

Medical education practice-based research networks: Facilitating collaborative research

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Abstract

Background: Research networks formalize and institutionalize multi-site collaborations by establishing an infrastructure that enables network members to participate in research, propose new studies, and exploit study data to move the field forward. Although practice-based clinical research networks are now widespread, medical education research networks are rapidly emerging.

Aims: In this article, we offer a definition of the medical education practice-based research network, a brief description of networks in existence in July 2014 and their features, and a more detailed case study of the emergence and early growth of one such network, the Association of Pediatric Program Directors Longitudinal Educational Assessment Research Network (APPD LEARN).

Methods: We searched for extant networks through peer-reviewed literature and the world-wide web.

Results: We identified 15 research networks in medical education founded since 2002 with membership ranging from 8 to 120 programs. Most focus on graduate medical education in primary care or emergency medicine specialties.

Conclusions: We offer four recommendations for the further development and spread of medical education research networks: increasing faculty development, obtaining central resources, studying networks themselves, and developing networks of networks.

Introduction

Multi-site research offers several compelling advantages for medical education research. First, multi-site studies help ameliorate the inherent limitations in sample size at individual medical schools and training programs, allowing for opportunities to pursue both smaller effect sizes and more nuanced hypotheses about interaction, mediation, and moderation of educational effects. Second, multi-site studies enable comparisons of effects among sites, potentially illuminating both overall generalizability of effects as well as contextual sources of variability in educational effects. In combination with a data repository for storing research data (Schwartz et al. 2010; Cleland et al. 2013), multi-site research encourages efforts by educational communities to share and leverage research resources (O'Sullivan et al. 2010; Huggett et al. 2011).

Research networks formalize and institutionalize multi-site collaborations by establishing infrastructure to enable network members to participate in multiple studies, propose new studies, and exploit study data to maximize scholarly output. Research networks also facilitate the dissemination of evidence-based practices to network members. Scientific research networks and clinical research networks have a long history, with primary care practice-based research networks (PBRNs) emerging in the 1960s (Green & Hickner 2006). On the

Practice points

- Medical education practice-based research networks (MEPBRNs) offer exciting opportunities to conduct multi-site studies in medical education and provide meaningful scholarship for members.
- Faculty development for investigators at sites participating in MEPBRNs is necessary for network success.
- MEPBRNs require some central resources, and must select a funding model that is agreeable to network members and stakeholders.
- As MEPBRNs are relatively new, formal relationships among networks for sharing best practices and multi-network projects have yet to be established, and are likely to be an important future development.

other hand, calls for research networks in medical education are comparatively recent (Carney et al. 2004; Beeson & Deiorio 2010). Network activities in support of collaborative research may include review, refinement, and approval of study proposals; coordination of study funding, human subjects approval, and site recruitment; faculty development and professional networking for participating network member faculty; data collection infrastructure and assistance;

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data warehousing; development and dissemination of scholarly products; and recognition of participating sites.

In this article, we offer a definition of the medical education PBRN, a brief description of networks in existence in July 2014 and their features, and a more detailed case study of the development, evolution, and activities of one such network, the Association of Pediatric Program Directors Longitudinal Educational Assessment Research Network (APPD LEARN). Our goal is to provide a common terminology and a catalog of medical education PBRNs to allow future investigators to study the features and life courses of these networks. Along the way, and in conclusion, we outline several challenges and opportunities for the further development and spread of medical education research networks.

Defining networks

We define a medical educational practice-based research network as an organization or consortium consisting of multiple educational sites (e.g. schools or training programs) formed for the primary purpose of facilitating multiple research studies each using all or a subset of the network sites. The several components of this definition place specific conditions on what we categorize as an educational research network for the purposes of this article.

First, the practice-based network must consist of educational sites, as opposed to individual researchers. Although research teams consisting of groups of individual scholars are of critical importance to medical education, and may persist for years, our focus is on research networks with institutional members who implicitly or explicitly are committing program resources to network participation. Of course, institutions conduct research through affiliated individuals, so we expect that each member institution in a medical education PBRN will be represented by one or more individuals.

The network members must be primarily medical educational organizations, directly involved in educational practice – the instruction or assessment of learners. This component of the definition is broad enough to allow for certifying boards or other regulatory institutions involved in assessment to be network members although they may not be directly responsible for instruction, although as a rule most members will be continuing medical education providers, training programs, or medical schools. We exclude by design networks whose only educational focus is either patient education or the education of network members themselves in the absence of educational research conducted by the network. A notable feature of the medical education research network is that most network members will have a primary education mission, rather than a research mission – this presents particular challenges we discuss later.

Second, our definition requires that the network intends to consider research its primary purpose and to engage in multiple research studies over time. In this, we mirror the Agency for Healthcare Research and Quality (AHRQ)'s description of PBRNs as including “a sense of ongoing commitment to network activities and an organizational structure that transcends a single research project”. In

particular, we do not consider one-time consortia or study groups formed for the purposes of a single multisite research project to fit our definition of a research network. Similarly, we exclude from this manuscript networks whose primary purpose is developing or disseminating educational materials and only engage in data collection to the extent necessary to assess the needs for, or satisfaction with, such materials. AHRQ maintains a registry of practice-based research networks that fit its criteria (including educational research networks), but as there is no definitive registry of medical education research networks in particular, it can be difficult to determine whether a collaborative not listed in AHRQ's registry is a research network. One potential indicator is the use of a group author on publications (Flanagin et al. 2002), which generally necessitates a description of the group and the contributions of member sites and their personnel, including sites involved in the research but not authorship of the publication.

Networks may conduct studies that do not involve all of their members at once; indeed, for larger PBRNs, this is typical. Nevertheless, even when only a subset of members are collaborating on a network project, the project is likely to be identified with the network if it partakes of centralized network resources (such as management or statistical support). The same group of sites may collaborate on non-network projects as well.

Existing networks

The development of research networks themselves may not be documented in the peer-reviewed literature. Although some practice-based clinical research networks publish manuscripts describing their formation (Wasserman et al. 1998; Deshefy-Longhi et al. 2002; Dickerson et al. 2007), there may be fewer journals in medical education research that publish such descriptions. In light of this gap, we sought to document existing networks at this historical moment.

Accordingly, we searched both peer-review literature sources (PubMed, OVID, and Wiley Online) and the broader web (via Google and Yahoo search engines) to attempt to identify medical education research networks in operation in July 2014. Our search was restricted to English- and Korean-language publications and web sites. Keywords used for search included “medical education” and “research” combined with each of the keywords “network”, “collaborative”, “consortium”, and “database”, as well as PubMed searches using each of those keywords as “corporate names” (group authors). We also hand-searched the AHRQ's Practice-Based Research Network portal to identify networks focused on medical education. We did not attempt to identify networks that may have existed in the past and are no longer in operation, and excluded networks when contact with their (former) directors indicated that the network was no longer operational.

In addition to APPD LEARN, which we describe in greater detail as a case study later in this article, we located 15 research networks in medical education. Figure 1 displays the founding year, size, and focus of these networks. We provide a brief summary of key network information in Table 1 to



Figure 1. Founding years and current membership size (as of July 2014) for 15 medical education practice-based research networks.

identify common features as well as to document and record their existence. When possible, we contacted the network director or coordinator to inform them about this paper and to verify this information, and we provide an overview below of those networks for which we could obtain additional information from their directors.

Innovative Strategies for Transforming the Education of Physicians

The American Medical Association (AMA) began organizing Innovative Strategies for Transforming the Education of Physicians (ISTEP) in 2005 through a competitive process in which medical schools or consortia applied to receive planning grants for the network, with the network itself officially established in 2007. ISTEP’s mission is “To be the premier transformational medical education research collaborative focused on identifying the connections between educational efforts across all learner levels (students, residents/fellows and practicing physicians) and improved patient care outcomes” (American Medical Association 2010). ISTEP currently comprises 41 medical schools in the US and Canada. Ongoing research includes a longitudinal investigation (in its third year as of this writing) into the relationship between educational climate and the development of professional attributes among students (the “Learning Environment Study” with 29 participating sites). ISTEP also

received funding from the National Institute on Drug Abuse to develop educational resources and curriculum on substance abuse and to survey residents and students on their attitudes and beliefs surrounding intervening when a patient presents with a substance abuse problem. AMA provides administrative coordination for ISTEP studies, and provides support to ISTEP sites to act as data coordination centers for particular studies.

Center for the Advancement of Healthcare Education and Delivery

Center for the Advancement of Healthcare Education and Delivery (C-AHEAD) is a family medicine network of six practices, one family practice residency, and three medical schools, that engages in both health care delivery and medical education research. Examples of recent projects include a study of osteopathic distinctiveness and its role in education, and evaluation of an online educational module in care transitions for medical students, funded by the American Association of Colleges of Osteopathic Medicine.

Medical Education Research Network

Medical Education Research Network (MedEdNet) is a national research network with a primary focus on family medicine. The network was founded in 2007 by 14 Family Medicine residency programs engaged in the P⁴ Initiative

Table 1. Summary of existing medical education practice-based research networks.

Network name (acronym)	Sponsoring organizations	Founded	Focus	Members	Number of members	Contact URL
Continuity Research NETWORK (CORNET)	Academic Pediatric Association	2002	Pediatrics health care delivery, disparities, and resident education	Pediatrics continuity clinics (US)	105	http://www.ambpeds.org/research/research_cornet.cfm
Educational Innovations Project (EIP)	ACGME (Internal Medicine Residency Review Committee)	2006	Internal Medicine education, particularly GME	Internal Medicine residency programs (US), approved by RRC	18	http://www.im.org/AcademicAffairs/EducationalInnovations/Pages/default.aspx
Innovative Strategies for Transforming the Education of Physicians (ISTEP)	American Medical Association	2007	Medical education, all levels	Medical schools (North America)	41	http://www.ama-assn.org/ama/pub/education-careers/stepinnovative-strategies-transforming-education-physicians.page
Medical Education Research Network (MedEdNet)	Oregon Health & Science University, Association of Family Medicine Residency Directors, American Board of Family Medicine	2007	Primary care education, particularly GME	Primary care residency programs (US)	39	https://fmresearch.ohsu.edu/medednet.org
Pacific Northwest Consortium for Outcomes in Residency Education (PNW-CORE)	American Board of Internal Medicine	2008	Internal Medicine GME	Internal Medicine residency programs (US)	9	None yet
Longitudinal Educational Assessment Research Network (APPD LEARN)	Association of Pediatric Program Directors	2009	Pediatrics education, particularly GME	Pediatrics residency programs (US)	123	http://learn.appd.org
Education in Pediatric Intensive Care (EPIC)	RBaby Foundation & Laerdal Foundation	2011	Pediatric intensive care education	Pediatric critical care fellowship programs	40	http://epicstudy.com for current study. None yet for network.
Simulation-Based Pediatric Innovation, Research, and Education (INSPIRE)	None	2011 (merger of EXPRESS, and POISE)	Simulation-based education in Pediatrics	Medical centers and schools (International)	112	http://inspiresim.com
Emergency Medicine Educational Research Group (EMERGE)	None	2012	Emergency Medicine	Emergency Medicine training programs	30	None yet
Educational Research Outcomes Collaborative (E-ROC)	None	2013	Internal Medicine, GME	Internal Medicine residency programs (US)	23	None yet
Canadian Network for Simulation in Healthcare (CNSH)	None	2012	Simulation (interprofessional)	Canadian investigators and institutions	Unknown	http://www.cns.ca
Center for the Advancement of Healthcare Education and Delivery PBRN (C-AHEAD)	None	2007	Family Medicine	Family Medicine practices and medical school programs	10	None currently
Western New York Pediatric Innovation Network (WNY-PIN)	None	2013	Pediatrics	Pediatric clinics (New York)	8	None identified
National Consortium for Multicultural Education for Health Professionals	NHLBI	2009	Health disparities	Medical schools (US)	18	http://culturalmed.stanford.edu/about/initiatives.html
Collaborative of the Primary Care Training Collaborative (Patient-Centered Primary Care Collaborative)	Patient-Centered Primary Care Collaborative	2014	Educational outcomes of patient-centered medical homes	Network of 5 networks of practices	102 total (4, 10, 19, 25, and 44 in the member networks)	http://www.pccoc.org/

(Preparing the Personal Physician for Practice) sponsored by the American Board of Family Medicine, the Association of Family Medicine Residency Directors, and TransforMED (Carney & Green 2011; Agency for Healthcare Research and Quality 2013; MedEdNet 2013). It currently includes 39 programs. MedEdNet focuses on physician education through longitudinal assessments of learners to evaluate which aspects of the residency experience correlate with primary care practice and innovation, with the ultimate goal of improving the health of populations served by primary care practices. The network is currently funded to conduct three national studies: an extension of the P⁴ study to collect two additional years of graduate data; the Accreditation Council for Graduate Medical Education (ACGME) Family Medicine Length of Training Pilot to compare 3- and 4-year FM residencies; and the Primary Care Faculty Development Initiative, a pilot program of the American Boards of Family Medicine, Internal Medicine, and Pediatrics funded by HRSA and the Macy Foundation that is studying how to train residents in primary care disciplines to practice safely and effectively in a rapidly evolving health care system.

Membership is open to all family medicine, general internal medicine residency and general pediatrics residency programs, with a membership fee based on participation level (participation in a single study versus full membership in the network). MedEdNet offers services to help programs with study design, program evaluation and instrumentation, and fulfilling accreditation requirements for scholarly activity. Members have access to a relational database with information on more than 800 residents linked to 6+ years of data from resident, program, continuity clinic, and graduate surveys (administered 18 months after residency completed). The network also provides IRB support and consultative services for research and faculty development. MedEdNet is governed by a Board of Directors and operated by a Scientific Director and an Administrative Director.

Educational Innovations Project

The Educational Innovations Project (EIP) was launched in 2006 by the Internal Medicine Residency Review Committee of the ACGME. EIP programs “are expected to develop, study, and disseminate methods for competency-based education and evaluation” (Accreditation Council for Graduate Medical Education 2011) Programs with excellence in past accreditation cycles were invited to join the EIP. Collaborative activities among the 18 Internal Medicine residency programs currently engaged in the EIP include studies to evaluate continuity experiences for residents and to operationalize the use of milestones for resident assessment.

Pacific Northwest Consortium for Outcomes in Residency Education

The Pacific Northwest Consortium for Outcomes in Residency Education (PNW-CORE) began in 2008 with support from the American Board of Internal Medicine. Nine Internal Medicine programs are currently members. The network is currently engaged in a study of assessment

of resident leadership in codes. PNW-CORE recently published a cultural consensus analysis among patients, nurses, residents, physicians, and administrators at eight of its member programs that provided evidence for construct validity of ACGME's six-competency framework (Smith et al. 2013).

Education Research Outcomes Collaborative

The Education Research Outcomes Collaborative (E-ROC) is a consortium of 13 Internal Medicine programs with analytic support from investigators at ACGME. E-ROC has been studying the impact of milestones on the training of residents and methods to increase engagement of residents with milestones (Meade et al., 2013a,b).

APA Continuity Research Network

Continuity Research Network (CORNET) is a national (US) practice-based research network composed of pediatric resident continuity practices and organized by the Academic Pediatric Association (APA). CORNET currently includes 104 pediatric training program continuity practices as members. CORNET focuses on research in primary care, health care delivery and medical education that improves the training of future pediatricians and the health care of children, with special attention to underserved children (Academic Pediatric Association 2013). Current CORNET studies include a three-phase CDC-funded quality improvement study of adolescent immunization (now in phase 3, with 12 CORNET sites participating), the second phase of a study examining resident education in mental health integration models, and a pilot study of an interactive DVD on methods to decrease aggressive behavior in young children in preparation for a larger randomized trial. Past studies have included a variety of topics and research designs involving 4–27 sites, as well as collaborations with the clinical PBRN Pediatric Research in Outpatient Settings (PROS).

Membership is free and open to any APA member. CORNET is governed by a Steering Committee, and operated by a Network Director and a Lead Research Associate/Research Network Coordinator. CORNET is organized into 11 regions with research chairs for each region. The Steering Committee and Regional Research Chairs together form an Executive Committee which reviews submitted research proposals, provides feedback, and designates approved proposals.

Emergency Medicine Educational Research Group

The Emergency Medicine Educational Research Group (EMERGE) is a newly formed network independent of other academic organizations. The network's initial development was reported by Newgard et al. (2012). Members to date include 30 Emergency Medicine training programs. The network's efforts are driven by the principal investigators of proposed studies, with the network providing review of studies, infrastructure to recruit sites, and guidelines for authorship and division of labor. The network is beginning

two studies, one on burnout among academic emergency physicians and the other on evaluation of a feedback tool for Emergency Medicine milestones (Hansen, personal communication).

Education in Pediatric Intensive Care

Education in Pediatric Intensive Care (EPIC) is a research collaborative focused on education-based research in pediatric intensive care involving 30 institutions, independent of other academic organizations. Network members are individual investigators, of whom there are currently approximately 40 (Turner, personal communication). It recently published its first study, an investigation of teaching modalities used by pediatric critical care medicine (PCCM) fellowship programs to teach communication and professionalism (Turner & Goodman 2011). Three other investigations are ongoing which include a follow-up investigation of how PCCM fellows perceive their teaching in communication and professionalism, the development of a valid and reliable tool to assess central venous catheter placement, and development of a mechanism to assess leadership competence. The network is developing an oversight committee and is in the process of formalizing its structure.

International Network for Simulation-based Pediatric Innovation, Research, and Education

The International Network for Simulation-based Pediatric Innovation, Research, and Education (INSPIRE) network was formed in 2011 through the merger of the examining pediatric resuscitation education through simulation and scripting (EXPRESS) and patient outcomes in simulation education (POISE) networks, and is supported by the Laerdal Foundation for Acute Medicine and the RBaby Foundation. INSPIRE's membership is international (North America, Europe, Middle East, and Australia) and includes 112 institutions. INSPIRE seeks to improve the delivery of medical care to acutely ill children through research in pediatric resuscitation, technical skills, behavioral skills, and simulation-based education. INSPIRE investigators have 15 studies planned, ongoing, or completed in areas including debriefing methods, teamwork, and simulation instruction in procedural and psychomotor skills, as well as simulation studies of clinical innovations. For example, the improving pediatric acute care through simulation (IMPACTS) study has developed and validated cases to study care of simulated infants by different emergency department teams; site enrollment has begun, with an anticipation that 32 hospitals will be involved (INSPIRE 2013).

INSPIRE's Executive Committee reviews and approves proposals, and develops policies and procedures for the network. An external Network Advisory Board provides counsel on study conduct and publications. INSPIRE has a consultative submission process (to obtain consultation to inform a submission) as well as a new project submission process. INSPIRE proposals with external support are expected to allocate 0.1 FTE for administrative support of the network (INSPIRE 2012).

Other networks

Our search identified several additional networks for which we did not receive additional information from network directors. Accordingly, we are not sure whether these networks fully meet our definition of the medical education PBRN, but we list them to improve the comprehensiveness of this review. These networks include the Canadian Network for Simulation in Healthcare (CNSH; Chiniara et al. 2013), the Western New York Pediatric Innovation Network (WNY-PIN), the National Consortium for Multicultural Education for Health Professionals (Lie et al. 2009; Carter-Pokras et al. 2010; Crenshaw et al. 2011), the Society for Academic Primary Care Special Interest Group in Educational Research, and the Asia neTwork to reguLate Sepsis care (ATLAS; Li et al. 2011).

APPD LEARN: A case study of the emergence of a medical education research network

In this section, we describe in greater detail the formation and early development of a single medical education research network (in which the authors are involved). In this case study, we highlight challenges that we believe will be typical for new medical education research networks.

Formation

The Association of Pediatric Program Directors Longitudinal Educational Assessment Research Network (APPD LEARN) grew from APPD's experiences with sharing of assessment tools and instructional materials (APPD Share Warehouse; Roberts et al. 2012). Sharing educational materials naturally led to questions about the value, validity, and transferability of the materials; an educational (residency program-based) research network was proposed as the approach for coordinating residency programs who sought to study these questions. Brainstorming for the creation of APPD LEARN began in 2006, with a strategic plan formulated by APPD leaders in 2008 and incorporated into APPD's 2010 strategic planning initiative (Burke et al. 2010).

As a parallel process, the American Board of Pediatrics (ABP) engaged the community in a four-year self-study of residency education, the Residency Review and Redesign Project (R³P; Jones et al. 2009) concluding that no prescription for training could withstand the test of time. Health needs of patients and the delivery systems in which we care for them are evolving and changing, and medical education needs to keep pace. The Initiative for Innovation in Pediatric Education (IIPE), a program supported by the ABP Foundation to foster and disseminate educational innovations in Pediatrics, was developed in response to this challenge. Members of APPD were invited to become members of the IIPE infrastructure, and matching funds from APPD's annual operating budget and the ABP Foundation were directed to support APPD LEARN from 2009 to 2012. An initial Advisory Committee (see the discussion of governance below) and the first APPD LEARN Director were selected in 2009. APPD LEARN registered as a PRBN with AHRQ in 2012.

Mission

In developing the mission for APPD LEARN, leadership was cognizant of the need to define the network's distinctive aims, particularly in light of the existence of APA CORNET, and APPD's own Research and Scholarship Task Force, which coordinates survey research on program directors themselves. Through advisory committee meetings, and informed by discussions between APPD LEARN leaders and other stakeholders, APPD LEARN defined its mission around the needs of Pediatrics program directors and a focus on learner (as opposed to patient or program director) outcomes.

The mission of APPD LEARN is "to conduct meaningful educational research that advances the training of future Pediatricians by developing and promoting participation and collaboration in research by program directors for the purpose of improving the health and well-being of children". Based in APPD, a member organization, APPD LEARN seeks to serve the educational research needs of pediatric training programs and their program directors by undertaking studies proposed by members as well as engaging in national initiatives and collaborations with other education organizations.

APPD LEARN's initial strategic plan defined six core interconnected network activities:

- Managing a collaborative research network of Pediatric Programs working together to conduct multi-site studies of educational methods and instruments.
- Maintaining an online repository of educational research study materials, raw data, and findings for dissemination to APPD members and collaborators.
- Promoting learning opportunities to enhance educational research participation and scholarship by Program Directors.
- Providing expert consultation for research conducted within APPD LEARN.
- Communicating regularly with the APPD membership and the larger medical education community about activities, opportunities, and outcomes.
- Exploring, conducting, and coordinating research with other organizations and initiatives across a continuum of medical and non-medical education (e.g., the education of other health professionals).

The first two activities embody the research operations, particularly data collection, management, dissemination, and sharing. The second two activities address the needs of program directors for specific faculty development and support to translate insights and questions arising out of the lived reality of directing a residency program into research questions, hypotheses, study designs, and analysis plans. The final two activities emphasize the aspiration of reaching out beyond APPD to enable members to advance the study of medical education broadly.

Organization and participation

Membership in APPD LEARN is open to any APPD member program. Programs are asked to name a liaison to APPD LEARN when they join (frequently the program director or an associate program director). There is no membership fee, but members are expected to complete an annual needs assessment survey and to participate in at least one study every two

years when there are active studies available. In practice, most, but not all, member programs comply with these expectations.

Operating personnel

The APPD LEARN Director is responsible for scientific and management oversight of all APPD LEARN activities. The APPD LEARN Director serves for a term of two years, renewable by the APPD Board indefinitely, at a time commitment of at least 0.4 FTE. This position is currently filled by a PhD social scientist working remotely through a contract with his home institution.

The APPD LEARN Project Manager facilitates communications among the participating institutions and funding agencies, develops and tracks project timelines, and ensures that regulatory requirements are satisfied; she also has a large role in assisting PIs with study management, including IRB submissions, data collection, and other study processes. She serves as liaison with research administration at all participating institutions. A full-time Master's or PhD-level project manager based at the APPD administrative headquarters fills this position.

Governance and operating committees

Three standing committees (Advisory, Educational Development, and Proposal Review) currently guide the major functions of the network. The APPD LEARN Director and Project Manager serve *ex officio* on each committee.

The APPD LEARN Advisory Committee provides guidance to the APPD LEARN Director, sets policies for APPD LEARN activities and resources, develops calls for proposals in specific research areas, and conducts annual formative and summative evaluations of the APPD LEARN Director. The Committee consists of five voting members (one of whom serves as the Chair, and another of whom is the Past Chair), and may include additional non-voting members representing external stakeholders or partners. APPD LEARN Advisory Committee terms are two years long, staggered, and renewable. APPD's Executive Director also serves *ex officio* on the Advisory Committee. This committee meets monthly by phone.

The APPD LEARN Educational Development Committee advises the APPD LEARN Director in determining the faculty development needs of APPD LEARN members in the area of educational research, designing and interpreting the annual APPD LEARN needs assessment survey, and identifying training opportunities. The APPD LEARN Proposal Review Committee assists the APPD LEARN Director in the review of proposals to conduct research using the network and its member programs. During proposal review, the committee identifies areas of strength and weakness in each proposal, and makes recommendations to the Director and the proposal investigators about whether the proposal is suitable for the network and what kinds of additional support (e.g., statistical consultation) APPD LEARN can provide to enhance its likelihood of success.

Study committees

Each approved study using the APPD LEARN network has an ad hoc project oversight committee, composed of the project

principal investigator, APPD LEARN Director, APPD LEARN Project Manager, and other members selected by the principal investigator and APPD LEARN Director. These committees hold regular conference calls during the period of the study to refine study protocols, monitor the progress of the study, and set guidelines for authorship of study manuscripts and presentations.

Infrastructure

APPD LEARN maintains an online data repository using the Dataverse Network system (King 2007), which provides support for permanent data and document archiving, data subsetting, simple online statistical analysis, and assignment of unique citable identifiers to data sets. Each APPD LEARN study archives the study protocol and materials, IRB documentation, study data, and manuscripts arising from the study. APPD LEARN members and other medical education researchers are eligible to request access to archived data for secondary analyses. Proposals for data access require both scientific and budgetary approval, as well as agreement to a standard set of terms and conditions intended to ensure uniform citation of the investigators and sites involved in the primary study. Oversight for the data repository is provided by the IRB at University of Illinois at Chicago.

An important goal of APPD LEARN is to permit learner data to be linked longitudinally and across studies. APPD LEARN member programs can generate an APPD LEARN data collection ID for each learner based on a one-way encryption system. The data collection ID is known only to the program director, is fixed over time and across studies, and cannot be feasibly decrypted to obtain any learner information. Member programs participating in a study obtain approval from their IRBs to provide their data sets to APPD LEARN with only these IDs, preventing APPD LEARN from obtaining identifiable data.

APPD LEARN then re-encrypts the IDs with a second one-way encryption to create a data storage ID before archiving the data, making the archived data de-identified even to the program that contributed the data. Figure 2 illustrates the process. APPD LEARN does not collect patient identifiers.

In early network studies, programs generated data collection IDs “just-in-time” as learners were enrolled into the study or as each learner completed the study and the program was preparing to provide the data to APPD LEARN. Although this process decreased the likelihood of misidentifying data in studies conducted with learners over several rotations (e.g., if a different learner participated than originally expected), it became more cumbersome for site investigators to generate and maintain the identifiers on an *ad hoc* basis. Because the identifiers are the same whenever they are generated, APPD LEARN is now encouraging programs to generate these identifiers for all their learners en masse in advance of any data collection, to avoid these delays.

APPD LEARN provides regular updates to the APPD membership at its annual meetings and maintains a web site for public updates. Administrative support for APPD LEARN activities is provided by Degnon Associates, Inc., APPD’s association management company. Other infrastructure components include an online survey platform (LimeService) and an online project management system (5pm(TM)).

Support for infrastructure is a standard challenge for research networks, and may be particularly irksome for medical education research networks in light of the relative scarcity of large-scale funding for medical education, particularly in the United States. Accordingly, most medical education research networks are supported by one or more sponsoring medical education organizations; this support typically extends to core network functions including the conduct of a limited number of modest studies, usually without compensation to participating sites. Following this model, APPD LEARN does

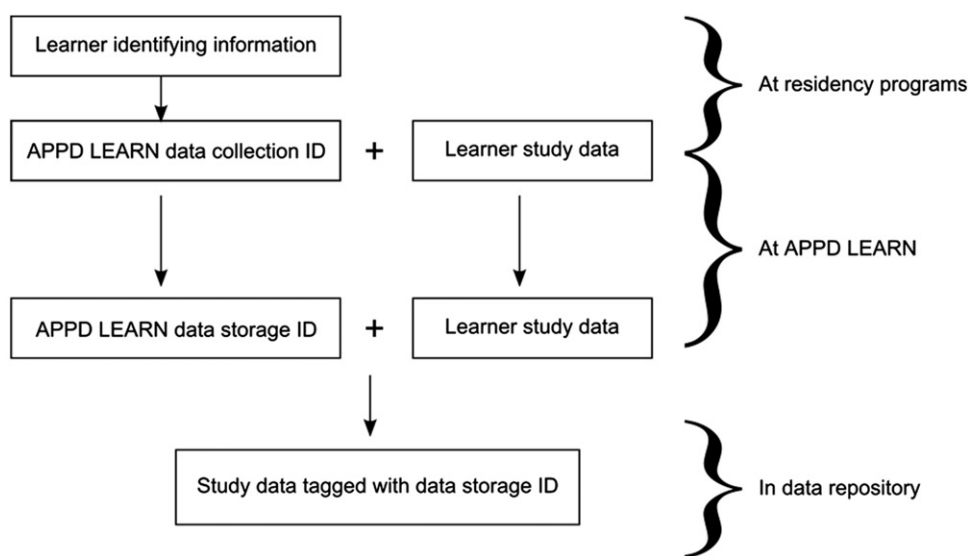


Figure 2. The APPD LEARN de-identification process. Residency programs collect data on (identified) learners. Programs generate permanent non-reversible APPD LEARN data collection IDs for their learners and transmit study data, tagged by data collection ID, to APPD LEARN. APPD LEARN re-encrypts the data collection ID to a data storage ID, and archives study data, tagged by data storage ID, in the data repository.

not typically provide direct funding to participating sites. The network instead encourages members proposing more extensive projects to seek external funding, and provides assistance in such proposals.

Past, current, and future activities

As an early proof-of-concept for the network's infrastructure, APPD conducted a study entitled "The New Duty Hour Regulations—Were Changes Necessary? A Survey of Pediatric Program Directors". This study sought to identify what, if any, changes in Pediatric Residency Program structure were necessary to achieve compliance with the new duty hour regulations by July 2011. Fifty-five APPD LEARN member sites responded to the survey, and (qualitative) data analysis and reporting continues. Although APPD LEARN focuses on residents, rather than program directors, as the unit of analysis, this study provided insights about network operations and serves as a model for the annual needs assessment survey of members. Once the data analysis is completed, the data set will also present a challenge to APPD LEARN's data sharing function, as the network will need to develop methods to archive and share qualitative data with appropriate de-identification.

In the same period, APPD LEARN in collaboration with the National Board of Medical Examiners (NBME) began collecting data in the Pediatrics Milestones Assessment Pilot, a study in which 18 sites have collected structured clinical observation, multisource feedback, and milestone classification data (summative performance level described by a given milestone for a competency) on interns and subinterns involving nine of the Pediatrics competencies and their corresponding Milestones (Hicks et al. 2010). Data were collected between June 2012 and June 2013. In 2013, APPD, NBME, and ABP announced the formation of the Pediatrics Milestones Assessment Collaborative, which will engage in further study of the reliability and validity of instruments for assessing competencies informed by the Pediatrics Milestones with the goal of offering a national assessment platform. Following the example of the Pediatrics Milestones Assessment Pilot, APPD LEARN serves as the primary vehicle for program director involvement and data collection. Validity evidence for a national assessment platform can only be developed with the active and coordinated participation of many residency programs, and APPD LEARN is ideally poised to conduct this potentially high-impact research.

In 2012, APPD LEARN issued its first call for member-initiated proposals with three deadlines per year. Since that time, eight proposals from members have been received by the proposal review committee; four have been approved for the network, and one is pending review. One, a year-long study of resident self-assessment using the Pediatrics Milestones, has recruited 44 sites and collected data for one of its two time points. Another, a study of resident perceptions of social media and professionalism across 13 sites has completed its data collection and is preparing manuscripts. The third and fourth, focused on medical errors and the balance of service and education in training programs, are still preparing to proceed. Additional submissions and a

collaboration with Pediatrics subspecialty program networks are expected in 2014.

Future directions for research networks

The emergence of collaborative educational research networks in medical education is an exciting development for the field. To date, many of these networks have been focused on graduate medical education in Pediatrics, Family Medicine, and Emergency Medicine, but if these networks prove successful in increasing meaningful educational scholarship and uptake of evidence-based educational practices, additional networks are likely to be formed spanning other specialties and the full continuum of medical education. Our experience with the formation and growth of APPD LEARN has identified several core challenges to this process, and we conclude with four recommendations for the future development of medical education research networks:

- (1) Most medical school faculty, even those experienced as teachers or clinical researchers, are not trained in educational (or other social scientific) research, and will require faculty development efforts to participate in an educational research network. Faculty may need education in human subjects regulations and ethics in educational research, educational research design, qualitative and quantitative analysis of behavioral data, and processes in team science such as authorship and data sharing. As it is possible to participate meaningfully at several different levels of commitment (e.g., as a study site investigator, as a principal investigator or co-investigator, or as a network committee member), faculty development should be tailored to the involvement of the audience, and take place at a time and in a setting appropriate to the audience. Proposal development and review processes provide teachable moments for both proposing investigators and review committee members. Each study run by a network is a chance to provide training to faculty at participating sites. Providing CME to network members is also an opportunity for the network to recognize and reward participation.
- (2) In addition to the skills and energy of participating sites, collaborative research networks need sufficient central resources to be productive and sustainable. These include program management staff time, access to expertise in educational research, technological infrastructure to support project management, data collection, and data analysis. In particular, the network director or steering committee should expect to invest substantial time in building and maintaining network infrastructure and operations, such as communications, technology, and policy. In addition, funding to support investigator meetings, study expenses, faculty development, and other network needs is ideal. There are several viable models for network funding, including direct sponsorship by an educational organization, network membership fees, and direct or indirect cost charges to external funders of individual network studies; our key recommendation is

that the network finds a model that serves its members' needs and that potential sponsors embrace the value of collaborative research in medical education.

- (3) This is a propitious time to begin to study medical education research networks themselves. Little is known about the organizational life cycle of such networks, including processes such as founding and failure and mechanisms such as legitimation and competition that characterize other organizational populations (Carroll & Hannan 1992), or about the perspectives of network members and leaders on the value of medical education research networks. IRB handling of network studies, which we have found to have substantial variability both in study classification and time to decision, is another area for investigation and potentially process improvement. Although, the networks reviewed here are relatively young, measures of effectiveness and cost-effectiveness of network research should be developed that go beyond tallying publications or funding support to look at the transfer and impact of the research on institutions, educators, learners, and patients.
- (4) Finally, as collaborative medical education research networks become more prevalent, we recommend looking ahead to the development of an international network of networks (NON) that can share best practices and coordinate multinational, multi-specialty, and cross-continuum studies run on multiple networks. Perhaps most importantly, the NON can promulgate specifications, standards, and practices for intellectual property and data sharing, such as those now emerging from Medbiquitous (Smothers et al. 2008) and Data Commons, LLC (2013; a partnership of the Federation of State Medical Boards, National Board of Medical Examiners, Association of American Medical Colleges, Educational Commission for Foreign Medical Graduates, American Board of Family Medicine, and American Board of Pediatrics). The NON might itself be organized as a member organization, with each member network contributing a membership fee to support periodic NON conference calls and meetings. An early example of such a network of networks is the Collaborative of the Primary Care Training Collaboratives, a network of five networks (ranging from 4 to 44 members per network) each interested in educational effectiveness of teaching methods for implementing patient-centered medical homes. The "Collaborative of the Collaboratives" is working to disseminate common methods used across its constituent networks (Warning W, personal communication).

Glossary

Medical educational practice-based research network (MEPBRN): An organization or consortium consisting of multiple educational sites (e.g., schools or training programs) formed for the primary purpose of facilitating multiple research studies each using all or a subset of the network sites.

Glossary of abbreviations (other than network/study names)

ABP, American Board of Pediatrics; ACGME, Accreditation Council for Graduate Medical Education; AHRQ, Agency for Healthcare Research and Quality; AMA, American Medical Association; APA, Academic Pediatric Association; APPD, Association of Pediatric Program Directors; HRSA, Health Resources and Services Administration; IRB, Institutional Review Board; NBME, National Board of Medical Education; PBRN, Practice-Based Research Network

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APPD LEARN is a research network composed of over 120 member programs, listed at <http://learn.appd.org>. Members and past members of the APPD LEARN Advisory Committee who met the ICMJE Criteria for Authorship of this article are: Alan Schwartz, PhD; Robin Young, MS; Patricia J. Hicks, MD, MHPE; Ann Burke, MD; Carol Carraccio, MD; Hilary Haftel, MD, MHPE; Robert McGregor, MD; and Laura Degnon, CAE.

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