behavioral, and developmental problems. Molecular medicine and newer imaging modalities, eg, positron emission tomography, functional magnetic resonance imaging, etc, are currently assisting investigators in these areas to further understand the nature of many neuropsychiatric disorders and to develop improved therapies. Closer collaboration with pediatrics is required to identify children at risk and to offer earlier diagnosis and treatment. Some of the subspecialty characteristics may change, some may grow in influence, and some may recede as the scientific and clinical rationale change for the discipline. Greater collaboration with mixed functional teams, including a generalist pediatrician, will likely be the rule. The increasing emphasis on behavioral disorders and the use of psychopharmaceuticals in children support the need for additional child psychiatrists to become involved in the education of pediatricians.

Outcomes Research

The development and application of an ever increasing number of studies related to outcomes mea-

surements regarding quality of care, cost, choice of diagnostic tests and therapies, choice of procedures, and patient satisfaction has occurred. Particularly important in pediatrics is the application of large multicentered trials. Outcome studies involve the gathering of large amounts of patient-specific data, their storage, and subsequent analyses. Results can alter the manner by which medicine is organized and practiced. On-line feedback to practitioners by providing instant analysis of their practice patterns offers significant opportunities and potential to achieve needed outcomes related to CME and continuous quality improvement.

Quality of care remains difficult to measure because of the complexity of disease, number of comorbidities, and the long period of time in which the outcomes are manifested. Particularly difficult to measure is the impact of socioeconomic factors and the severity of illness. Few studies compare patient care delivery by pediatric versus nonpediatric subspecialist. Studies show that the survival rate of children and adolescents with acute lymphocytic leukemia, Wilms' tumor, medulloblastoma, and rhabdomyosarcoma experience is significantly greater when treated according to pediatric oncologic study group protocols in specialized tertiary children's centers, compared with children treated outside and not enrolled on protocol.[34] Thus, outcome may depend on access and most probably the application of clinical experience in making appropriate early diagnoses as well as recognizing and managing therapeutic complications in children of varying age. Similar outcomes have been demonstrated in other countries. As protocols to deliver care continue to evolve, pediatric subspecialists should assume the responsibilities for their development and evaluation. The knowledge base for assessing the impact on children's health of changing delivery systems and health care utilization is considerably less developed than that currently utilized in adults.[35] Examples include the debate over the timing of hospital discharge for newborns and the limited number and types of measures used in the Health Plan Employer Data and Information Set. Only 4 of the 21 quality, access, and utilization indicators are child-specific. The limited supply of child health researchers may reflect unstable funding for education and sustained support in this area.

In summary, biology and medicine are changing rapidly. The new biology will have huge impact and offers opportunities to significantly improve our quality of life. It is necessary to prepare our students and trainees while enabling our current practitioners to face the vocabulary, principles, and practice of this technological revolution. Clinicians will play a central role in the development of this new knowledge and its translation to individuals who can benefit from these advancements. Subspecialists in a broad range of disciplines will feel the influence of advances in molecular biology. As we are already seeing, this information is having effects well beyond the specialty of genetics and is influencing the way all physicians approach their patients.

Future Scope of Activity

Pediatric subspecialists will continue to function in a wide variety of roles and appropriate reimbursement for these activities must be provided. These roles include direct patient services, research, and education. A significant number of pediatric subspecialists will also need to be involved in administration, management, public health programs, government agencies such as the NIH, Centers for Disease Control and Prevention, military, international agencies, and foundations. Pediatric subspecialists should function as team leaders in establishing patient care protocols and providing oversight for monitoring outcomes.

The pediatric generalists should be involved with the care of more complex patients to the degree that they have the appropriate level of skills. At the request of the pediatric generalist, some subspecialists should provide comprehensive services for children with chronic disease such as organ transplant, cystic fibrosis, and end-stage renal disease. Pediatric subspecialists should also continue to function as consultants and provide, when appropriate, ongoing input to nonpediatric specialists and for large multispecialty groups.

Because pediatric subspecialty care provides important care for children with chronic disease, efforts at regionalization and involvement of pediatric generalists should be strengthened. Information and consequent care is better in centers where ideas can be exchanged. The concept of "Centers of Excellence" should be expanded.

Another issue relates to the amount of experience necessary to maintain competence. It is necessary those performing procedures meet performance criteria. Exposure on a regular basis to exchange of ideas and self-learning experiences is necessary to maintain cognitive skills. This can best be achieved when subspecialists work within or as a part of a network.

Given the experience of the past few decades, it is reasonable to expand the role of the generalist in evaluating and treating a segment of the current clinical workload of subspecialists. The use of diagnostic and management protocols, implemented and monitored widely, can improve access to quality care in less populated regions and improve the efficiency of care delivery. Clear guidelines for referral to pediatric subspecialists should be developed for problem categories. Telecommunications technology should facilitate interactions between subspecialists and generalists and other members of the patient care team as well as provide important case-based CME to support the expanded generalist role.

Future Location of Activity

It is widely appreciated that individuals who perform significant numbers of procedures are likely to have better outcomes. It is also recognized that different sets of skills are needed to perform procedures in patients of differing ages and that it requires a longer total time and more personnel to carry out procedures in younger children. The increasing

number of trainees in procedural specialties as well as the increased numbers of procedures by nonpediatric subspecialists may reduce the level of skill currently available to children. These considerations lead to the conclusion that the number of sites where such procedures are performed should be regionalized. Pediatric programs should be integrated, whenever possible, with the aim of reducing equipment and program costs. The numbers of procedures necessary to qualify for approval should be rationalized by a data-driven process. Standards should be set at the national level and nonpediatric specialists performing these procedures should be required to meet them. Parents should be informed of such standards. Particularly important are issues of sedation, anesthesia, and surgical procedures. The availability of other pediatric specialists working within the same system is desired to meet all diagnosis and treatment requirements and to enhance positive outcomes from both a clinical and cost-containment perspective.

It is known that there is a greater likelihood of an enhanced educational experience when a critical mass exists. Moreover, the stimulation of a minimal number of individuals working within the same area of research is more likely to result in an enhanced outcome. Groups of individuals based in the same facility are most likely to accomplish these tasks.

Clinical pediatrics is also becoming more technologically intense and such technology offers great promise in improving access to knowledge for those located long distances from centers of excellence, the ability to transfer clinical information in real time to both generalists and subspecialists and to incorporate single case management into databases containing many cases at remote sites. Investments in telemedicine will require integration of resources beyond those of the department of pediatrics and the academic health center. Such centers should also serve as the source of continuing education and patient care coordination for generalists.

Each subspecialty needs to develop expertise in outcomes research to demonstrate the added value of that specialty. Efforts aimed at improving care while avoiding unnecessary expense need to become a core value of each subspecialty.

There is increasing discussion, documentation, and even malpractice litigation addressing the limitation of referral of children to pediatric subspecialists. Some managed care organizations are increasingly referring children to nonpediatric specialists employed by or contracted by these organizations even in urban areas. Patient accessibility to pediatric subspecialists should be available to all children and families.

In summary, the progressive increase in the number of individuals working for different organizations and caring for a limited number of ill children in diverse locations may limit or even reverse the expertise currently provided by pediatric subspecialists.

Future Educational Issues

Because of the unpredictability of future directions in the organization of patient care programs, research, and education, it is imperative that the core education of pediatric subspecialists be broad in scope, enable trainees to develop the necessary clinical and technologic skills to meet the needs of children, enable physicians to apply new information, and enable physicians to provide appropriate leadership for programs to meet these missions. Consequently, the training of pediatric subspecialists should not be limited in scope. Flexibility in training opportunities that allow individuals to develop their particular interests should be a significant component of all fellowships. All fellowships should include activities that encourage lifelong learning.

Subspecialists need to be educated in practice management, managed care, be able to demonstrate clinical excellence, collecting data for purposes of continuous improvement, demonstrate ability to provide services using practice guidelines and critical pathways, and be able to share care with generalists and to understand the principles of patient care satisfaction. Other factors include response time and effective, efficient communication, management of children with special health care needs, and use of preventative care.

Pediatric specialists need training in both inpatient and ambulatory settings. The increasing shift of care to ambulatory settings requires that curricula be developed to ensure that trainees have adequate exposure to the natural history of disease and have opportunities to experience the complexity of psychosocial and financial issues that confront families and children who have chronic disease. The curriculum needs to include training in team leadership, consultative liaison, outcome monitoring, and use of various forms of telecommunication. Subspecialty training needs to include the development of knowledge related to cost-containment and resource utilization and evidence-based clinical decision-making.

Academic medical centers, which have been the traditional resource for the training of pediatric subspecialists, should remain the principle site of pediatric subspecialty training. Unless the organization of health care continues the referral of sufficient numbers of patients to pediatric subspecialists, the ability to provide structured teaching experiences will diminish. To ensure an appropriate breadth and depth of clinical experiences, elements of teaching pediatric subspecialists should be shared interdepartmentally and intradepartmentally with subspecialty full-time practitioners. Academic medical centers have spent the last few decades developing the expertise and resources to offer meaningful training. Duplication of facilities and faculty is expensive and offers no material advantage. As subspecialists have pursued clinical practices in sites away from those institutions providing most subspecialty training, they have become involved in caring for a large number of subspecialty patients. Many have developed and use the principles involved in managed care and should be encouraged to participate in providing critical clinical experiences for fellows.

Fellowship training should include structured, supervised, and evaluated opportunities and experiences in patient care, teaching, and research. Suffi-

cient time should be available to allow trainees to pursue individually determined interests. The level of training must result in fellows being able to provide direct patient care, consultative services, skills as educators, and should include experiences that allow them to serve as future educators for any level of physician. The core years of fellowship training should be viewed as providing the necessary elements for each subspecialty.

Fellowship training should include continued exposure to issues considered primarily generalist in nature, based on a thorough general pediatrics foundation. In a survey of AAP sections, subspecialists believed that more generalist training than the present 3-year requirement was not needed.

Research experiences should include opportunities to gain knowledge in depth and will require either additional fellowship training or junior faculty positions to obtain competitive funding and promotion. Currently it takes such an extensive period of time to become grant competitive and consideration should be given to lengthening the duration of structured training. This might be accomplished by beginning training after 2 core years or developing the initial few years of faculty appointment as extended years of protected research time.

Recognizing substantive involvement in patient care remains the foundation of clinical education; new modalities capable of assisting in patient care and education continue to evolve. This technology has the potential to offer education experiences. Examples include telemedicine, self-instructional interactive computer-based software, and medical information systems. Online methodology offers immediate feedback. Subspecialists will need training, so they will be able to obtain the latest information, to answer more sophisticated questions, to quickly analyze recent reports, and to interpret them to patients and families.

In summary, the education of the future pediatric subspecialists needs to provide a broad foundation in direct patient care skills and the development of research, the latter being sufficiently intense to permit fellows to be grant competitive after sponsored mentorship. The long-term successful pediatric subspecialist, especially those pursuing academic careers, will also require specific training experiences in teaching methodology, child advocacy, program design, financing, management, and learning the skills to coordinate care by working with generalists.

Future Research Issues

The future of research into the cause, treatment, and prevention of childhood diseases is best invested in those who devote their clinical effort to the care of children. This will require adequate numbers of pediatric subspecialists to be trained and given the opportunity to work within a system as a physician–scientist. In addition to the costs of developing the personnel who will be the subspecialists of the future, there are also the costs of the infrastructure for research and clinical practice. The technological changes that have occurred since FOPE I have been profound, and many of the most fundamental innovations (eg, fax and e-mail) were unanticipated. Success in the future will require the flexibility to incorporate new technologies.

The number of pediatrician–scientists should be increased through targeted recruitment, specially designed training programs, loan repayment, and augmented early faculty research support.

Pediatric scientists must be equipped to compete effectively for grant support. Fundamental to these investigations are various types of digital imaging technology and the ability to transfer images among investigators. Access to and manipulation of databases (eg, image catalogues, sequence libraries, and clinical databases) will also be required. Clinical departments of pediatrics will need information system groups that effectively support their office and business needs. However, the pediatric clinician scientists also require the same access and support to the networks shared by their colleagues in the basic science departments at their institutions.

One mechanism is to integrate pediatrician scientists with their basic science colleagues but it will be important for the pediatrician scientist to interact with other pediatricians. Such interactions permit dialogue to be driven by clinical questions. The presence of a critical mass of physician–scientists in a department of pediatrics is a necessary educational environment for medical students, residents, and fellows. Such an environment will attract, stimulate, and educate trainees. Both academic-bound and practice-bound trainees will need to be knowledgeable with current and future advances.

Each subspecialty should seek to provide training that can meet needs related to basic science, preventive medicine, translational research, and outcomes research. Each subspecialty requires programs that address the gamut of current research needs and have the resources available to incorporate new tools. The movement of patient care away from centers of excellence will require new collaborative approaches to accomplish clinical trials and outcomes research.

To contain costs, training programs should seek and develop programs using facilities and personnel within their parent and institution-based department. Training programs should share teaching and research facilities with other departments and similar training programs located in other medical schools. National subspecialty organizations should develop educational programs directed toward the training of future subspecialists.

Collaborative research efforts between institutions need to increase to address the need to study diseases that affect small numbers of children, to obtain normative data and idiosyncratic local population characteristics. Increased efforts to define common clinical descriptors together with appropriate centralized databases are essential.

In summary, each subspecialty should review training criteria and make recommendations for change that will enhance the ability of future subspecialists to obtain ongoing funding for their investigative programs. Processes that continuously monitor available positions should be put in place and train-

ing programs limited in their number to meet projected needs. Also, training programs will have to operate within available and projected funding levels and conduct the various forms of research necessary to allow the specialty to continue to contribute to the health and welfare of children.

Future Work Force

The fact that the number of first-time physician–scientist applicants to the NIH has fallen by 31% between 1994 to 1997 raises serious concerns about the future of this group of investigators.[36] The number of MDs applying for Howard Hughes Fellowships has fallen by 57% from 1996 to 1998. Finally, the number of medical students expressing a strong interest in pursuing a research career has fallen from 14% to 10% between 1989 and 1996. These numbers suggest that the physician–scientist is an endangered species at risk of becoming extinct. The need to reverse this trend is critical, if the potential of the recent advances in medical research is continued to be applied to the needs of children.

Because the training of pediatric specialists is costly, the number of trainees should be matched to need and the availability of meaningful jobs. The workforce need for pediatric subspecialists should be reviewed routinely. Various national pediatric subspecialty societies might work together to track and develop workforce databases. Workforce recommendations are more likely to be accepted if there is outside input from purchasers of health care institutions, governmental agencies, etc.

Future Financial Issues

The education of future pediatric specialists should be viewed as a public good and needs to be addressed as a component funding for the multiple missions of academic medical centers. Mission-based financing offers the greatest probability of separating and clarifying the costs of service, education, and research.

Changing market forces are expected to lower the income of pediatric subspecialists and to progressively limit their ability to subsidize the academic missions of education and research. These trends are likely to increase as more subspecialists enter the job market. Current projections by some groups of health care planners and economists suggest that compensation for multiple specialists might fall by 25% to 30% over the next decade. This will severely limit the ability of departments of pediatrics to subsidize nonprocedural subspecialties and to protect time for research and education.

The increasing debt burden of physicians limits the capacity of some to obtain pediatric subspecialty training or for others to sustain research-oriented careers after subspecialty training has been completed. Loans, which are deferred for the early years of training, are likely to come due either during fellowship training or during the early faculty years. This may lead promising faculty to leave research careers. It is possible that salaries may fall because of increased competition. Assuming such a scenario and the continued level of debt, it will make it even more difficult for young physicians to pursue academic careers.

GENDER AND DIVERSITY ISSUES

Because background and experience influence the site of practice and the nature of research pursued, there exists a need to work toward a pediatric subspecialty workforce that is reflective of the gender and cultural diversity of the public that is served. The past decade has been associated with an increase in the number of women in pediatrics, including those in leadership positions. Although women have reached a simple majority among recent graduates from pediatric residency programs, they continue to be a minority among subspecialty trainees, especially in procedurally oriented subspecialties. This phenomenon is most evident among international medical graduates. Some subspecialties, such as adolescent medicine, have a large representation of women. It is quite possible that women are making a positive choice for careers that offer time control, but other factors that discourage them from choosing a subspecialty career (lack of role models and debt burden) have not been eliminated. Current challenges related to gender include levels of salary, academic advancement, the pressures of raising a family, and dual-career families. Part-time fellowships might offer additional women physicians the opportunity to obtain pediatric subspecialty training. Many female physicians do not work full-time, and consideration should be given to their desire to function as physicians (for example, part-time faculty positions, deferment of tenure, etc). Other important needs are well- and sick-child care and assistance with job searches for spouses. Approximately 50% of female physicians are married to physicians. Most universities and hospitals offer, at best, limited help with these issues.

The ability of women with children to attend professional meetings and conferences is often limited because of the inability to meet the costs of child care while attending meetings and the inability to take their families with them to meetings, which makes planning difficult.

The need to train additional minorities in pediatric subspecialties is supported by the observation that minority physicians are more likely to provide services to minorities. Based on the growth rate of minorities in the United States between 1980 and 1995, it is projected that by the middle of the 21st century, the majority of the US population will be members of minority groups.[37] This underscores the importance of attracting minority physicians to pediatric subspecialty careers. Minority research and career development awards are an important step in this direction. Early involvement of minority undergraduates and medical students in research must also be advanced.

CONCLUSIONS

Since the report of the first Task Force, rapid changes in the development of new knowledge have led to increased survival of children with acute, chronic, and complex health problems. The resulting increase in pediatric subspecialty workload and mar-

ket demand has led to a modest increase in the US workforce. The number of clinical subspecialists is roughly in balance, and, in some cases, at risk for exceeding resources for support.

A limited number of workforce studies suggest that saturation of funded academic positions has been or will shortly be reached in some of the procedurally oriented subspecialties. In some subspecialties, however, there is insufficient workforce to provide needed clinical and educational service. The career track in most serious undersupply is the pediatrician–scientist. The underlying reasons for this shortfall include: reduced cross-subsidization from clinical funds to provide protected time for research development, debt burden of US medical graduates, inadequate numbers of research mentors, and, in some part, selection of pediatric residents who are interested in community-based clinical careers. At the same time, there is greater competition for research funding, greater administrative and clinical burdens on academic faculty, and resulting deterioration in faculty morale and lessened opportunity for intellectual cross-fertilization.

IMGs form a substantial proportion of pediatric subspecialties, especially in research tracks. The planned restriction of residency positions of IMGs will dramatically worsen the shortfall in several subspecialties and in basic scientists in general. Additional factors that might significantly impact subspecialty workforce needs over the next decade include the number of women entering pediatrics and their desire to reduce their time commitment during childbearing years; the length of the work week for both sexes; and job satisfaction, security, and financial solvency of academic institutions. Meeting these challenges will require new strategies for developing GME policies, delivering clinical service, financing research, and recruiting and educating trainees.

Clinical Care

The pediatric subspecialist should be the most extensively trained and experienced provider to deliver comprehensive care to children with severe and complex disorders. It follows that all children should have direct access to pediatric subspecialists. The medical home for children with special health care needs should be with a general pediatrician in concert with a pediatric subspecialist. In some circumstances, a pediatric subspecialist may provide comprehensive care and a medical home. Nonpediatricians who provide care for children with life-threatening and chronic disease should be formally linked to a pediatric subspecialist and should be held to the same standard as pediatric subspecialists. The added value provided by pediatric subspecialists should be supported by scientific study, and informational materials should detail for families, other health care providers, and purchasers of care the expertise provided by that subspecialty.

Subspecialists should assume the responsibility for educating generalist trainees in the diagnosis and management of diseases traditionally in the subspecialty domain to better prepare the generalist of the future for the management of lower acuity diseases and for interaction in the management of the more severe clinical problems. University pediatric departments and children's hospitals should move toward the development of integrated service delivery systems that provide telemedicine and consultative services over long distances to facilitate the interaction of pediatric subspecialists and generalists, and so provide convenient as well as high-quality patient care.

Education

The core period of fellowship training should be a minimum of 3 years, with sufficient time to master core competencies, develop technical skills, and gain a foundation of research experience on which to build a successful academic career. Protected time for developing a research career will be needed for the early faculty years to compete successfully for external funding. Some generalists may wish to obtain clinical training in a subspecialty area and may serve an extremely important role in health care delivery to a specific population. These individuals should be considered specialists in pediatrics and should work with pediatric subspecialists within an integrated system.

Fellowship training should be limited to centers of educational excellence that can provide core scientific teaching and access to the required patient volume for trainees to develop a full range of cognitive and technical proficiencies as well as access to funded investigators who can serve as research mentors. Educational centers should have an established record of faculty and fellow publication and a track record of training successful academicians.

Financial support for the education of pediatric subspecialists should be derived from all payers. To eliminate the cost of education from that of service delivery, the government, health care insurers, and institutions providing patient care should develop a clearly defined mechanism of supporting the true costs of education.

Research

The pediatric subspecialist should be the individual best prepared and qualified to design and conduct basic science research, to translate its results to children, and to evaluate outcomes related to the prevention, cause, and cure of pediatric disease as well as normal developmental processes. An increased number of competitive investigators are needed in pediatric medicine, to ensure that the potential of molecular and genetic research to improve health care for children will be realized. Also, increased numbers of investigators schooled in the principles of outcomes research are needed to continuously improve the multiple components of health care delivery for children.

In general, the number of research-funded pediatrician–scientists is critically low and remedies to increase their number should be implemented as rapidly as possible. Potential remedies include: a federal loan repayment program, specially designed research training tracks for some individuals, enhanced recruitment of scientists into pediatric train-

ing, and eliminating barriers for qualified IMGs to enter research programs in the pediatric subspecialties. Greater flexibility in residency programs would allow residents with a bench research background to maintain some continuity of experience throughout their training.

Subspecialty fellows should have at least 80% time protected during research rotations. Continued protected time during early faculty years is required to successfully compete for external support. To be competitive for external funding, investigators will need to devote at least 75% effort to research activities.

Clinical research should be fostered by the establishment of national databases to study complex childhood diseases. The number of child health research centers should be expanded beyond the current 19, and the duration should be increased beyond the two 5-year cycles or 10-year funding limit. Greater flexibility within residency training programs is needed to enable a resident with clinical research interests to earn a masters degree in public health or public policy.

Workforce

The critical mass of subspecialists required for research and teaching can and should be quantified and used as a rationale for determining the number and type of fellowship positions, while the number of pediatric subspecialists needed for clinical service should be market-driven. It is recommended that oversight for subspecialty workforce be vested in the Federation of Pediatric Organizations and actively vetted by its executive director. This individual should use appropriate resources of the member organizations to track the output of fellowship programs, monitor needs, develop policy, and to report to pediatric and public organizations interested in the welfare of children.

Programs that address gender differences are needed to fully integrate the increasing numbers of women into all of the programmatic areas of pediatric subspecialty by providing greater flexibility in training and in university tenure and promotion policy. Planning for scientific meetings should be organized in a manner that facilitates attendance of all. Convenient and reliable programs of well- and sick-child care should be developed. Conference times should be scheduled in a manner that allows individuals reasonable time for family responsibilities.

Finances

The concept of mission-based financing should be implemented by proper valuation and reimbursement for pediatric subspecialty services. Frequency, complexity, and resource needs differ widely between pediatric and adult diseases, yet reimbursement for child health care is based on the Medicare standard for older adults. Specific strategies for financing child health care are essential. Reimbursement programs should cover direct and indirect patient care, including distance management, quality of care oversight, and protocol development.

Summary

The role of the pediatric subspecialist is the delivery of complex and technically expert care to children with severe, complex, or chronic health problems; the provision of new knowledge in the genesis and treatment of pediatric and adult disorders; and the education of generalists, adult subspecialists, and nonphysician providers. The fully trained subspecialist requires at least 3 years of fellowship training in a center of educational excellence, followed by an extended protected research time and mentoring as young faculty. Because of a serious shortage of pediatrician–investigators, aggressive action must be taken to facilitate recruitment, remove obstructions to academic career tracks, and to organize academic resources for maximum effectiveness.

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