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The APA and the Rise of Pediatric Generalist Network Research

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Abstract

The Academic Pediatric Association (APA – formerly the Ambulatory Pediatric Association) first encouraged multi-institutional collaborative research among its members over thirty years ago. Individual APA members went on subsequently to figure prominently in establishing formal research networks. These enduring collaborations have been established to conduct investigations in a variety of generalist contexts. At present, four generalist networks – Pediatric Research in Office Settings (PROS), the Pediatric Emergency Care Applied Network (PECARN), the CONTinuity Research NETwork (CORNET), and Pediatric Research in Inpatient Settings (PRIS) – have a track record of extensive achievement in generating new knowledge aimed at improving the health and health care of children. This review details the history, accomplishments, and future directions of these networks and summarizes the common themes, strengths, challenges and opportunities inherent in pediatric generalist network research.

Introduction

Researchers typically work at single institutions, and the patients available to them as research subjects may be either too few in number or insufficiently representative to address certain scientific questions. In recognition of this fact, the APA (formerly the Ambulatory Pediatric Association – now the Academic Pediatric Association) began in the late 1970s to encourage ad hoc multi-institutional collaborative research among its members.^{1, 2} Over time, many APA members became prominently involved in establishing more enduring

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collaborations – formal research networks designed to conduct studies in a variety of generalist contexts, including primary care sites, emergency departments, and hospital inpatient units. The founders of these collaborations recognized that, apart from the enhanced numbers of subjects and increased generalizability afforded by networks, clinicians might be more likely to adhere to guidelines based on research results that they themselves had generated from their own settings. In this sense, the establishment of research networks anticipated the modern emphasis on translation of evidence into practice.

Both as an organization, and through its members, the APA has been a leader in the multi-institutional collaborations known as research networks. The objective of this review is to track and highlight the APA's history in the rise of pediatric generalist network research, drawing attention to early models for research networks, and describing the development, accomplishments, and future directions of four national generalist research networks (see Table): Pediatric Research in Office Settings (PROS), the Pediatric Emergency Care Applied Network (PECARN), the COntinuity Research NETwork (CORNET), and Pediatric Research in Inpatient Settings (PRIS). This review will conclude by summarizing the common themes, strengths, challenges and opportunities inherent in pediatric generalist network research.

Regional Practice-Based Research Networks

An early collaboration between a pediatrics department and a group of primary care practices began in Rochester, as described by Hoekelman and colleagues.³ Begun under the aegis of former APA Presidents Robert Haggerty and Evan Charney, this group, although never formally designated as a “network,” conducted landmark investigations on such topics as adherence to medication and the acceptability of pediatric nurse practitioners.^{4, 5}

The Pediatric Practice Research Group (PPRG) of Children's Memorial Hospital in Chicago was the first regional collaborative group to self-designate as a network.⁶ This highly productive group has been generating new knowledge for 25 years and has served as the model for more than a dozen successful regional networks, from Seattle to New Hampshire. Although a full discussion of these groups and their contributions is beyond the scope of this summary, it is worth citing their role as innovation engines. For example, the Puget Sound Pediatric Research Network conducted a definitive placebo controlled trial of Echinacea for upper respiratory infections.⁷ The Pediatric Research Consortium (PeRC) of Children's Hospital of Philadelphia has evaluated the effectiveness of clinical decision support for immunization in its electronic health record-based research network.⁸

National Research Networks

Pediatric oncologists^{9, 10} and rheumatologists¹¹ had formed the first national pediatric multi-institutional research networks in the 1950s and 1970s, respectively. Family physicians created the first U.S. national primary care network in the early 1980s.¹²

Pediatric Research in Office Settings (PROS)

With these national models, Drs Haggerty and Charney collaborated with another former APA President, Barbara Starfield, and other APA leaders in the creation of Pediatric Research in Office Settings (PROS). PROS is a program of the American Academy of Pediatrics (AAP). Dr Haggerty, in his capacity as AAP President in 1985, set in motion the process that created the nation's first national pediatric primary care research network. The PROS mission is to improve the health of children and enhance primary care practice by conducting national collaborative primary care research. PROS history, governance, structure, and function of have been described in detail elsewhere.^{13, 14} Of note, PROS

strives to be a practitioner-driven network, wedding the wisdom of the practitioner to scientifically sound research methods. As such, its steering committee is controlled by practicing pediatricians and new project approval depends upon a majority vote of practitioner representatives. PROS currently comprises over 1750 pediatric clinicians in more than 730 practice and clinic sites in all 50 states, the Commonwealth of Puerto Rico, and two Canadian provinces. Network practitioners care for an estimated 2.7 million children. Network research has resulted in scores of publications and presentations.¹⁵ Particular contributions of PROS research are changes in guidelines for the age of vision screening¹⁶ and referral of girls for signs of puberty.¹⁷ Findings from another PROS study¹⁸ have underlined the need for revision of guidelines for managing young febrile infants,¹⁹ with a new guideline currently under development by the AAP Clinical Practice Guideline Subcommittee on Fever in Infants Under 3 Months.

Key Strengths

The strengths of PROS include: 1) longstanding core funding from the Health Resources and Services Administration Maternal and Child Health Bureau (HRSA/MCHB) and the AAP; 2) a well-tested set of processes for selecting projects, designing protocols, and obtaining high quality data from busy clinical settings; 3) a 25 year track record of dozens of federal and foundation grants and successful collaborations with researchers from around the country; 4) the ability to capitalize on the communications infrastructure of the AAP to recruit new practices; and 5) the capacity to employ the AAP Committee, Section, and Council infrastructure to disseminate results in accordance with the PROS mission of improving child health and enhancing primary care practice.

Key Challenges

PROS faces many challenges. The network under-represents minority children,²⁰ which has prompted collaborations with networks such as CORNET, that have disproportionately large numbers of minority children.¹⁴ Other challenges include increasing financial pressures on primary care practitioners overall²¹ and a gradual decline in the number of independent self-employed private practitioners,²² who traditionally have formed the core of PROS members. The conversion of an increasing proportion of pediatric practices and clinics from paper to electronic health records (EHRs)²³ presents both a challenge and an opportunity for PROS. The challenge is that studies designed for paper record offices translate with difficulty into practices using EHRs, and the mix of paper-based and EHR-based PROS practices complicates study planning. The opportunity is the chance for PROS to create an “ePROS” subnetwork among PROS practices that employ EHRs.

Future Goals

An EHR-based network would allow for comparative effectiveness research through the extraction of routinely collected data elements, insertion of study-specific data collection, and the testing of EHR-based point-of-care clinical decision support. The Pediatric Research Consortium (PeRC) of the Children's Hospital of Philadelphia is an EHR-based network which functions using a single application of a single EHR product in 30+ practice sites. PROS recently has received funding to support creation of its own EHR-based network. However, unlike PeRC, the “ePROS” network will operate in practices using *multiple* applications of *different* EHR vendor products. PROS will likely need to evolve into “ePROS” in the coming decades of the 21st century.

Pediatric Emergency Care Applied Network (PECARN)

The need for a federally-funded, pediatric emergency care research network which could enroll a large number of diverse patients into research studies was identified after many

years of background work, discussion, and advocacy work by EMSC stakeholders, researchers, and national organizations.²⁴ The APA helped organize some of these early discussions, in two meetings in 1998-1999 regarding barriers to research in Pediatric Emergency Medicine.²⁵ During these meetings, the need for a federally funded infrastructure in which to conduct research in Emergency Medical Services for Children was emphasized. The Pediatric Emergency Care Applied Research Network (PECARN) was created in 2001 through a HRSA/MCHB Emergency Medical Services for Children (EMSC) Program request for applications. Groups of hospitals were asked to serve as “nodes” consisting of 5-6 hospital emergency department (ED) sites to be joined together into one network – PECARN (www.pecarn.org) – with a Central Data Management and Coordinating Center. The four nodes of PECARN comprise 22 EDs in ten states and the District of Columbia with the data coordinating function at the University of Utah. Together, these EDs evaluate nearly 1 million children annually, including a diverse population, with a high percentage of under-represented minority patients.²⁶ Each PECARN node has a principal investigator (PI) who holds the cooperative agreement with HRSA/MCHB/EMSC, and is responsible for the functioning of the node. Each site has a funded site PI and research coordinator, who together are responsible for the conduct and oversight of each PECARN research study. The resulting network has emerged as a potent and robust research network, with many completed and ongoing research studies covering a wide breadth of issues in EMSC.^{27, 28}

The mission of PECARN is to conduct high-priority, multi-institutional research pertaining to the prevention and management of acute illnesses and injuries in children and youth of all ages. PECARN conducts studies of pediatric acute illnesses and injuries which may be encountered in the out-of-hospital setting, in the ED, or in the pediatric critical care unit.

The implementation of this mission is guided by PECARN's bylaws, a Steering Committee with equal representation from all 4 research nodes, and a published research agenda which was created with broad representation within PECARN.²⁹ The PECARN Steering Committee, the primary governing body of PECARN, established and revises network bylaws, policies, and procedures, reviews and approves PECARN research proposals, and established and empowered PECARN subcommittees. The five subcommittees include the Protocol Review and Development Subcommittee, Safety and Regulatory Subcommittee, Quality Assurance Subcommittee, Feasibility and Budget Subcommittee, and Grant Writing and Publication Subcommittee. These subcommittees provide essential input into research design, organization and implementation, assist with the development of network policies, and facilitate the timely publication of research studies.

The PECARN Central Data Management and Coordinating Center serves PECARN in a variety of capacities, and is fundamental to the success of the network. The center provides coordination and assistance in protocol and grant development, training and education of study personnel, preparation of study manuals of operation, study management and organization, technical expertise and support, data management and analysis, and site monitoring of research studies.

Key Strengths and Successes

The key strengths of PECARN include the large number and diversity of patients available for enrollment into research studies, the highly coordinated and robust infrastructure, experienced investigators, and the great spirit of volunteerism, collaboration and collegiality among network investigators and staff. The rigorous processes for research study selection and protocol development insure studies of high quality. The result is a network which is prepared to answer the pressing clinical questions in EMSC in a definitive fashion and with wide generalizability. The utility of PECARN for answering important research questions is

evident in the substantial success of PECARN proposals in obtaining funding for network research from federal agencies such as the National Institutes of Health, the Centers for Disease Control and Prevention, and from HRSA/MCHB/EMSC. PECARN also invites investigators from outside the network to submit proposals, and if endorsed, to lead PECARN research studies. The successes, collaborations and mentoring relationships developed within PECARN have fostered continued commitment from investigators and institutions. These strengths have resulted in 12 federal grants in addition to infrastructure funding, 22 peer-reviewed publications and 65 abstracts (as of May 2010). Research topics range from out-of-hospital care to the management of trauma, acute medical illnesses, mental health issues in the ED,³⁰ 31 cardiopulmonary resuscitation,³² 33 and safety³⁴ and quality³⁵ of pediatric emergency care. Two recent PECARN studies (one a randomized controlled trial (RCT) of corticosteroid use in bronchiolitis³⁶ and the other a derivation and validation of neuroimaging prediction rule after head trauma³⁷) were published in *the New England Journal of Medicine* and *the Lancet*, respectively.

Key Challenges

PECARN also faces a set of challenges which must be overcome in order for the network to achieve its full potential. These include: 1) securing substantial funding to support large-scale multicenter trials; 2) lack of an NIH institute with a singular focus on emergency care research; 3) a substantial workload, which, despite infrastructure and research funding, greatly depends on volunteerism; 4) distributing authorships equitably, particularly to junior investigators needing promotion; 5) nurturing and mentoring the next generation of EMSC investigators and grant-writers for PECARN in a climate of limited funding for training in, and conduct of emergency care research; 6) ensuring uniform standards of conduct of research at each site; 7) coordinating IRB submissions at many independent centers; 8) ensuring sufficient in-person meeting time; and 9) ensuring development and transition of network leadership for the future success of the network, while maintaining stability and cohesion.

Future Goals

Future goals of PECARN include conduct of more interventional RCTs and comparative effectiveness research, encouragement of the transfer of network research findings to EMSC practitioners through research in knowledge translation, increasing the amount of out-of-hospital research, and development of a sustainable plan for nurturing young investigators. To these ends, we have made recent substantial progress. We are initiating two new RCTs funded through the R01 mechanism of the NIH, one a classic placebo-controlled trial of adjunctive magnesium therapy for the treatment of sickle cell pain crisis. The second is a more traditional comparative-effectiveness trial, defined as the conduct of research comparing the benefits and harms of different interventions and strategies to prevent, diagnose, treat, and monitor health conditions in “real world” settings. In this latter study, we are comparing four different fluid therapy strategies for the management of children with diabetic ketoacidosis. Most recently, we received a large grant through the American Recovery and Reinvestment Act (ARRA) of 2009 to perform a time series trial of a computerized clinical decision support tool to implement the PECARN neuroimaging prediction rule after head trauma.³⁷ This will be PECARN's first study testing the meaningful use of electronic health records, and this effort will help to further our goal of enabling the network to engage in state-of-the-art patient-centered knowledge translation research within the field of pediatric emergency medicine. Finally, we are actively pursuing funding mechanisms to train future investigators in multicenter pediatric multicenter research.

COntinuity Research NETwork (CORNET)

CORNET, the COntinuity Research NETwork, is the practice-based research network of pediatric resident continuity practices that developed from the APA Continuity Special Interest Group (SIG). In 1995, the Task Force of the Continuity SIG presented a workshop at the APA National Meeting. In preparation for this workshop, 70+ manuscripts of research studies completed in pediatric residency continuity practices were collated. Research topics included clinical care, health services and education yet all were single site studies with limited sample sizes and generalizability. As a result, the Task Force undertook a research study in 1999 that included a multi-site evaluation of pediatric residents' continuity experiences. CORNET was born when 42 continuity practices expressed interest and 36 programs completed the study, with over 1100 resident responses – a powerful demonstration of the potential and power of collaboration.³⁸ The results led to a request for Continuity SIG input into future Residency Review Committee (RRC) guidelines on the continuity experience.

The mission of CORNET is to establish a self-sustaining collaborative research network among pediatric continuity clinic clinicians that will produce quality research in primary care, health care delivery and medical education. Findings will be disseminated in order to improve the health care of underserved populations and the training of future pediatricians.³⁹ CORNET research goals are to: 1) study health and health care issues of minority and underserved children;⁴⁰ 41, 42 2) examine health care disparities in children;⁴⁰ 41 and 3) study pediatric resident education within the continuity setting³⁸, 43-45 by increasing exposure to and involvement of residents in primary care research and comparing practice behaviors of residents in training with those of pediatricians in practice.

CORNET is in a unique position to examine health care issues of underserved children, health care disparities and resident education. Currently 100 pediatric training programs are enrolled in CORNET, which includes 47% of all training programs nationally. The 117 continuity sites are located in 40 states and include over 4,800 categorical pediatric residents who provide primary care to over 750,000 pediatric patients. Weitzman et al. noted that 21% of all children in large cities with a regular source of care use hospital clinics and health centers as their usual source of care.⁴⁶ These are the same clinical sites where residents have their continuity practices. CORNET practices provide care to a higher proportion of black, Hispanic and Medicaid patients when compared to practices that participated in the National Ambulatory Medical Care Survey.⁴³

The patient populations served at the CORNET sites include children and youth with special health care needs and reflect health services issues linking primary care with pediatric subspecialists. These populations represent an important segment of the pediatric population in examining social determinants of care, health care disparities, medical home concepts and children and youth with special health care needs.⁴⁷⁻⁵⁰

The education related goals of CORNET are equally important in both the study of resident primary care education and resident exposure to and involvement in primary care research. Residency is a powerful time of apprenticeship to develop new knowledge, exposure to evidence based medicine, incorporation of practice guidelines and life-long learning, all important in the provision of high quality care. Research has shown that practitioners treat patients in the manner in which they were trained during residency and fellowship⁵¹ and residents are influenced by and conform to the standards of other physicians.⁵² For these reasons, the study of resident education in pediatric training programs, examining their exposure to and implementation of primary care and assuring effective exposure to practice guidelines is essential to assuring the competence of our future pediatric work force in primary care.

CORNET is governed by an Executive Committee comprised of a 6 member Steering Committee and the Regional Research Chairs from the 10 APA regions and the Uniformed Services. CORNET members include faculty with varied levels of research expertise. Projects are designed both from the top down and bottom up, with ideas both from seasoned investigators and from network members at the front lines of patient care, who can reflect day-to-day practice experiences. Study selection and development includes feedback from members of the Executive Committee, ensuring high quality of research on key questions that are practical, feasible and critical to the patient population and practice sites. CORNET received intellectual support and mentoring from the PROS network and has used that network as a model for development of the infrastructure and rules of governance. Collaboration between PROS and CORNET has enhanced representation of minority patients in PROS research studies. CORNET has been acknowledged as a core function of the Academic Pediatric Association, which serves as CORNET's intellectual and professional home. Infrastructure support has been obtained from the Academic Pediatric Association, the American Academy of Pediatrics, and the Agency for Healthcare Research and Quality (AHRQ). CORNET has been successful in obtaining funding for research projects from federal agencies such as AHRQ, HRSA/MCHB and the Centers for Disease Control along with institutional funding and regional foundation support.

Key Strengths and Successes

The key strengths of CORNET include the ability to produce translational research to underserved patient populations, address social determinants, health care disparities and critical patient care issues in the laboratories of everyday practice, enhance sample size and generalizability of study findings, work with a group of ethnically diverse patients who may serve as a resource to collaboration with other national networks, study and enhance pediatric resident involvement in primary care, provide mentorship and faculty development in research, national networking and collaboration that assists faculty in promotion at academic institutions, give site specific data from each study which allows individual sites to compare to the aggregate study outcomes and allow them to improve services, and provide the ability of all members to contribute to a collaboration larger than each individual.

CORNET faculty are affiliated with academic medical institutions where the continuity experience is a mandatory part of pediatric resident training and faculty seek scholarly pursuits. CORNET studies allow members to participate in important national research studies with large sample sizes and highly generalizable results. CORNET provides mentorship for faculty and residents who desire to participate in clinical research. Members learn how to navigate their Institutional Review Boards and how to implement and lead the research protocols at their sites. Involvement as a site co-investigator allows development of networking and research skills. Since its origin in 2001, CORNET members have published seven manuscripts, which include 23 unique coauthors and 48 participating co-investigators. An additional three studies have been completed, with manuscripts in development, and three studies are currently ongoing. Strategies have been identified as to how multi-site research can be referenced on curricula vitae (CVs).^{53, 54} The CORNET Director routinely sends a letter of acknowledgement to the chair of pediatric departments where participating faculty work to highlight their involvement.

A unique aspect of CORNET is the link between continuity faculty and the residents that they train. Site investigators can encourage resident involvement, with the likelihood that residents exposed to primary care research may be more likely to value and participate in research in their future careers. While not yet studied in CORNET, the new RRC mandate that residents participate in quality improvement projects will enhance CORNET's ability to address national quality improvement issues.⁵⁵

CORNET has had several successes. The publications surveying pediatric residents about their continuity experiences helped to inform the Residency Review Committee on continuity experiences, 34-38. 40 Studies have demonstrated that patients at academic based continuity sites include higher proportions of ethnic diversity and are insured by medical assistance,³⁹ yet these patients perceive receiving high quality of care even when looking at ethnic differences.^{36,37,41} These studies demonstrate that academic continuity sites are important sources of medical care for underserved populations.

Key Challenges

As with other research networks, obtaining and maintaining infrastructure support for research associates, network staff and the daily functioning of the network is challenging. The majority of our infrastructure support thus far has come from individual research grants for the specific studies, in addition to funding from the APA and PROS. We plan to seek consistent infrastructure funding from a federal agency. Since the continuity sites are at academic institutions, individual IRB approval must be obtained from every institution. We have made great strides in this area by providing an institutional template for sites to modify for submission to their individual IRBs, with our Steering Committee and Research Associate providing site specific guidance to investigators. While national representation of patients is a strength, geographic dispersion presents a challenge. Our centralized staff use email and teleconferencing for faculty development, discussion of projects, data collection, patient interviews and communication. An annual meeting following the Pediatric Academic Societies meeting allows for in-person interactions among the CORNET Executive Committee.

Future Goals

Future goals for CORNET include serving as practice platforms for implementation of health care reform initiatives (specifically the implementation of *Bright Futures* components), development of a medical home curriculum for pediatric residents with study of patients with special health care needs (a collaborative project with the AAP, APPD and APA), randomized controlled trials of educational interventions, and quality improvement projects.

Pediatric Research in Inpatient Settings (PRIS)

PRIS is an open pediatric hospitalist network that was formed in 2001 with joint sponsorship of the APA, the AAP and the Society of Hospital Medicine (SHM). The early years of PRIS were focused on capitalizing on the enthusiasm in the field and building membership, establishing relationships within the national organizations and amongst pediatric research network leaders, and conducting studies on practice patterns of pediatric hospitalists, documenting organizational structures and the variation of care within inpatient pediatrics and their relationship to outcomes.⁵⁶⁻⁵⁸ PRIS received financial support from the APA for a network coordinator who was shared with CORNET.

In 2009, the Strategic Planning Roundtable of Pediatric Hospitalist Medicine was convened with 22 national leaders from across the U.S. and Canada. From that meeting, research within the field of pediatric hospitalist medicine was discussed and voted as the most important future contribution to the field. As such, PRIS underwent a redesign which is ongoing and involves several critical steps. Individual pediatric hospitalist medicine investigators with a proven track record of publications and funding were sought to form a new Executive Council within PRIS. Their charge was to lead PRIS from its previous incarnation into a new arena of stable infrastructure funding, growing the membership and helping sites establish their capacity to conduct high quality studies, oversee the conduct of

the next series of studies that are transformative to the field of inpatient pediatrics, and mentor the next generation of hospitalist investigators to continue the work of PRIS. The APA played a key role in the redesign by working with PRIS to help form its new Executive Council.

During this redesign, in addition to developing ongoing support from the three national organizations, PRIS has partnered with the Child Health Corporation of America (CHCA), a business alliance of 42 children's hospitals and their CEO's to work on an initial study that will help guide PRIS on prioritizing future studies in the field of pediatric hospital medicine. The prioritization project seeks to identify conditions that are prevalent, costly to the healthcare system, and demonstrate high inter-hospital variation in resource utilization, which signals either lack of high quality data upon which to base medical decisions, and/or an opportunity to standardize care across hospitals. This project would establish a priority list, focus on the highest ranking conditions that demonstrate the most variation of care, at a high cost/frequency, and for which there is actionable evidence that if followed in the inpatient setting, would lead to a decrease in unnecessary variation with no adverse or even superior patient outcomes. This project is being conducted within both academic and community settings, in order to have broad reaching effects, as most children are hospitalized in community hospitals.

Key Strengths

The key strengths of PRIS include the support and buy-in of both the general membership within PRIS and the leadership within pediatric hospital medicine, the hospitalist investigators who have formed the Executive Council, and the partnerships with key organizations that support this open network (the APA, AAP, SHM and CHCA). The energy and enthusiasm undergirding the recent redesign has led to infrastructure and project funding for 3 years from CHCA, four PRIS Executive Council face-to-face meetings where critical network issues were discussed and two large ARRA funded grants for PRIS. Issues addressed included: a strategic framework with mission, values and vision, organizational structure, governance documents, protocol selection, and what processes are necessary to be tested prior to coming out of redesign and being available to the > 160 hospitals that are part of PRIS (especially the 35% that are from community hospitals and may lack robust research support/capabilities). The two ARRA grants are focused on (1) linking clinical data from disparate EMRs from 6 hospitals to a common administrative database in order to conduct pediatric CER studies and (2) studying the effectiveness of a "resident handoff bundle" in accelerating adoption of safer communication practices in pediatric hospitals. Effects on safety outcomes, resident workflow and work processes, and education are being measured.

Key Challenges

PRIS is facing many challenges that other research networks face including the need for stable infrastructure to build sufficient capacity across such a large network. An additional challenge is to determine how research findings will be implemented at the bedside and what impact these effectiveness studies have on patient outcomes. If PRIS is to accomplish its mission of improving the health of and healthcare delivery to hospitalized children and their families, then each research study undertaken will need to have a tightly coupled implementation plan. Once results of these studies are known, then practicing hospitalists in their academic and community settings can be studied in their natural laboratory with their patients, and PRIS can show how results from research are translated at the bedside. The impact of these implementation methods on patient outcomes are critical to understanding which methods can ensure that our hospitalized children and their families receive the highest quality care that our system can deliver.

Discussion

The last 25 years have seen the establishment of four pediatric generalist research networks with the active involvement and leadership of APA members, and for some, with financial support and guidance from the APA as an organization. These are research networks representing both the “trunk” and the “branches” of the generalist tree that Stephen Ludwig described in 2003.⁵⁹ The generalist “trunk” refers to general pediatric practice, preventive pediatrics, and academic general pediatrics, and the “branches” refer to what Ludwig described as generalist “subspecialties”, which are not organ-based and which arose from the nurturing of traditional general pediatrics. These include pediatric emergency medicine, pediatric hospital medicine, developmental-behavioral pediatrics, adolescent medicine, health services research, environmental medicine and child abuse pediatrics. While PROS is a practice-based research network (PBRN) with the traditional PBRN composition of practitioners in non-university community-based environments, all four can be considered PBRNs in generalist “trunk” (resident continuity clinics in CORNET) and generalist “branch” (pediatric emergency medicine in PECARN and pediatric hospitalist medicine in PRIS) clinical settings. In each case, groups of practitioners are networked for the purpose of examining and evaluating the health care processes that occur in real world pediatric clinical sites.

The four research networks are at different stages of development, based on longevity and consistent core funding for infrastructure, with PROS being the most mature and PRIS in its formative stage. In parallel fashion, the networks also have gone through developmental stages with respect to the type of research performed, beginning with descriptive and observational studies, followed by smaller trials or feasibility studies of interventions, followed by larger randomized controlled trials (RCTs) of interventions. All have published observational studies, and both PROS and PECARN have completed and published RCTs. CORNET recently has completed its first RCT. None have yet studied dissemination or implementation. All the networks have sought out and depend upon support from national organizations and funding agencies. PROS has had longstanding core funding from HRSA/MCHB and the AAP, and PECARN has had core funding from HRSA/MCHB/EMSC. CORNET and PRIS have received core staff support from the APA, and PRIS has also had the support of the AAP and SHM as well as short-term infrastructure funding from CHCA. The level of core funding is substantially different among the networks. While PROS and PECARN have developed significant funded infrastructure based on core funding, CORNET's infrastructure is lean, and PRIS is beginning to develop its infrastructure needs and plans. Nevertheless, in spite of core funding and grant funding for individual research projects, all of the networks still depend very much on large-scale volunteerism to accomplish their goals.

The role of networks in providing mentorship cannot be stressed enough. “Colleague networks” regarding research, supported by professional organizations, have been shown to be extremely important in the professional development and academic advancement of higher education faculty.⁶⁰ CME activities, involvement in study design planning, guidance from more senior investigators, peer mentorship, and “research in progress” discussions in the more established networks (such as PROS, PECARN and CORNET) have led to impressive growth in research expertise among pediatricians with less research experience, regardless of their seniority or previous research training. The networks also nurture the next generation of young investigators, developing them to become the future leaders of network research. By providing young investigators with opportunities to participate in studies, hone their research skills, and ultimately lead individual studies, the networks are critical in moving young faculty into research and advancing those careers. It is anticipated that as

PRIS develops, a similar mentorship role will become an important component of its activities.

The networks share a number of important strengths. They all have the ability to make available large numbers of subjects for research protocols, and a diversity of patient characteristics and geographic locations that leads to better generalizability of study results. And they all have an organization that can bring together multiple “nodes”, regions, chapters, and sites for collaboration on a research protocol. They also provide a real world laboratory to find out how health care is presently delivered, to test interventions to improve outcomes, and to provide an opportunity for studying implementation of evidence-based protocols and standards of care. Because of the interface of all these networks with academia, research ideas can percolate from academic researchers to members of the networks, providing an opportunity for real translational research. In addition, opportunities exist for ideas from clinicians and educators to percolate from the ground up to academic researchers, and for mentorship of clinicians and more junior faculty in research design and implementation. Members of the networks, situated in the real world on a daily basis, are in a unique position to identify critical questions in child health that need further study. Older networks have also mentored the younger networks, with PROS providing guidance to the leadership of both CORNET and PRIS and PECARN advising the PRIS leadership.

The networks also share common challenges. Several challenges described in this paper deserve special comment. First, the coordination of IRB submissions at many independent centers as well as the successful procurement of approvals of these multiple IRBs in a timely fashion is a challenge shared by all the networks, and frequently an impediment to participation of some of the sites. PROS investigators have published on this topic and suggested potential changes to the IRB review process to ameliorate this problem.⁶¹ As the PROS investigators state, federal action will be required to identify innovative protocol review processes for multisite PBRN studies in order to reduce redundancy and improve efficiency and timeliness of reviews.

Second, equitable distribution of authorships, particularly to junior investigators needing academic promotion, as well as adequate recognition and reward of co-investigators who don't meet journal criteria for authorship, is another shared challenge.⁵⁴ How should co-investigators list their contributions to a published research project on their CV if they are not authors? Should a special category be developed for CVs describing participation in multisite or network research? How can academic institutions provide adequate recognition for this important role in consideration for promotion? These important questions lack definitive answers at present, and the APA may be able to play a role bringing academic leaders together in an effort to establish clear and equitable guidelines. These two challenges, timely coordination of IRB submissions at multiple independent centers and equitable allocation of authorship and recognition and reward of co-investigators, are also challenges for CTSIs (Clinical and Translational Science Institutes) attempting multi-institutional pediatric research and collaborations in the longitudinal National Children's Study. Lessons learned and methods developed in the pediatric generalist networks will be useful for those important endeavors.

Third, successfully obtaining core funding is both a shared and differential challenge for these pediatric networks. Infrastructure funding is needed for stable leadership, research coordination staff, data collection and control, meetings, and communication among a widely dispersed group of investigators and site directors and staff. While none of these networks has “sufficient” funding for infrastructure, both PROS and PECARN have relatively stable commitments from the AAP (PROS) and HRSA-MCHB (PROS and PECARN), whereas CORNET and PRIS have much lower levels of infrastructure support.

PROS and PECARN have been more successful for somewhat different reasons. PROS can be viewed as a member benefit in a large membership organization which can leverage outside funding as well as provide some level of ongoing support, and legislative interest in emergency medical services for children has led to the EMSC funding stream for PECARN. The APA has been critical to the development of both CORNET and PRIS in providing financial support, but does not have the “deep pockets” to provide extensive infrastructure funding. CORNET has, nevertheless, been able to thrive because of finding a true “home” in the APA and finding resources in the academic centers in which the continuity clinics reside. PRIS, having received short term infrastructure support, has begun to search for and had some recent success in obtaining longer term funding. The issue of core funding for infrastructure will be an enduring challenge for the existing networks and for each new network that is formed.

Pediatric research networks also face potential threats to funding that are different from adult-oriented research networks, due to the spotlight on cost-cutting in health care that is likely to motivate government funding of comparative effectiveness research, and the infrastructure for that research, in the coming years. There is concern that the massive health care costs of adult medical care, especially for the burgeoning geriatric population, will intensely focus government funding on seeking cost-effectiveness measures for that population. While cost-effectiveness is a component of health services research in pediatrics, the total health care expenditure for children is only a small portion of all US health care dollars, and savings in pediatrics will not significantly impact the health care “bottom line”. The major argument to be made for investment in pediatric research network infrastructure will have to be standardization, enhanced safety, and improvement of care for children leading to better outcomes and enhanced long term life trajectories. We, in the pediatric health care and academic community, will have to make sure that the importance of these long-term cost benefits and dividends for the future of our country are heard above the cacophony of concern regarding the growing percent of the GDP due to health care expenditures in the US.

The future of pediatric generalist network research holds great promise and opportunities for growth. There is an important need for network research to begin to focus on translational, implementation, and comparative effectiveness research, areas for which funding by federal agencies should be available, in spite of the concerns raised above. In addition, reassessment of research methodology to deal with EMRs is both an opportunity and a challenge, but clearly a necessity for all the networks. Networks also need to assess the most efficient and safest method of electronic data collection, storage and sharing. Networks need to consider in-house systems vs. contracting with national data coordinating centers, as well as the use of established electronic data capture systems such as the Research Electronic Data Capture (REDCap) database system.⁶² The pediatric educational community must begin to plan training of pediatric residents and fellows in PBRN research in order to nurture the next generation of network researchers. Furthermore, collaboration between networks, which has occurred to a small degree, must be encouraged, as it will lead to a greater understanding of the health care and disease management of patients across the continuum of care, as well as a better elucidation of health care disparities in children. There is also opportunity for the development of new pediatric generalist research networks in such areas as the newborn nursery, foster care, developmental-behavioral pediatrics (DBP) and school health. In fact, HRSA-MCHB recently issued a request for proposals to provide infrastructure support for a DBP Research Network and has funded such a network. The Newborn Nursery Special Interest Group of the APA has begun actively planning a newborn nursery research network – Better Outcomes through Research in Newborns (BORN). These new networks will likely, in turn, be mentored by the existing research networks and will offer new opportunities for

collaboration among researchers, clinicians and educators, as well as career development for young investigators.

The enhancement of generalist research networks, from both the “trunk” and “branches” of general pediatrics, and the development of young investigators are two of the important strategic objectives of the APA in its goal to promote professional development, research and scholarship in pediatrics.⁶³ Through APA special interest groups, committees, workshops, sponsored conferences, board initiatives, collaborations with other professional organizations and funding agencies, and advocacy for funding, the APA will continue to play an important and leadership role in the future of practice-based network research in pediatrics.

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Table

Pediatric Generalist Networks Overview

NETWORK	Year founded	Mission/Purpose	Number of sites	Estimated patient population
Pediatric Research in Office Settings (PROS)	1986	To improve the health of children by conducting collaborative practice-based research to enhance primary care practice	750	2.7 million
Pediatric Emergency Care Applied Research Network (PECARN)	2001	To conduct high priority multi-institutional research on the prevention and management of acute illnesses and injuries in children and youth of all ages	22	950,000 emergency department visits annually
Continuity Research Network (CORNET)	2001	To establish a self-sustaining collaborative research network among pediatric continuity clinicians that will produce high quality research in primary care, health care delivery and medical education	100 pediatric training programs/ 129 clinical sites	750,000
Pediatric Research in Inpatient Settings (PRIS)	2001 / (redesigned 2009)	Improve the health of and healthcare delivery to hospitalized children and their families	168 hospitals	> 500,000 annual discharges