

ORIGINAL RESEARCH

A Review of 50 Years of International Literature on the External Environment of Building Practice-Based Research Networks (PBRNs)

Anna Dania, MPH, PhD, Candidate, Zsolt Nagykalai, PhD, Ari Haaranen, PhD, Jean W. M. Muris, MD, PhD, Philip H. Evans, FRCGP, MPhil, Pekka Mäntyselkä, MD, PhD, and Chris van Weel, MD, PhD

Background: This article is the second part of a novel scoping review of the international literature that presents those key elements that underpin the foundational activities of Practice-Based Research Networks (PBRNs). In this article, we examine the external environment and the intersection between the internal and external environment domains.

Methods: We searched electronic databases, including MEDLINE (PubMed), OVID, CINAHL (EBSCOhost), Scopus, and SAGE for publications in English between 1/1/1965 and 9/15/2021. We also searched reference lists of selected publications, gray literature and other online sources. Inductive thematic analysis was applied to construct the main themes, subthemes, and key elements from a scoping review covering up to 10 years of reported experiences of each of the 98 PBRNs that met the inclusion criteria.

Results: In this study we present 2 main themes: “Stakeholders at the Intersection Between the Internal and External Environment” and the “External Environment.” The first is linked to the subthemes “Patient and Community Stakeholders” and “Other Healthcare Stakeholders” and 11 key elements. The second relates to the subthemes “National Health System,” “Institutional/Governmental Support, National/State Policy and Regulatory Environment” “Professional Organizations,” “Leveraging Previous Research and PBRN Experience and Interacting with Other Networks” and “Health Information Technology (HIT) and HIT Vendors” and 21 key elements.

Conclusions: Despite variations in geography, time, and healthcare context, PBRNs shared many similar developmental experiences over the past 5 decades. Their external environment contributed significantly to their developmental trajectories during the first 10 years of their operation. (J Am Board Fam Med 2022;35:762–792.)

Keywords: Family Medicine, Practice-Based Research Networks, Primary Healthcare, Scoping Review

Introduction

Practice-Based Research Networks (PBRNs) are collaborations of academics and practitioners in the field working together as research laboratories for primary care, to generate and implement practice-

based evidence and quality improvement in primary healthcare.^{1–5}

PBRNs initiated their activity over 5 decades ago in several pioneering countries. In Birmingham, UK, a group of general practitioners started collecting morbidity data systematically in their practices and developed the first primary care research collaboration in 1967.⁶ In the Netherlands, Huygen engaged 4

This article was externally peer reviewed.
Submitted 15 October 2021; revised 6 January 2022;
revised 14 January 2022; accepted 20 January 2022.

From CAPHRI Institute, Maastricht University (AD); University of Oklahoma Health Sciences Center, Oklahoma City, OK (ZN); University of Eastern Finland (AH); University of Exeter Medical School, Exeter, England (PHE); University of Eastern Finland and Kuopio University Hospital, Kuopio, Finland (PM); Radboud Institute of Health Sciences, Nijmegen, the Netherlands, Radboud University Nijmegen, and Australian National University (CVW).

Funding: None.

Conflict of interest: None.

Corresponding author: Anna Dania, MPH, PhD Candidate, Department of Family Medicine/General Practice, CAPHRI Institute, Maastricht University, P.O. Box 616, 6200 MD Maastricht, The Netherlands, (E-mail: a.dania@maastrichtuniversity.nl).

Dutch family practices in the Nijmegen area in 1967.⁷ In the USA, the Family Medicine Information System in Colorado (FMIS) and the Cooperative Information Project (COOP) were developed in the 1970s to investigate problems encountered in primary care.^{8–11} Since these early initiatives, research-driven community family physicians, academics, and researchers, increasingly committed themselves to working collaboratively to improve and transform primary healthcare.^{2,12,13}

Although there is information about the development of PBRNs around the world and in specific countries, it remains unclear what characteristics they may share with regards to their developmental trajectory and what may be unique to each PBRN's own history of development. We addressed this gap in the literature by conducting a scoping review of publications and sources from as many countries as possible. We reviewed English-language publications to elucidate the broadest information about the factors that enhance or impede PBRN development. In a previous article¹⁴, we presented facilitators and barriers of the internal environment related to the creation of PBRNs. In contrast, this article explores the 2 distinct domains of the external environment that include the *“Stakeholders at the Intersection between the Internal and External Environment”* and the *“External Environment”* in terms of facilitators and barriers in building PBRNs.

Methods

We completed a scoping review of the literature following a methodological framework described by Arksey and O'Malley.¹⁵ This type of review was considered appropriate to map key elements from a broad variety of data sources and various types of evidence about building PBRNs across the world.

We followed specific analytic steps suggested by the method: (1) defining the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, (5) collating and summarizing the findings, and (6) reporting the results. The methodology was identical to what we used in a previous publication.¹⁴

Identifying Relevant Studies and Study Selection

We identified relevant publications in a 2-step process. In the first step, we searched the English literature systematically and reviewed articles

published between 1/1/1965 and 9/15/2021 in the following databases: MEDLINE (PubMed), OVID, CINAHL (EBSCOhost), Scopus, and SAGE Premier, using the following search terms: “primary care,” “family practice,” “general practice”; in combination with: “practice-based,” “research,” “network,” “data,” and “infrastructure.” In the second step, we searched the “gray literature” for white papers, newsletters, conference abstracts, posters, proceedings, presentations, individual PBRN web sites, editorials, and online materials published by national organizations. We also assessed the references of selected articles and bibliographic lists. Google Scholar and public online sources were searched as well. Additional communications with authors and colleagues helped clarify knowledge gaps.

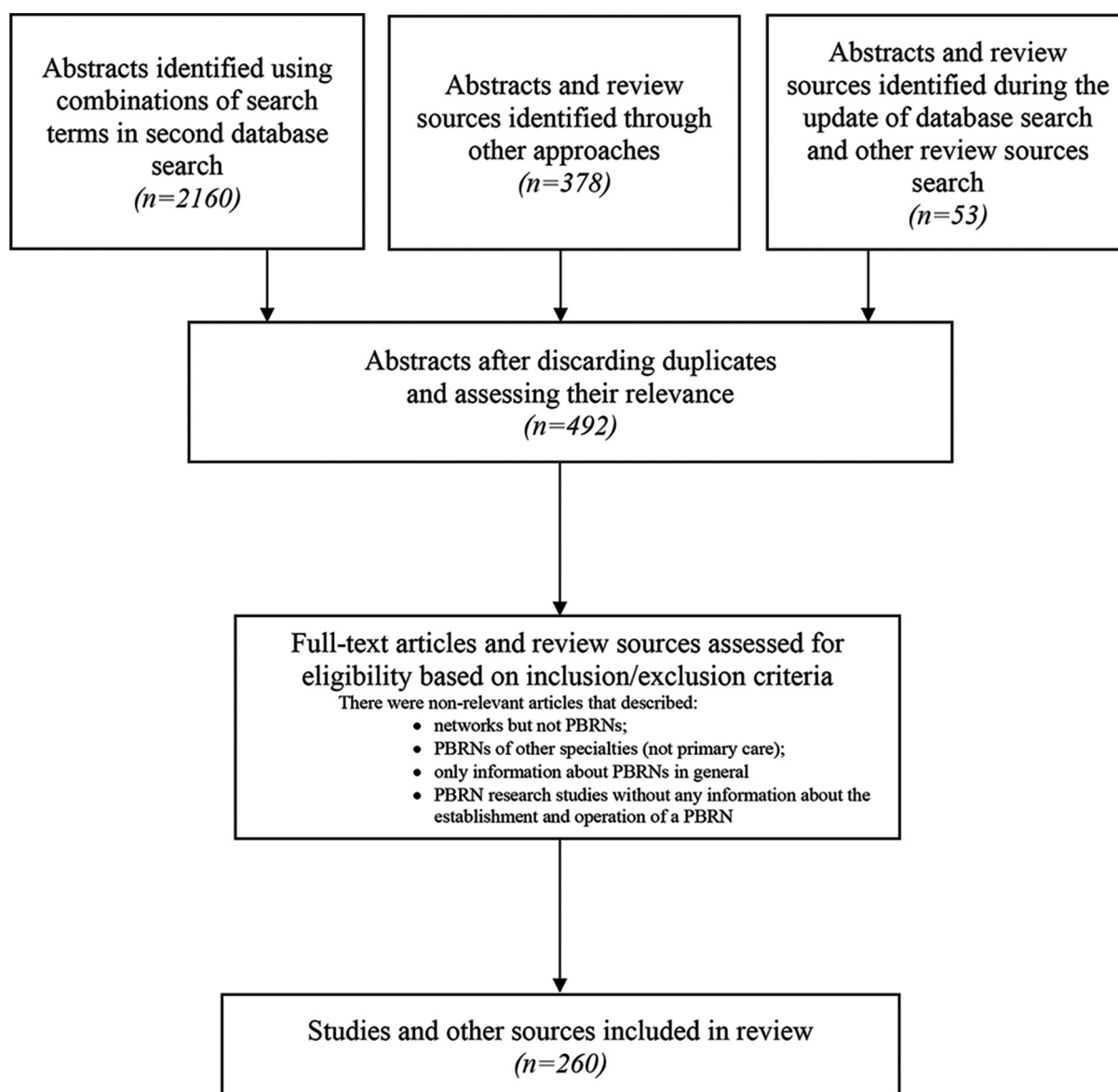
Three reviewers (AD, PM, and AH) scrutinized all articles separately and applied rigorous inclusion/exclusion criteria.¹⁴ (Appendix Table 1) The lead author (AD) communicated with authors and colleagues to clarify ambiguities and another reviewer (ZN) evaluated uncertainties about specific studies. The details of the review process are presented in Figure 1.

Charting the Data, Collating, and Summarizing the Findings

We examined the development of PBRNs in a period of over 50 years and we focused our study on the first 10 years from the inception of each individual PBRN. We gleaned information about each network during their first 10-year period using specific sources listed above. Some PBRNs had only 1 relevant publication, while others had multiple data sources that they produced. The data we collected were limited to those available in our selected sources. We reviewed identified sources to discover key actors, attributes, relationships between them and the nature of these relationships, resources contributed, and properties produced, using social network theory-concordant key concepts.^{16–18} Thus, we considered each network to develop relationships and interactions (“ties”) with actors from the external environment (“nodes”), and we looked at the “features” of their relationships and interactions with the PBRNs, and the outcomes (“properties”) that were derived from these relationships and interactions.

We applied an inductive thematic analysis approach^{19–21} using an iterative process that allowed us to group the narrative observations into components. We clustered the components

Figure 1. Chart flow diagram of the process of systematic selection of articles. Abbreviation: PBRNs, Practice Based Research Networks.



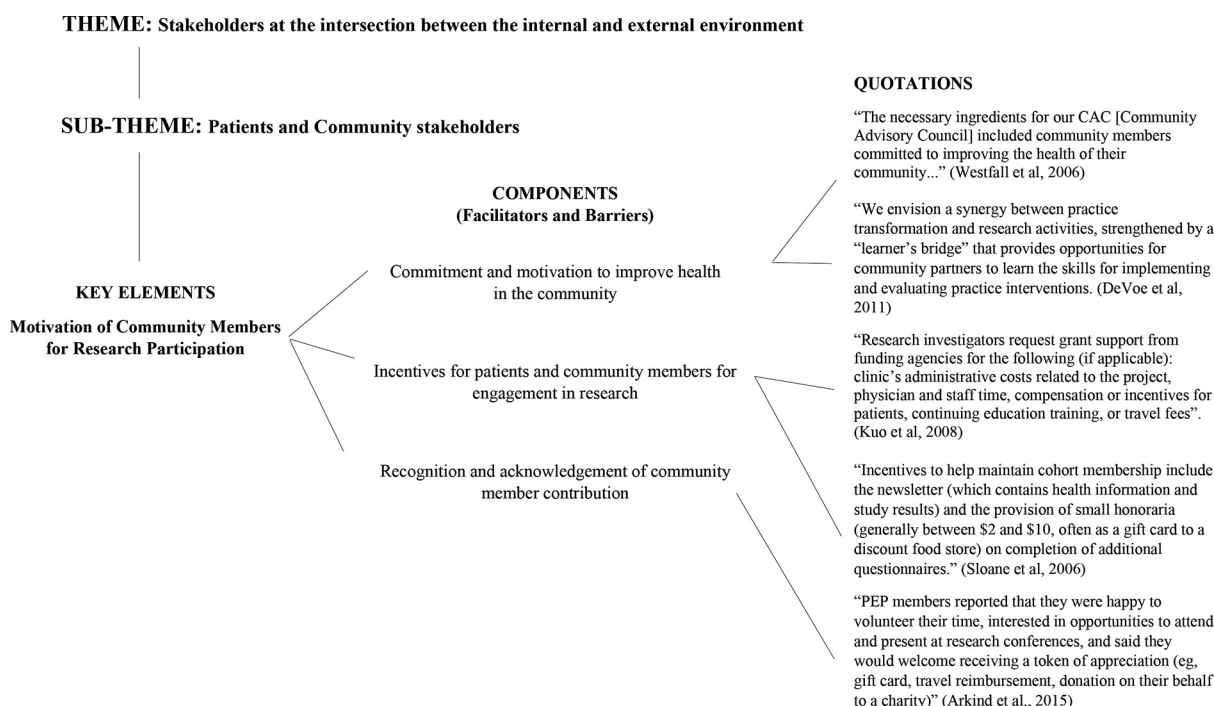
into key elements according to their relevance to specific domains of building PBRNs. Then we linked the key elements to subthemes that corresponded with groups of actors that influenced the establishment of PBRNs, considering their high-level similarities. Finally, we connected the subthemes with the main themes, which were developed to reflect the environmental domains where the subthemes clearly belonged.

Our synthesis resulted in the conceptualization of 3 main themes, 12 subthemes and 57 key

elements. Many components captured information about the facilitators and barriers for building PBRNs, although not all components delineated facilitators and barriers. This article focuses on the 2 main themes “*Stakeholders at the Intersection between the Internal and External Environment*” and “*External Environment*,” and the 8 subthemes and 32 key elements that are linked to them.

In summary, our analytic pathway from data gathering to theme development can be described as follows:

Figure 2. An example of the methodological approach in synthesizing components, key elements, subthemes, and themes from the quotations.



Note: As a methodological example, the Figure illustrates how the key element "Motivation of Community Members for Research Participation" was derived from quotations we collected from the literature

Gathering original narratives from articles (relevant quotations) > Structuring and grouping narratives > Developing components (eg, "Commitment and motivation to improve health in community") > Grouping components > Developing key elements from groups of relevant components (eg, "Motivation of Community Members for Research Participation") > Grouping key elements > Developing subthemes from groups of relevant key elements (eg, "Patients and Community Stakeholders") > Grouping subthemes > Coalescing themes (eg, "Stakeholders at the Intersection between the Internal and External Environment").

An example of the methodological approach to synthesizing components, key elements, subthemes, and main themes is presented in Figure 2.

Results

Our original database search identified 2538¹⁴ publications and the updated literature search yielded 53 publications. The inclusion/exclusion criteria were identical to the previous publication¹⁴ and applied on now 2591 publications, of which, 31 new sources met

our inclusion/exclusion criteria. Of these 31 sources, 19 came from the same PBRNs reported in the previous study¹⁴ and 12 led us to the identification of 5 new PBRNs. This resulted in 260 articles for this study.

Our review yielded 98 PBRNs, 2 of which were binational, 4 multinational, 37 from the USA, 15 from the UK, 12 from Australia, 4 from Belgium, 7 from the Netherlands, 3 from Ireland, 2 from Switzerland, 2 from New Zealand, 3 from Canada, and 1 PBRN from Finland, Germany, Greece, Italy, Singapore, South Africa, and Sweden, respectively (Figure 3).

The synthesis of our results yielded 3 main themes, 12 subthemes, and 57 key elements. The overarching thematic framework and thematic connections between its components are presented in a previous publication,¹⁴ while in Appendix Table 2 we show the key elements related to the internal environment (not included in this study; see shaded cells).

In this study, we identified 2 main themes that represented 2 groups of stakeholders. The main theme "*Stakeholders at the Intersection between the Internal and External Environment*" reflects the

Figure 3. The world map of Practice-Based Research Networks (PBRNs).

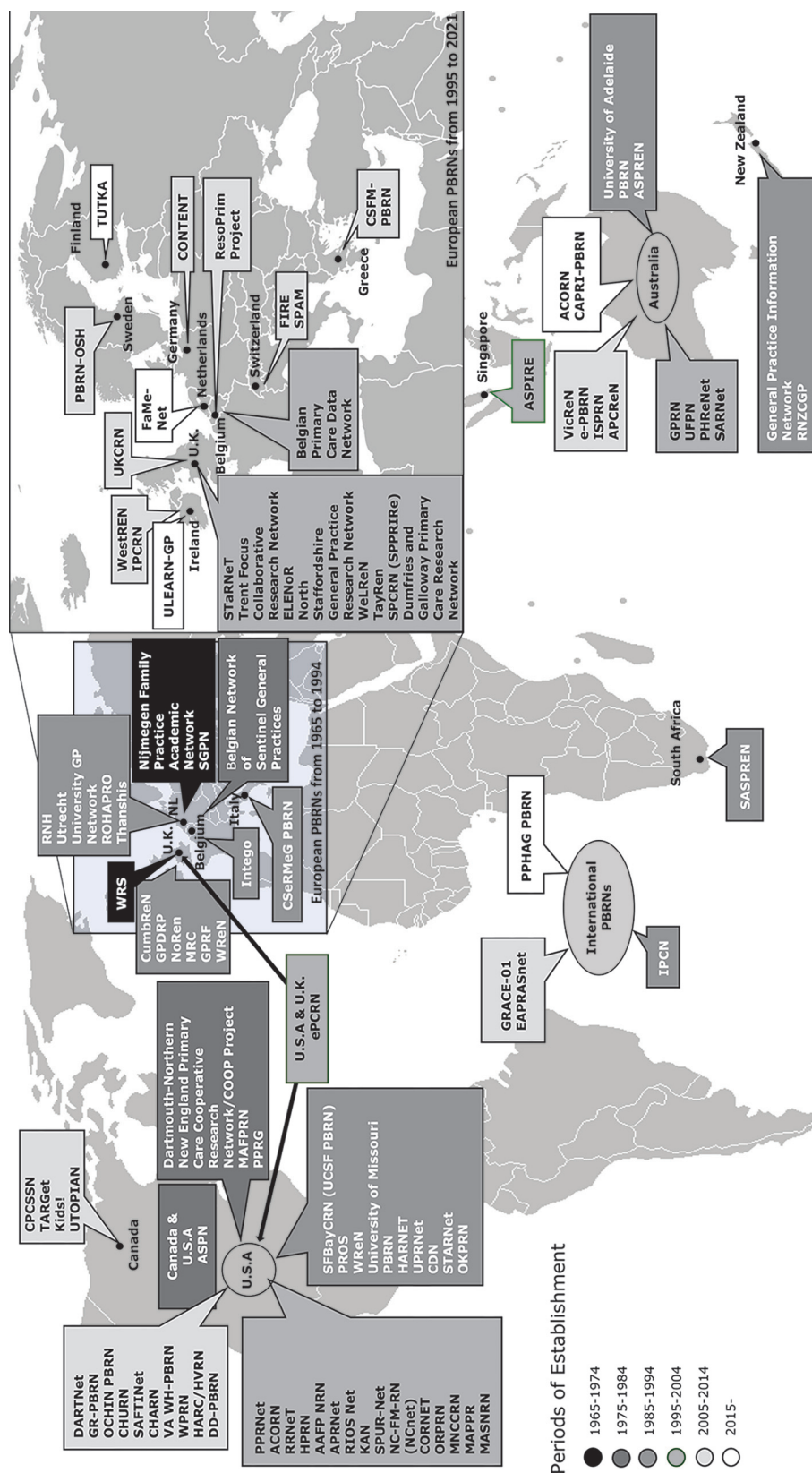
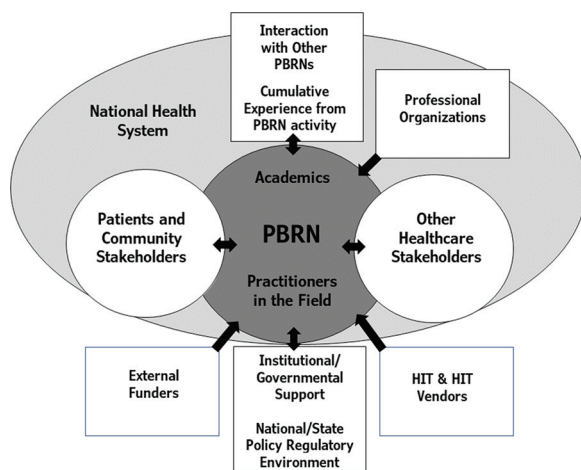


Figure 4. Stakeholders influencing the development of Practice-Based Research Networks (PBRNs). Abbreviation: HIT, Health Information Technology.



Note: The Figure is an illustration of connections between various stakeholders in relation to PBRNs (internal environment) and to the national healthcare system in which PBRNs and some of the stakeholders are situated. The directions of the arrows reflect the nature of these relationships. Relationships with “Patient and Community Stakeholders” and “Other healthcare Stakeholders” permeate the internal environment of PBRNs

group of “boundary spanners” between the internal and external environments. These stakeholders spanned both the external and internal environments in the networks we explored, which were created at various times during a period of over 50 years, and so we categorized these in a separate main theme. The other main theme “*External Environment*” includes stakeholders that, although located in the external environment,²² influenced the development of PBRNs. (Figure 4)

Main Theme: Stakeholders at the Intersection of the Internal and External Environment

We identified 2 subthemes and 11 key elements linked with the main theme “*Stakeholders at the Intersection of the Internal and External Environment.*” The overarching thematic structure of this theme (subthemes, key elements, and components) are presented in Table 1. The included components are facilitators and barriers for building PBRNs.

Subtheme: Patients and Community Stakeholders

Our review identified an increased focus on rural,^{9,22–25} nonmetropolitan,^{26–28} or disadvantaged communities^{29,30} across American PBRNs that

emerged before the 2000s. A considerable number of PBRNs aimed to address health disparities among underserved, minority, or vulnerable populations in the community they served,^{30–40,41,66} or participated in consortium of PBRNs with similar missions.⁴² Australian PBRNs expressed interest in rural populations through the membership of local practitioners.^{42–46,157} We also identified several UK PBRNs that focused on rural populations.^{47–49}

A few of the early networks linked patient care excellence to patient-centeredness and community engagement,^{29,50,51} This spread across the majority of networks over time and highlighted the importance of patient-engagement to improve patient outcomes and satisfaction.^{33,40,51–58} Fundamental components of the key elements “relationships with patients and community groups” included trusting and long-standing partnerships to promote equity and address health disparities.^{25,31,34–39,48,53,57–67}

Networks with more “bottom-up” governance^{17,68,69} implemented Community-based Participatory Research (CBPR) methodologies at least in some of the steps of their research, to increase the impact of research on their community,^{25,29,31,32,40,54,59,62,70} The work of Community Advisory Boards (CABs) was essential to CBPR research.^{55,62,66,67,70,71,73} On the other hand, several networks with a more “top-down” (hierarchical) approach^{17,68,69} also established collaborative relationships, shared decision-making and research dissemination activities with patients, and incentivized patient participation in research to generate benefit for broader populations.^{58,63,74–76}

Subtheme: Other Healthcare Stakeholders

Various healthcare stakeholders such as academic institutions, health systems, public health entities, industry, insurers, health organizations, and policy advocates were involved in the activities of PBRNs.^{10,38,39,46,51–54,60,61,63,66,69,77–90} The majority of UK PBRNs started in the 1990s reported engagement of health authorities and community trusts in their partnerships,^{48,69,78,79,92} while they also integrated social care research into their activities.^{48,49,60,78,93,94}

In the past 2 decades, more emphasis was placed on the engagement of stakeholders from different levels of healthcare (national, state, and local) and educational institutions.^{37,38,52,66,68,69,71,72,77–}

Table 1. Subthemes, Key Elements and Components Linked to the Main Theme “Stakeholders at the Intersection Between the Internal and External Environment”

Theme: Stakeholders at the Intersection between the Internal and External Environment											
Sub-theme: Patients and Community Stakeholders								Sub-theme: Other Healthcare Stakeholders			
Key elements								Key elements			
Patient-centeredness and community engagement in PBRNs	Relationship building with patient or community groups as an essential part of research	Quality improvement activities guided by patient feedback	Involving patients or community members in PBRN governance	Integrating CBPR and PCOR methodology into PBRN research	Community Engaged Research methodology in PBRN research	Motivation of community members for research participation	Community engagement in health policy-making through PBRN activity	Identification, engagement and contribution of healthcare stakeholders	Relationship building with healthcare stakeholders	Other aspects of working with healthcare stakeholders	
Components											
<u>Facilitators</u>	<u>Facilitators</u>	<u>Facilitators</u>	<u>Facilitators</u>	<u>Facilitators</u>	<u>Facilitators</u>	<u>Facilitators</u>	<u>Facilitators</u>	<u>Facilitators</u>	<u>Facilitators</u>	<u>Facilitators</u>	
Patient care excellence linked to patient-centeredness and community engagement	Building collaborative relationships and shared decision-making with patients	Develop patient satisfaction surveys to future QI studies	Patient advisory board engaged in research planning	Research designed for CBPR implementation	Development and promotion of a community engagement model	Commitment and motivation to improve health in the community	When the involvement in policymaking is anchored in the practice model of care, which is a member of PBRN	Identifying relevant stakeholders and establishing roles and responsibilities of the various stakeholders	Engaging other healthcare stakeholders in research agenda development and in research translation	Use of network data	
Increased importance of patient engagement in PBRN research	Building longstanding relationships of trust and mutual respect and gaining strong commitment from community patient groups	Linking patient complaint to practices QI activity	Community representatives or leads engaged in the PBRN governance	Community engagement in shared decision-making pertaining to all aspects of research through CABs that guide planning and conducting projects	Training and brainstorming meetings for community members	Incentives for patients and community members for engagement in research	The PBRN research impact is strengthened when the research aims are linked to community users	Developing a PBRN infrastructure as part of a broader effort of other healthcare stakeholders (eg., Clinical and Translational Science Awards infrastructure)	Barriers	Engagement in research prioritization	
A cultural shift in the role of primary care research	Improving the patient and clinician interaction for better care	Improving the patient and clinician interaction for better care	Involving patients or community groups in PBRN governance, even from the network formation point	Community members facilitate outreach, research translation, dissemination and feedback	Community engagement may entail increased costs for a study	Recognition and acknowledgment of member contribution	The PBRN research impact is strengthened when the research aims are linked to community users	Multi-stakeholder engagement strengthens the infrastructure of a network, increases the potential for multidisciplinary research and enables broader collaborations with scientific assemblies	The research culture is not rooted in all healthcare stakeholders, and if so, the engagement of other groups is hindered or considered not necessary	Development of PBRN infrastructure as part of the effort of an academic research infrastructure (CTSA) and a university faculty	
Setting community needs and/or health equity as a priority of PBRN and a community-based and/or patient-centered	Development of trusting relationship with parents	Best practices implementation with the contribution of patients and other stakeholder feedbacks	Community engagement in some or all procedures of research activity	Data collection and analysis engaging community	Tangible benefits from CBPR implementation			PBRN collaboration that builds on existing resources.	The integration of the different cultures of other healthcare stakeholders may challenge expectations and policies within the network	Engagement in operations strategic planning	
	Academics linking to local community		Community members engaged		Developing patient-centered outcomes			Engaging sponsoring organizations motivated to provide initial and		Informing the research outcomes to various stakeholders	

(continued)

Theme: Stakeholders at the Intersection between the Internal and External Environment										
Sub-theme: Patients and Community Stakeholders					Sub-theme: Other Healthcare Stakeholders					
Key elements					Key elements					
Patient-centeredness and community engagement in PBRNs	Relationship building with patient or community groups as an essential part of research	Quality improvement activities guided by patient feedback	Involving patients or community members in PBRN governance	Integrating CBPR and PCOR methodology into PBRN research	Community Engaged Research methodology in PBRN research	Motivation of community members for research participation	Community engagement in health policy-making through PBRN activity	Identification, engagement and contribution of healthcare stakeholders	Relationship building with healthcare stakeholders	Other aspects of working with healthcare stakeholders
Components					Components					
outcomes research agenda	partners through the network				research (PCOR) integrating community engaged research methodology in PBRN research			continuing support, both political and financial, and input into the governance of the network		
Patient-centered care as a priority of the network	Patients favor practices and doctors engaged in research Patients value their engagement in research Co-designing a PBRN with patients and community members providing strong mutual responsibilities (e.g., ownership of studies, use the findings, assistance in dissemination) if the network wishes to have strong patient-centered orientation		Community-based organizations and community members part of network partnership		Barriers Community engagement is challenged by the turnover of community members participating either in CABs or research procedures			Building a PBRN to be an interface that fosters collaboration with other healthcare groups (eg., local hospitals, social care) Developing coalitions of interest from different parts of the healthcare system that strengthen the research impact and sustainability of the PBRN Sharing administrative activities for cross-organizational research oversight and quality assurance		
	<u>Barriers</u> Balancing community advocacy with the PBRN research demands				Equitable partnerships with engagement of CABs may be challenged by the confidence and experience of researchers and requires continuous re-assessment and improvement to be both effective and sustainable Research participant "burnout" or recruitment situation due to PBRN special population or limited pool of research motivated and eligible patients Challenges from increased costs due to CBPR implementation					

Note: The Table presents only those components of our findings that represent facilitators and barriers of building PBRNs. Our broader findings were used to develop key elements that are linked to PBRN development. Key elements presented here are linked to sub themes, which correspond with groups of actors that influenced the establishment of PBRNs and belong to the main theme "Stake holders at the Intersection between the Internal and External Environment".

Abbreviation: PBRNs, Practice-Based Research Networks.

80,84,88,89,94–96,237,250 Shared mission between a PBRN and other healthcare stakeholders for the improvement of healthcare engendered relationships for R&D and learning in a wide array of projects.^{34,36,39,47,48,53,62,69,79,89,93,98–107} Further, a considerable number of more recently created PBRNs established such partnerships from their inception.^{39,54,55,63,72,80,88,89,97,108,109}

Main Theme: External Environment

We identified 6 subthemes and 21 key elements linked with the main theme “*External Environment*.” The overarching thematic structure of this theme (subthemes, key elements and components) are presented in Table 2. These components are facilitators and barriers for building PBRNs. In addition, a condensed presentation of the subthemes is presented below.

Subtheme: National Healthcare System

Many publications indicate that PBRNs were anchored in the broader healthcare system in their country.^{7,32,35,45,58,63,67,78,81,86,89,106,116,120,121,135} A strong position of general practice/family medicine in the healthcare system positively influenced PBRN development, whereas networks reported more barriers to their development in countries with less primary care support or no requirement for patients to have a primary care/family doctor as their coordinator of health services.^{45,52,63–65,81,115–122}

In some countries, where PBRN activity was appreciated, networks were incorporated into the broader healthcare system.^{63,117,121,151} to function as research laboratories of primary care,^{63,86,102} or as organizations that conducted research that focused on the priorities of the healthcare system.^{63,86,123} In some other countries PBRNs built on their linkages to the broader healthcare system with objectives for optimizing the quality and efficiency of healthcare^{28,33,39,44,50,51,62,64,67,80,81,84–86,105,111,113,120,122–133} and for timely knowledge translation and dissemination.^{25,53,55,67,70,80,85,89,95,97,114,128,129,135–139}

Subtheme: Institutional/Governmental Support, National/State Policy, and Regulatory Environment

Many PBRNs provided an interface for collaborative effort with governmental bodies and institutions.^{9,38,52,89,92,97,109,136,149–152} They disseminated their results to the government and health authorities, influenced health policies and recommendations and advocated for

R&D programs and practice-based and/or community-based evidence.^{29,38,40,52,57,58,70,80,81,89,92,106,109,114,120,130,149,152,153} In some countries, their recognition secured more systematic and substantial funding, via national-level initiatives.^{22,86,104,114,125,154,157}

In other cases, PBRNs were influenced by national initiatives and policies that either supported networks at their inception^{45,47–49,52,63,68,69,72,75,79,102,104,109,120,155–157,161,165,184,250} or later,^{32,36,52,75,138,158–162} or they were linked to their transformation,^{63,85,123,163,164} or to the dissolution of some PBRNs.^{165,166} The regulatory environment in different countries facilitated commitment to long-term funding to help improve evidence-based practice and research capacity in primary care,^{46–49,63,68,69,72,78,79,86,102,123,149,155–159} shored up indirect support through development of agencies which became pivotal supporters of PBRNs,^{32,34,35,40,51,54,87,89,128,139,141,158,159,161–163,188} or positively influenced the research impact of PBRNs^{34,39,55,82,108,113,128,132,169,171,172} and reinforced the patient-centeredness of their research^{38,39,56,57,62,70,73–75,87,113,128}

Subtheme: Professional Organizations

National or local-level professional organizations identified a need for collaborative practice-based research and helped establish it as part of the development of the academic discipline.^{5,11,22,28,89,92,99,110,136,141,143,148,150,175,188} A number of networks were initiated by professional organizations^{26,92,136,141,148,166,167,176–179} alone or in collaboration with academic departments and/or (research) institutes,^{28,64,77,82,85,92,97,109,119,130,134,178} to link PBRNs to education and professional development.

In the USA, UK and Netherlands these organizations collaborated closely with PBRNs, promoting participation in research studies among their members.^{22,56,92,110,126,141,150,175,235} In the Netherlands, professional organizations supported the development of Electronic Health Records (EHRs) appropriate for primary care practices.^{126,180} Publications suggested that international professional organizations such as the World Organization of National Colleges and Academics (WONCA), the North American Primary Care Research Group (NAPCRG), the European Academy of Pediatrics (EAP), and the European General Practice Research Network (EGPRN) played an important role in linking and motivating academics and professionals with

Table 2. Subthemes, Key Elements and Components Linked to the Main Theme “External Environment”

Theme: External environment									
Sub-theme: National Health System	Sub-theme: Institutional /Governmental Support, National/State Policy and Regulatory Environment					Sub-theme: Professional Organizations		Sub-theme: External Funders	
Key element	Key elements					Key elements		Key element	
The impact of primary healthcare structure on PBRN development	Decision-makers	National policy	Regulatory environment	Interaction with policy makers	Community impact on public health policymakers through PBRN	National professional organization contribution and support	International professional organizations contribution	External Funders contributions	
Components	Components					Components		Components	
Facilitators	Facilitators	Facilitators	Facilitators	Facilitators	Facilitators	Facilitators	Facilitators	Facilitators	
Anchoring the network in the national health system	Initiative to develop the general practice discipline	Political agenda supporting plans that reinforce the role of primary care and primary care research	National initiative for funding PBRN	PBRN research results inform policymakers (eg., recommendations and e-health services)	Influencing healthcare policy and legislation for community care	Providing official endorsements and/or funding and/or in-kind support for building the PBRN	Linked academics and professionals with common research interests	Funding to start-up research	
Strong position of Family practice in the healthcare system	Assigned study to evaluate the research capacity in primary care	Promotion of PBRN development as part of research and technology enhancement	National legislation and subsequent initiatives for PBRN development to build capacity and implement evidence, pull data for research and population health, health service monitoring and promoting effective research translation	The PBRN provides the appropriate framework for a national strategy or initiative implementation	Research relevant to community needs and effective dissemination of findings to impact public health and policy	Linked the practice-based research to education growth	Inspired development of PBRNs	External infrastructural funding	
Integration of the PBRN activity in the health system	Recognized need for evidence-based practice in primary care	Strategy for PBRN reform throughout the country	National awards for activities promoting community engagement in research and translation	Policymakers advocacy through the network	Recognized need for primary healthcare data informing population health	Identified the need for collaborative research based in the practitioner organization	Facilitated supportive activities for PBRN research	Funding for research capacity building	
Driver for evidence-based care and control of healthcare costs	Funding allocation for PBRN development	National policies aligned with the mission of the members (practice/clinics) of the network (eg., addressing health disparities).	National initiatives for funding to university departments to develop PBRNs	Health/disease monitoring needs to inform government and health authorities		Recognized research as part of the development of the academic discipline	National initiatives or strategies for developing research in primary care that entail relevant fundings	Sustainability linked to both political and financial support	
Transformations in the national healthcare system seeking more efficient primary healthcare	Incentives for computerization of practices	Promotion of funding to university departments to develop PBRNs	<u>Barriers</u>	PBRN members represent the primary care researchers for the formulation of the R&D program		Engagement of professional organization in the research activity of the network	National initiatives or strategies for funding PBRN	Variability in financial support for early projects	
Insufficient national alignment of primary care leadership and may provide opportunities for PBRNs to contribute to this leadership and vision		Promotion of linking academia to community-based care in primary care setting	Laws that hinder or prohibit GPs doing research by setting bureaucratic	Interconnections with other databases (eg., hospital care) increased the value of the data for the government and		Promoting incentives (eg., professional credits) for PBRN activity	National initiatives or strategies for funding PBRN	International opportunities for infrastructural funding	

(continued)

Theme: External environment									
Sub-theme: National Health System	Sub-theme: Institutional /Governmental Support, National/State Policy and Regulatory Environment					Sub-theme: Professional Organizations		Sub-theme: External Funders	
Key element	Decision-makers	National policy	Regulatory environment	Interaction with policymakers	Community impact on public health policymakers through PBRN	Key elements		Key element	
Components			Components			Components		External Funders contributions	
<p>A cultural shift towards research in the primary healthcare system</p> <p>Development of modern health systems that recognizes as a key foundation for a well-functioning family medicine/general practice the existence of a strong research component</p> <p>Common plans for joint social and healthcare</p> <p>Barriers</p> <p>National health system where the family physicians/general practitioners are not “gate-keepers” for specialized services</p>		<p>Promotion of funding for PBRN development</p> <p>Promotion of funding for PBRN with specialized objectives (eg., the inclusion of community members or patient groups in research and procedures</p> <p>National information technology strategy supporting the full implementation of EHR</p> <p>Incentives for use HIT solutions for data-sharing for patient-centered care (eg., national policies, initiatives or incentives that support the development EHRs, and/or HIT applications that may support directly or indirectly the PBRN infrastructure)</p>	<p>limitations (eg., special license for research)</p>	<p>national agencies decision-making</p> <p>The PBRN is necessary and has a special position in the research continuum</p>		<p>Identified the need for detailed information on population morbidity</p> <p>Linking the PBRN activity with either a national or state professional organization, or both</p> <p>Developing a PBRN as a sub-entity of a professional organization</p>		<p>Funders’ interests and network goals are aligned</p> <p>Financial and in-kind support for infrastructure development from a variety of organizations, including the national agencies and professional organizations</p> <p>Funding targeted to research questions seeking for more effective healthcare and patient engagement</p> <p>Brokering models of collaboration with experienced researchers that bring research grants to network</p> <p>Funding from industry (eg., pharmaceuticals) for research aligned to mission and ethics of the network</p>	

(continued)

Theme: External environment									
Sub-theme: National Health System	Sub-theme: Institutional /Governmental Support, National/State Policy and Regulatory Environment					Sub-theme: Professional Organizations		Sub-theme: External Funders	
Key element	Key elements					Key elements		Key element	
The impact of primary healthcare structure on PBRN development	Decision-makers	National policy	Regulatory environment	Interaction with policymakers	Community impact on public health policy makers through PBRN	National professional organization contribution and support	International professional organizations contribution	External Funders contributions	Components
<p>National health systems where each patient is not registered with a sole FP/GP may face challenges with overlapping data or changing population, when their data derive from EHR recording</p> <p>The transformation of the small physician-owned practices into health systems and clinics or hospitals challenges that requests other types of membership and participation</p> <p>National health system with less primary care support</p>		<p><u>Barriers</u></p> <p>Reduction or elimination of government support in PBRN activity</p> <p>Unstable political climate and contradictory national policies towards PBRN development</p>						<p><u>Barriers</u></p> <p>Lack of stability of infrastructure funding is an instrumental problem for the PBRN development</p> <p>Dependence on study-specific grants to maintain the infrastructure of the network</p> <p>Low levels of funding from industry due to conflicts of interest with network mission</p>	

(continued)

(continued)

Sub-theme: Leveraging previous research and PBRN experience and interacting with other networks						Sub-theme: HIT and HIT vendors					
Key elements						Key elements					
International experience	National experience	Leveraging previous research expertise	Leveraging PBRN practice models	Leveraging experience from peer networks	Interacting with other networks	Developing networks of PBRNs	HIT applications sustain the infrastructure	HIT applications facilitating or supporting the PBRN operation	HIT vendors contribute to sustainability	HIT vendor in the partnership of the network	Challenges from the variety of EHR systems
Components						Components					
Facilitators	Facilitators	Facilitators	Facilitators	Facilitators	Facilitators	Facilitators	Facilitators	Facilitators	Facilitators	Facilitators	Facilitators
Learning lessons from the international experience in PBRNs	Development of international PBRN based on national experience	Members with previous research experience or collaboration with a PBRN	Adopting PBRN practice model used by previous network	Integrating the experience of peer network into a PBRN	Building a network with complementary activity to previous ones	Benefiting from strategic partnership where each PBRN shares administrative, HIT and mentoring, support through a cost-effective coordinating infrastructure that assists collaborative research projects, local and national level benchmarking, QI activities, sharing best practices, learning communities and innovation spread	Advances in computerization	Interventions using HIT application	The use of HIT/EHR integrated into PBRN activity (eg., the use of common or shared EHR is a strong facilitator in building a PBRN; the application of standardized coding in EHR when recording health conditions or episodes of health ensures better data quality for research)	HIT vendor is among the founders of the network	Extracting data from all certified EHRs is unfeasible due to high costs
Learning from literature review on PBRN establishment	Providing opportunities for shared resources and research facilitation	Previous research experience or collaboration with a PBRN	Adopting PBRN practice model used by previous network	Integrating the experience of peer network into a PBRN	Building a network with complementary activity to previous ones	Benefiting from strategic partnership where each PBRN shares administrative, HIT and mentoring, support through a cost-effective coordinating infrastructure that assists collaborative research projects, local and national level benchmarking, QI activities, sharing best practices, learning communities and innovation spread	Network based on a shared EHR	Facilitation of multiple interventions and demanding methodology	The use of HIT/EHR integrated into PBRN activity (eg., the use of common or shared EHR is a strong facilitator in building a PBRN; the application of standardized coding in EHR when recording health conditions or episodes of health ensures better data quality for research)	HIT vendor is among the founders of the network	Extracting data from all certified EHRs is unfeasible due to high costs
Research Fellowships to capitalize on knowledge about PBRN development in other country	Providing opportunities for shared resources and research facilitation	Previous research experience or collaboration with a PBRN	Adopting PBRN practice model used by previous network	Integrating the experience of peer network into a PBRN	Building a network with complementary activity to previous ones	Benefiting from strategic partnership where each PBRN shares administrative, HIT and mentoring, support through a cost-effective coordinating infrastructure that assists collaborative research projects, local and national level benchmarking, QI activities, sharing best practices, learning communities and innovation spread	Network based on a shared EHR	Facilitation of multiple interventions and demanding methodology	The use of HIT/EHR integrated into PBRN activity (eg., the use of common or shared EHR is a strong facilitator in building a PBRN; the application of standardized coding in EHR when recording health conditions or episodes of health ensures better data quality for research)	HIT vendor is among the founders of the network	Extracting data from all certified EHRs is unfeasible due to high costs
Capitalizing experience from smaller (eg., regional) PBRNs as a step to bigger infrastructure development (eg., national)	Building new more specialized and/or national range PBRNs with the support of large national or international networks	Members with previous research experience or collaboration with a PBRN	Adopting PBRN practice model used by previous network	Integrating the experience of peer network into a PBRN	Building a network with complementary activity to previous ones	Benefiting from strategic partnership where each PBRN shares administrative, HIT and mentoring, support through a cost-effective coordinating infrastructure that assists collaborative research projects, local and national level benchmarking, QI activities, sharing best practices, learning communities and innovation spread	Network based on a shared EHR	Facilitation of multiple interventions and demanding methodology	The use of HIT/EHR integrated into PBRN activity (eg., the use of common or shared EHR is a strong facilitator in building a PBRN; the application of standardized coding in EHR when recording health conditions or episodes of health ensures better data quality for research)	HIT vendor is among the founders of the network	Extracting data from all certified EHRs is unfeasible due to high costs
Interacting with other researchers from various countries in the context of a project	Building new more specialized and/or national range PBRNs with the support of large national or international networks	Members with previous research experience or collaboration with a PBRN	Adopting PBRN practice model used by previous network	Integrating the experience of peer network into a PBRN	Building a network with complementary activity to previous ones	Benefiting from strategic partnership where each PBRN shares administrative, HIT and mentoring, support through a cost-effective coordinating infrastructure that assists collaborative research projects, local and national level benchmarking, QI activities, sharing best practices, learning communities and innovation spread	Network based on a shared EHR	Facilitation of multiple interventions and demanding methodology	The use of HIT/EHR integrated into PBRN activity (eg., the use of common or shared EHR is a strong facilitator in building a PBRN; the application of standardized coding in EHR when recording health conditions or episodes of health ensures better data quality for research)	HIT vendor is among the founders of the network	Extracting data from all certified EHRs is unfeasible due to high costs

Sub-theme: Leveraging previous research and PBRN experience and interacting with other networks							Sub-theme: HIT and HIT vendors					
Key elements							Key elements					
International experience	National experience	Leveraging previous research expertise	Leveraging PBRN practice models	Leveraging experience from peer networks	Interacting with other networks	Developing networks of PBRNs	HIT applications sustain the infrastructure	HIT applications facilitating or supporting the PBRN operation	HIT vendors contribute to sustainability	HIT vendor in the partnership of the network	Challenges from the variety of EHR systems	
Components							Components					
					Interacting with other researchers from various countries in the context of a project	Networks of PBRNs and large-scale collaboratives of PBRNs may entail higher infrastructure and transaction costs during research	HIT changes and slow pace in adoption of HIT applications may hinder the ability to access and evaluate data, and thus research participation Selection of an EHR vendor that has not considered needs for data extraction for research when the software was developed		HIT vendors supporting a PBRN development, (eg., improving the EHR potential or developing effective methods of extracting, linking, and managing data, or creating HIT applications useful for the PBRNs or the primary healthcare) architectures enabling the use of multifaceted approaches beneficial for PBRN function such as repositories or QI audits, and study facilitation and translational research support Development of “big data” with increased capacity for specific big scale studies (eg., CER) is attractive to funding organizations			

Note: The Table presents only those components of our findings that represent facilitators and barriers of building PBRNs. Our broader findings were used to develop key elements that are linked to PBRN development. Key elements presented here are linked to sub-themes, which correspond with groups of actors that influenced the establishment of PBRNs and belong to the main theme "External Environment".

Abbreviations: PBRNs, Practice-Based Research Networks; HIT, Health Information Technology; EHR, Electronic Health Record.

shared research interests to initiate international,^{11,22,112,143,181} and national^{22,48,67,145,250} or even regional PBRN^{22,67,91} activity. WONCA also facilitated the spread of the International Classification of Primary Care (ICPC) system over the PBRN registries.^{7,126,130,184}

Subtheme: External Funders

In addition to base-level funding from academic departments, which belong to the internal environment of PBRNs,¹⁴ PBRNs reported that received infrastructural financial support from a range of entities, including professional organizations, government-based funding agencies, academic and private institutions and foundations, national healthcare organizations, hospitals and other healthcare stakeholders,^{33,52,54,63,72,79,85,87,95,99,102,104,109,119,121,125,128,138–146,250} and even HIT vendors.⁸³

A number of PBRNs reported that their early projects were conducted on small, local grants and as they matured and their methodological approaches developed, they were able to secure more substantial funding from a broader set of sources.^{22,147,148} However, we found a few networks that started their research activities with sizeable funding.^{29,63,123,136}

Some other networks used a 3-pronged mechanism to fund their research: Large-scale, externally funded projects that pooled recognized researchers, internal network-wide projects that were supported financially by the network partnerships, and small-scale projects conducted by clinician-members, which addressed their individual research interests and provided limited funding from the network.^{22,68,69,83,218}

Subtheme: Leveraging Previous Research and PBRN Experience and Interacting with Other Networks

Our findings suggest that many PBRNs were developed based on experience gleaned from previous long-standing PBRNs and by interacting with other networks on a national or international level.^{11,22,45,48,63,75,92,102,109,110,112,120,130,136,181,182,183,184} In some cases, they simply relied on literature reviews and presentations/publications by other PBRNs to translate and apply knowledge gathered from networks either from the same or other countries.^{103,120}

Some of the networks were founded to accomplish goals that were complementary to those of a

previous network,^{111,127} or to leverage the research capacity of a dissolved¹ or older network,¹⁸⁵ or merging older networks,^{57,215} while others adopted specific PBRN practice models borrowed from prior networks^{48,92,112,181,187} and a considerable number tapped into previous research experience of their members and peer interaction.^{22,29,37,63,86} Federated networks could upscale research, quality improvement, and learning community activities, and provide economies of scale critical for the infrastructure of PBRNs.^{55,114,128,188}

Subtheme: HIT and HIT Vendors

Various HIT applications were used by PBRNs at their foundation phase, as early as the 1980s.^{9,11,83,116,125,126,180} Contributions of HIT sustained the development of PBRN infrastructure, either directly empowering networks to meet their growing research needs, or indirectly, when the use of a specific EHR was required for PBRN membership.^{36,38,53,73,81–83,109,130,132,133,138,146,185,191–193,197,236}

Many articles stated that PBRNs leveraged the potential of EHRs for healthcare data standardization, motivated HIT vendors to improve the quality of EHRs, and developed tools that facilitated data extraction and sharing,^{53,57,61,81,106,110,114,128,130,133,138,185,186,192–197} clinical decision-making, learning communities, and quality improvement activities.^{40,51,53,55,57,61,105,106,109,114,130,133,138,197}

PBRNs in collaboration with vendors, gave rise to numerous innovative HIT applications for example, technologies developed by e-PCRN,^{105,138,160,199} the shared EHR of OCHIN^{32,53,107} and the data-driven CPCSSN infrastructure.^{109,198,200,201} The expansion of EHR use facilitated “big data” aggregation and the development of Federated Networks^{87,114} and Distributed Data Networks (DDNs).^{39,128} These “big data” networks, contributed to the utilization of PBRN data by various healthcare stakeholders, including research institutes and government organizations, and advanced data-driven and policy-informing research for the benefit of wider populations.^{39,90,114,123,168,237}

Discussion

We conducted a scoping review of all discoverable literature on building PBRNs in an over 50-year period. Our analyses elucidated many facilitators and barriers for building PBRNs but our study was not limited to these exclusively. In this article, we

present 32 key-elements related to the main themes of “*Stakeholders at the Intersection between the Internal and External Environment*” and “*External Environment*.” Some of the stakeholders that belong to the first main theme (patients, community groups and other healthcare stakeholders) gradually moved from an initially external position (“recipients” or “organizers”), toward PBRNs as “co-organizers” or “co-founders” and increasingly engaged in evidence generation, implementation, and training partnerships over time. These transitions occurred at different times for PBRNs, but they were clearly visible over the 50-year study period. Thus, the separation between the main PBRN constituents, academics and practitioner members and external stakeholder groups, has diminished over time. The main theme “External Environment” represents the social context of family medicine where PBRNs were developed, which influenced their evolution, since there was a need to adjust to new challenges, but also to leverage new opportunities and experience that emerged from each particular context. In addition, as PBRNs matured, the influence of prior experience with PBRN work and interaction with other networks increased, likewise the impact of HIT and HIT vendors.

An extensive amount of evidence from the literature that we examined suggests that there are specific processes and activities that are necessary for creating new PBRNs. The cornerstone of developing PBRNs seems to be the reciprocal relationships and trust between the actors engaged in PBRN activities.¹⁴ Other pivotal ingredients include the participation of community stakeholders and other healthcare stakeholders in PBRN activity. Just as significantly, partnerships should be developed with actors of the external environment that augment the PBRN’s impact on the community that the network serves or on the broader social environment. Finally, we must note the importance of the healthcare context where PBRNs are developed and the role of infrastructural funding.

Some of our findings do not apply to all networks that are in the establishment process. For example, not all networks were shaped by all aspects of collaboration that were included in the key element “Other Aspects of Working with Healthcare Stakeholders.” In addition, some facilitators and barriers we listed in the Results section may be sensitive to the context of occurrence. For example,

quality improvement tends to emerge as a strong driver to engage in a PBRN,¹⁴ but it is usually curbed by the specific healthcare environment the PBRN is situated in.

This study was based on scoping review methodology which explores and assesses the available body of literature and allows the identification of key concepts that underpin the research topic.^{15,248,249} In addition, for the reasons we outlined in the Methods section, we purposefully selected social network theory to organize our data and structure our analysis, which provided our specific investigative lens. Although there may be other possible approaches to analyzing the data (eg, based on organizational theory), these were not in our scope. It may be beneficial for future studies to explore these alternative methods.

Beyond the immediate findings of this study, we also generated a repository of the international literature which may provide further information on the developmental experience of PBRNs across the world. From this repository, we also plan to create various resources that may help support the diffusion of PBRNs internationally.

Connection of Findings with Social Network Theory

Our analyses, anchored in social network theory,^{16,18} indicated that the highest density in thematic associations in our findings was identified in “relationship building,” and it was expressed by the degrees of interconnections between the individuals (eg, practitioners or academics)¹⁴ and between nodes (eg, practices, institutes, stakeholder groups) and the actual number of ties between them. The most common features of these relationships (ties) were multiplexity, reciprocity and reachability and express the qualities the PBRNs were built on and sustained their ties. The ties are strongly homogenous within the network, less homogenous when they connect the network with “boundary spanners,” and more heterogenous when they link the network with stakeholders of the external environment.^{16,18} These findings underscore that in addition to academic-practitioner relationships that shaped the internal environment of PBRNs, networks developed relationships with a diverse set of actors that were “boundary spanners” or were located in the external environment and they influenced the formation of networks directly or indirectly. The intensity and

density of these ties indicates that PBRNs operated as an interface for multilateral communication, interaction, and knowledge-sharing that shortened the time of spreading innovations from the “early majority” to the “late majority” of stakeholders. The first group includes practitioners and academics of the network and the second includes patients, community and other stakeholders (eg, healthcare authorities) or policymakers, who engage more actively in PBRN projects.^{202,203}

Other Interpretations on Key Elements of PBRNs

Publications indicate that each network was influenced by the *timing and location of its development* and many of them reported that previous experiences with healthcare systems, professionals, research policies or resources had an impact on them.^{206,214}

Our review suggests that the cumulative experience gained from PBRN activity and advancements in HIT was time-dependent. The same applies to the depth of engagement of patients, community members, and other healthcare stakeholders in PBRN activity. In addition, we identified bidirectional interactions between PBRNs and health policymakers, through which PBRNs became not only the subjects of policies that supported or hindered their inception or activities,^{154,156,158,159,165,172–174,209,238–243} but they also emerged as developers of priorities that influenced health policy.^{9,10,13,28,33,37–39,51,52,67–69,76,79,88,91,97,110,118,119,125,128,135,150,170,183,211,216,217,237}

In some situations, they acted as “conveners” who actively engaged health policymakers in the mission of PBRNs narrowing the “distance” between PBRNs and policymakers.^{9,53,85,88,89,142,237}

Through collaboration with patients, community groups and other healthcare stakeholders PBRNs paved the way for direct translation of research into policy and practice.^{29,39,48,54,67,80,86,88,89,97,109,152} Some of these partnerships also became “communities of solutions”²¹⁹ and were considered necessary to develop better health systems, health policies and guidelines.^{220,221} Health disparities played an important role here, through which PBRNs were able to shape a “geographic footprint” of their community to respond to the needs of their constituents and to consider the local primary care clinician as part of the community.²²² Our review suggests that a strong community and health equity focus was articulated by PBRNs by envisioning community-based research to be more pragmatic when it engages a wider variety of populations (eg, rural, uninsured, minorities) that

experienced community-based care as the only accessible care option. In addition, the interdependence we found between the pronounced motivation of practitioners to contribute to community health excellence and to serve these populations¹⁴ supports previous literature which suggests that PBRNs strengthen the ties between their internal structure and the community they serve when they embrace health equity and community engagement.^{222–224}

The Effect of National Environments

Variations in PBRN goals and pathways of network formation¹⁴ depended on specific national characteristics, of their health system over time that accentuated the role and the underlying culture of family medicine/general practice/primary care.

In our first scoping review,¹⁴ we found that most PBRNs were created either as a practitioner or academic initiative. In the current article, we show that networks were established either in the context of a national strategy that supported and defined their trajectory (a more centralized approach), or as a professional initiative that originated from groups of academics and individual practitioners, in addition to collaborations with professional organizations (decentralized or individualized approach). A decentralized approach for building PBRNs tended to be more common in the USA and the Netherlands, while a centralized (eg, national strategy-based) approach was more prevalent in the UK, Australia and Canada, in addition to the supportive involvement of the professional organizations in these countries.^{45,92,109}

Our results suggest that the characteristics of the national environment and various approaches to building PBRNs¹⁴ influenced the structure of research governance (who is leading); the priorities of research (who decides on research topics); and the methodology of research. The literature indicates that research priorities in the UK are typically defined by the national healthcare system,^{86,204,237} while in the USA, emerging funding opportunities tend to direct, but do not completely define research priorities of PBRNs.^{205–208} Methodologically, Dutch PBRN data registry networks were positioned well to conduct observational studies, while many local, regional and statewide networks in the USA were designed to facilitate quality improvement activities,¹⁴ capitalizing on the understanding of the local culture, interests and closer relationships with their members and the community. In this context,

practitioner aspirations for care quality improvement created a solid foundation and strong incentive for PBRN research, while community-based participatory research (CBPR) and patient-centered outcomes research (PCOR) methodologies also found fertile ground²⁰⁹ and fostered a stronger community-based role of primary healthcare.^{31,154,156,158,189,209–213}

Collaborations of PBRNs and the Benefits of HIT

PBRNs developed various types of collaborations and “federations” to enhance their sustainability and to foster collaborations with advocacy groups.^{12,137,226} They also leveraged HIT advancements that enabled the development of large databases and HIT-driven multi-network collaborations.^{57,61,114,123,128,138,168,190,197} This type of infrastructure helped extended access to a variety of populations, leveraged wider stakeholder interests, engaged in multiple types of research and focused on research topics and innovative methodologies^{190,229} leading to broader generalizability.^{123,168,244,245} These resources became more common in the late 2000s, which was expressed by the development “meta-networks” (ie, networks of networks) in USA and UK.^{14,86,123,170,189,227,228} PBRN meta-networks asked more ambitious research questions by pooling their resources and expertise and managed diversified research portfolios and business models that facilitated external stakeholders to influence PBRN research priorities and to accelerate the dissemination of research findings.^{114,189,230,231}

Financial Stability and Sustainability Models

The timing of building networks and the characteristics of the national environment defined PBRN management approaches and their funding opportunities. Early regional American and Dutch PBRNs received limited infrastructural support from professional or academic organizations. Conversely, the binational ASPN network received funding from private foundations and national organizations. Networks gradually benefited from supportive national strategies and more tangible infrastructural support from various funding bodies, as a result of recognizing the value of PBRN research and its impact on healthcare and policy.^{29,36,58,68,85,89,114,121,128,137,158,159,165,170,227,228} This underscores the importance of external relationships and support in the development of PBRNs,^{209,210,246} but also the risk

of becoming dependent on these relationships.^{206,246,247} In addition, research funds targeting the collection of data without much relevance to primary care, might also be seen as barrier. Some PBRNs responded to financial instability by developing either a model of limited resources^{125,153,232} or a business model that involved relationships with stakeholders in the external environment, as we reported in our previous article.¹⁴

Limitations

In this scoping review we completed the widest possible search in English-language publications and sources, and we explored a 10-year period of each network’s initial development, which may have influenced our frame of reference. Therefore, PBRNs that published in other than English language or never published, although they may have substantial experience, are not included in this review. However, the parameters we used were congruent with the temporal and source-language distribution of most PBRN literature.

The list of PBRNs that met the inclusion criteria is more limited than those that ever existed in the USA,²³³ Australia,^{238,250} the UK⁴⁸, Canada,²³⁴ the Netherlands,¹⁷⁵ and in web-based sources that refer to particular PBRNs, since there was no supporting literature in every case. We also excluded articles with insufficient information on the development of PBRNs.

Scoping reviews may carry selection bias, if all available data are not identified or included in the study. Inductive thematic analysis methodology was implemented in this study, however, some a priori knowledge about PBRNs may also contributed to the development of the thematic model.

Conclusions

This analysis highlights the importance of the external environment in the development of PBRNs, in addition to the previously reported role of the internal environment. A key finding is that “internalizing” the “outside world,” by involving patients, community leaders, health authorities and policymakers in their mission, makes the functioning of PBRNs more robust and the impact of their work on the health of populations more tangible. Understanding the health and social environment in which they operate is therefore a key to success in PBRN development.

To see this article online, please go to: <http://jabfm.org/content/35/4/762.full>.

References

1. Lindbloom EJ, Ewigman BG, Hickner JM. Practice-based research networks: the laboratories of primary care research. *Med Care* 2004;42.
2. Thomas P, Griffiths F, Kai J, O'Dwyer A. Networks for research in primary health care. *BMJ* 2001;322:588–90.
3. Green LA, Dovey SM. Practice based primary care research networks: They work and are ready for full development and support. *BMJ* 2001;322: 567–8.
4. van Weel C, de Grauw W. Family practices registration networks contributed to primary care research. *J Clin Epidemiol* 2006;59:779–83.
5. van WC, Rosser WW. Improving health care globally: A critical review of the necessity of family medicine research and recommendations to build research capacity. *Ann Fam Med* 2004;2:S5–S16.
6. Fleming DM, Norbury CA, Crombie DL. Annual and seasonal variation in the incidence of common diseases. *Occas Pap R Coll Gen Pract* 1991;1–24.
7. van Weel C. The continuous morbidity registration Nijmegen: Background and history of a Dutch general practice database. *Eur J Gen Pract* 2008;14.
8. Green LA, Simmons RL, Reed FM, Warren PS, Morrison JD. A family medicine information system: The beginning of a network for practicing and resident family physicians. *J Fam Pract.* 1978; 3:567–576.
9. Nelson EC, Kirk JW, Bise BW, et al. The Cooperative Information Project: Part 1: a sentinel practice network for service and research in primary care. *J Fam Pract* 1981;13.
10. Nelson EC, Kirk JW, Bise BW, et al. The cooperative information project: Part 2: some initial clinical, quality assurance, and practice management studies. *J Fam Pract* 1981;13.
11. Iverson DC, Calonge N, Miller RS, Niebauer LJ, Reed FM. The development and management of a primary care research network. *Fam Med* 1988;20:1978–87.
12. Green LA, Hickner J. A short history of primary care practice-based research networks: from concept to essential research laboratories. *J Am Board Fam Med* 2006;19:1–10.
13. Van Weel C, Smith H, Beasley JW. Family practice research networks: experiences from 3 countries. *J Fam Pract* 2000;49.
14. Dania A, Nagykalai Z, Haaranen A, et al. A review of 50 years of international literature on the internal environment of building Practice-Based Research Networks (PBRNs). *J Am Board Fam Med* 2021;34:762–97.
15. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol Theory Pract* 2005;8.
16. Moren-Cross J, Lin N. Social networks and health. In: Binstock R, George L, Cutler S, Hendricks J, Schulz J, eds. *Handbook of aging and the social sciences*. Academic Press; 2006:111–5.
17. Thomas P, Graffy J, Wallace P, Kirby M. How primary care networks can help integrate academic and service initiatives in primary care. *Ann Fam Med* 2006;4:235–9.
18. Brass DJ, Galaskiewicz J, Greve HR, Tsai W. Taking stock of networks and organizations: A multilevel perspective. *Acad Manag J* 2004;47.
19. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol* 2006;3.
20. Maguire M, Delahunt B. Doing a thematic analysis: a practical, step-by-step guide for learning and teaching scholars. *All Irel J Teach Learn High Educn* 2017;8.
21. Vaismoradi M, Turunen H, Bondas T. Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nurs Heal Sci* 2013;15.
22. American Academy of Family Physicians. *Practice-based research networks in the 21st century: the pearls of research*.; 1998. https://www.aafp.org/dam/AAFP/documents/patient_care/nrn/pearlsofresearch.pdf.
23. Fagnan LJ, Morris C, Shipman SA, Holub J, King A, Angier H. Characterizing a practice-based research network: Oregon rural practice-based research network (ORPRN) survey tools. *J Am Board Fam Med* 2007;20.
24. Williamson HA, Hector MG, LeFevre M, White RD. Establishing a rural family practice research network. *Fam Med* 1988;20.
25. Westfall JM, VanVorst RF, Main DS, Herbert C. Community-based participatory research in practice-based research networks. *Ann Fam Med* 2006;4.
26. Solberg LI, Cole PM, Seifert MH. The Minnesota Academy of Family Physicians' Research Network: a vehicle for practice-based research. *Minn Med* 1986;69.
27. Pearce KA, Love MM, Barron MA, Matheny SC, Mahfoud Z. How and why to study the practice content of a practice-based research network. *Ann Fam Med* 2004;2.
28. Mold JW, Barton ED. OAFP starts practice-based resource/research network. *J Okla State Med Assoc* 1996;89.
29. Sardell A. Clinical networks and clinician retention: the case of CDN. *J Community Health* 1996;21:437–51.
30. RRNET. About RRNeT Institute for Integration of Medicine and Science. Accessed June 28, 2020. Available from: <https://iims.uthscsa.edu/RRNeT/about>.

31. Dulin MF, Tapp H, Smith HA, Urquieta de Hernandez B, Furuseth OJ. A community based participatory approach to improving health in a Hispanic population. *Implement Sci* 2011;6.
32. DeVoe JE, Sears A. The ochin community information network: Bringing together community health centers, information technology, and data to support a patient-centered medical village. *J Am Board Fam Med* 2013;26:271–8.
33. Kuo GM, Steinbauer JR, Spann SJ. Conducting medication safety research projects in a primary care physician practice-based research network. *J Am Pharm Assoc* 2008;48.
34. Anderko L, Lundeen S, Bartz C. The Midwest Nursing Centers Consortium Research Network: translating research into practice. *Policy Polit Nurs Pract* 2006;7:101–9.
35. Serwint JR, Thoma KA, Dabrow SM, for the CORNET Investigators, et al. Comparing patients seen in pediatric resident continuity clinics and National Ambulatory Medical Care Survey practices: A study from the Continuity Research Network. *Pediatrics* 2006;118:e849–e858.
36. Sloane PD, Callahan L, Kahwati L, Mitchell CM. Development of a practice-based patient cohort for primary care research. *Fam Med* 2006;38.
37. Fagnan LJ. ORPRN “Blue Highways”. *Reflections* 2018;1–9.
38. Carsley S, Borkhoff CM, Maguire JL, et al. Cohort profile: The Applied Research Group for Kids (TARGet Kids!). *Int J Epidemiol* 2015;44.
39. Sills MR. SAFTINet overview for EDRC. presented to the Emergency Department Research Committee, Department of Pediatrics, University of Colorado School of Medicine. 6 January 2015. Published 2015. Accessed June 29, 2020. <https://www.slideshare.net/MarionSills/saftinet-overview-for-edrc>.
40. Likumahuwa S, Song H, Singal R, et al. Building research infrastructure in community health centers: A Community Health Applied Research Network (CHARN) report. *J Am Board Fam Med* 2013;26.
41. McCloskey B, Grey M, Deshefy-Longhi T, Grey LJ. Aprn practice patterns in primary care. *Nurse Pract* 2003;28:39–44.
42. Australian Primary Care Research Network APCReN. 2014 PHC Research Conference Highlights. *Aust Prim Care Res Netw APCReN Newsl*. Published online 2014. <http://www.apcren.org.au/news-events/>.
43. Marley J. Establishing a rural research network. *Med J Aust* 1992;156.
44. Australian Primary Care Research Network APCReN. APCReN. www.apcren.org.au.
45. Gunn JM. Should Australia develop primary care research networks? *Med J Aust* 2002;177.
46. Ried K, Farmer EA, Weston KM. Bursaries, writing grants and fellowships: A strategy to develop research capacity in primary health care. *BMC Fam Pract* 2007;8:19.
47. Robertson S, Hornby C, Jones R. Joint working to develop R&D capacity in three rural primary care trusts. *Prim health care res dev* 2005;6:1–4.
48. Comino E. The Winston Churchill Memorial Trust of Australia Churchill Fellowship 2002 Primary health care research (networks) in the United Kingdom. Published online 2002:1–38. http://nswcfa.churchilltrust.com.au/media/fellows/Comino_Elizabeth_2002-1.pdf.
49. Hannay DR. Evaluation of a primary care research network in rural Scotland. *Prim Heal Care Res Dev* 2006;7.
50. Nelson E, Conger B, Douglass R, et al. Functional health status levels of primary care patients. *JAMA* 1983;249:3331.
51. Mold JW, Peterson KA. Primary care practice-based research networks: Working at the interface between research and quality improvement. *Ann Fam Med* 2005;3.
52. Schweikardt C, Verheij RA, Donker GA, Coppieters Y. The historical development of the Dutch Sentinel General Practice Network from a paper-based into a digital primary care monitoring system. *J Public Heal* 2016;24.
53. DeVoe JE, Gold R, Spofford M, et al. Developing a network of community health centers with a common electronic health record: description of the Safety Net West Practice-based Research Network (SNW-PBRN). *J Am Board Fam Med* 2011;24.
54. Anderko L, Bartz C, Lundeen S. Practice-based research networks: Nursing centers and communities working collaboratively to reduce health disparities. *Nurs Clin North Am* 2005;40.
55. Baldwin LM, Keppel GA, Davis A, Guirguis-Blake J, Force RW, Berg AO. Developing a Practice-based research network by integrating quality improvement: challenges and ingredients for success. *Clin Transl Sci* 2012;5:351–5.
56. Love MM, Pearce KA, Williamson MA, Barron MA, Shelton BJ. Patients, practices, and relationships: challenges and lessons learned from the Kentucky Ambulatory Network (KAN) CaRESS clinical trial. *J Am Board Fam Med* 2006;19:75–84.
57. Luijckx H, van Boven K, Hartman T. O, Uijen A, van Weel C, Schers H. Purposeful incorporation of patient narratives in the medical record in the Netherlands. *J Am Board Fam Med* 2021;34.
58. Tu K, Sodhi S, Kidd MR, et al. *The University of Toronto Family Medicine Report: caring for our diverse populations*. Department of Family and Community Medicine; 2020. Accessed September

- 19, 2021. https://dfcm.utoronto.ca/sites/default/files/university_of_toronto_family_medicine_report_-_caring_for_our_diverse_populations.pdf.
59. Arkind J, Likumahuwa-Ackman S, Warren N, et al. Lessons learned from developing a patient engagement panel: an OCHIN report. *J Am Board Fam Med* 2015;28:632–8.
60. Graffy J, Hines M, Fosam H, et al. Report. In: *Report.*; 2002.
61. Stephens KA, Lin C-P, Baldwin L-M, et al. LC Data QUEST: a technical architecture for community federated clinical data sharing. *AMIA Jt Summits Transl Sci proceedings AMIA Jt Summits Transl Sci* 2012;2012:57–62.
62. Tyler CV, Werner JJ. Community-engagement strategies of the developmental disabilities practice-based research network (DD-PBRN). *J Am Board Fam Med* 2014;27.
63. Sullivan F, Hinds A, Pitkethly M, Treweek S, Wilson P, Wyke S. Primary care research network progress in Scotland. *Eur J Gen Pract* 2014;20.
64. Visentin G, on behalf of R&P Collaborative Group. R&P: the multiple meaning of a research project in general practice. *Eur J Clin Nutr* 2005;59:S89–S92.
65. Schers H, Bor H, van den Hoogen H, van Weel C. What went and what came? Morbidity trends in general practice from the Netherlands. *Eur J Gen Pract* 2008;14 (Suppl 1):13–24.
66. Dulin MF. *The Creation of PBRN to study health care delivery to a transitioning community (HS16023).*; 2005.
67. Lamont R, Fishman T, Sanders PF, Ofanoa M, Goodyear-Smith F. View from the canoe: Co-designing research pacific style. *Ann Fam Med* 2020;18:172–5.
68. Soós M, Temple-Smith M, Gunn J, Johnston-Ata'Ata K, Pirotta M. Establishing the Victorian primary care practice based research network. *Aust Fam Physician* 2010;39:.
69. Thomas P, While A. Increasing research capacity and changing the culture of primary care towards reflective inquiring practice: the experience of the West London research network (WeLReN). *J Interprof Care* 2001;15.
70. Williams RL, Shelley BM, Sussman AL. The marriage of community-based participatory research and practice-based research networks: can it work? A research involving outpatient settings network (RIOS Net) study. *J Am Board Fam Med* 2009;22.
71. Dulin MF, Ludden TM, Tapp H, et al. Geographic information systems (GIS) demonstrating primary care needs for a transitioning hispanic community. *J Am Board Fam Med* 2010;23.
72. Porcheret M, Hughes R, Evans D, et al. Data quality of general practice electronic health records: the impact of a program of assessments, feedback, and training. *J Am Med Informatics Assoc* 2004;11.
73. Kwan BM, Sills MR, Graham D, et al. Stakeholder engagement in a patient-reported outcomes (PRO) measure implementation: a report from the SAFTINet practice-based research network (PBRN). *J Am Board Fam Med* 2016;29:102–15.
74. Hayes H, Buckland S, Tarpey M. *Briefing notes for researchers: public involvement in nhs, public health and social care research.*; 2012. http://www.invo.org.uk/wp-content/uploads/2014/11/9938_INVOLVE_Briefing_Notes_WEB.pdf.
75. Peckham S, Hutchison B. Developing primary care: the contribution of primary care research networks. *Healthc Policy* 2012;8.
76. National Institute for Health Research. *Patient and public involvement in health and social care research: a handbook for researchers by research design service London.*; 2014. <http://www.rds.nihr.ac.uk/wp-content/uploads/RDS-PPI-Handbook-2014-v8-FINAL.pdf>.
77. Dovey S, Tilyard M. RNZCGP computer research network: an update. *N Z Fam Physician* 1999; 26:37–9.
78. Boydell L, Grandidier H, Rafferty C, McAteer C, Reilly P. General practice data retrieval: The Northern Ireland project. *J Epidemiol Community Health* 1995;49:22–5.
79. Trent Focus Group. *Trent focus. For the promotion of research and development in primary health care. Annual Report 1996–97.*; 1997.
80. Duggan A, Minkovitz CS, Chaffin M, et al. Creating a national home visiting research network. *Pediatrics* 2013;132:S82–S89.
81. Sayer GP, McGeechan K, Kemp A, et al. The general practice research network: The capabilities of an electronic patient management system for longitudinal patient data. *Pharmacoepidemiol Drug Saf* 2003;12.
82. De Clercq E, Vandenberghe H, Jonckheer P, Bastiaens H, Lafontaine MF, Van Casteren V. Assessment of a three-year experience with a belgian primary care data network. *Stud Health Technol Inform* 2002;93:163–9.
83. Ornstein SM, Jenkins RG. The Practice Partner Research Network: description of a novel national research network of computer-based patient records users. *Carolina Heal Serv Policy Rev* 1997;4:145–51.
84. Rodnick JE. International Family Medicine Education: The electronic medical record as the basis of a practice-based research network. *Fam Med* 2000;32:353–4. <https://www.stfm.org/familymedicine/vol32issue5/Dolhun353>.
85. Vessey JA, Founding Oversight Board Members of MASNRN. Development of the Massachusetts School Nurse Research Network (MASNRN): a

- practice-based research network to improve the quality of school nursing practice. *J Sch Nurs* 2007;23:65–72.
86. Sullivan F, Butler C, Cupples M, Kinmonth AL. Primary care research networks in the United Kingdom. *Br Med J* 2007;334:1093–4.
 87. Pace WD, West DR, Valuck RJ, Cifuentes M, Staton EW. *Distributed Ambulatory Research in Theurapeutics Network (DARTNet): Summary Report.*; 2009.
 88. Pulcini J, Sheetz A, Desisto M. Establishing a practice-based research network: Lessons from the Massachusetts experience. *J Sch Health* 2008;78:172–4.
 89. Frayne SM, Carney DV, Bastian L, et al. The VA women's health practice-based research network: amplifying women veterans' voices in VA research. *J Gen Intern Med* 2013;28:504–9.
 90. ACORN. ACORN. Department of Family Medicine, VCU School of Medicine. Accessed June 28, 2020. <https://familymedicine.vcu.edu/research/family-medicine-research/acorn/>.
 91. Lionis C, Symvoulakis EK, Vardavas CI. Implementing family practice research in countries with limited resources: a stepwise model experienced in Crete, Greece. *Fam Pract* 2010;27:48–54.
 92. Carter Y. *Research opportunities in primary care*. 1st ed. Radcliffe Medical Press; 1998.
 93. Trent Focus Group. *Trent focus for the promotion of research and development in primary health care. Annual Report 2000–2001.*; 2001.
 94. Cooke J, Owen J, Wilson A. Research and development at the health and social care interface in primary care: a scoping exercise in one National Health Service region. *Heal Soc Care Community* 2002;10.
 95. Dijkmans-Hadley B, Bonney A, Barnett SR. Development of an Australian practice-based research network as a community of practice. *Aust J Prim Health* 2015;21.
 96. Middelkoop BJ, Bohnen AM, Duisterhout JS, Pleumeekers HJ, Prins A. A computerized network of general practices in Rotterdam, The Netherlands. *Am J Public Health* 1994;84:1852–3.
 97. Jensen IB, Brämberg EB, Wählin C, et al. Promoting evidence-based practice for improved occupational safety and health at workplaces in Sweden. Report on a practice-based research network approach. *IJERPH* 2020;17:5283–15.
 98. Serwint JR, Continuity Clinic Special Interest Group, Ambulatory Pediatric Association. Multisite survey of pediatric residents' continuity experiences: their perceptions of the clinical and educational opportunities. *Pediatrics* 2001; 107:E78.
 99. Fleming DM, Elliot AJ. Lessons from 40 years' surveillance of influenza in England and Wales. *Epidemiol Infect* 2008;136:866–75.
 100. Smith HD, Dunleavy J. Wessex primary care research network: a report on two years progress. *Southampton Heal J* 1996;3:43–7.
 101. ACORN. ACORN: a PBRN project. Accessed June 28, 2020. <http://www.acorn-arccim.com/pbrn/>.
 102. Pitkethly M, Sullivan F. Networking four years of TayRen, a primary care research and development network. *Prim Heal Care Res Dev* 2003;4.
 103. Laurence CO, Beilby JJ, Marley JE, Newbury J, Wilkinson D, Symon B. Establishing a practice based primary care research network. The University Family Practice Network in South Australia. *Aust Fam Physician* 2001;30.
 104. Waters RL, Weston KM, Farmer E. Linking primary health care researchers in South Australia: a network strategy., SARNet Linking primary health care researchers in South Australia: a network 2004;13–21.
 105. Delaney BC, Peterson KA, Speedie S, Taweel A, Arvanitis TN, Richard Hobbs FD. Envisioning a learning health care system: the electronic primary care research network, a case study. *Ann Fam Med* 2012;10.
 106. Liaw ST, Taggart J, Dennis S, Yeo A. Data quality and fitness for purpose of routinely collected data—a general practice case study from an electronic practice-based research network (ePBRN). *AMIA Annu Symp Proc* 2011;2011.
 107. DeVoe JE, Likumahuwa S, Eiff MP, et al. Lessons learned and challenges ahead: Report from the OCHIN Safety Net West Practice-based Research Network (PBRN). *J Am Board Fam Med* 2012;25:560–4.
 108. Gibson K, Szilagyi P, Swanger CM, et al. Physician perspectives on incentives to participate in practice-based research: a greater rochester practice-based research network (GR-PBRN) study. *J Am Board Fam Med* 2010;23.
 109. Birtwhistle R, Keshavjee K, Lambert-Lanning A, et al. Building a pan-Canadian primary care sentinel surveillance network: initial development and moving forward. *J Am Board Fam Med* 2009;22.
 110. Metsemakers JFM, Knottnerus JA, Van Schendel GJ, Kocken RJJ, Limonard CBG. Unlocking patients' records in general practice for research, medical education and quality assurance: the Registration Network Family Practices. *Int J Biomed Comput* 1996;42:43–50.
 111. Slora EJ, Wasserman RC. PROS: a research network to enhance practice and improve child health. *Pediatr Ann* 2010;39:352–61.
 112. del Torso S, van Ezzo D, Gerber A, et al. European Academy of Paediatrics Research in Ambulatory Setting network (EAPRASnet): a multi-national general paediatric research network for better child health. *Child Care Health Dev* 2010;36.

113. Kwan BM, Graham DG, Sills MR, et al. Methods for the collection of patient reported outcomes in a safety net-oriented practice based research network. A SAFTINet Demonstration Project. poster presentation, AcademyHealth Annual Research Meeting. June 24, 2013. Baltimore. Published 2013. Accessed June 29, 2020. <https://www.slideshare.net/MarionSills/academy-health-pro-poster-final-2013-0620>.
114. Pace WD, Fox C, White T, Graham D, Schilling LM, West DR. The DARTNet Institute: seeking a sustainable support mechanism for electronic data enabled research networks. *eGEMs (eGEMs)* 2014;2:6.
115. Pomernacki A, Carney DV, Kimerling R, et al. Lessons from initiating the first Veterans Health Administration (VA) Women's Health Practice-based Research Network (WH-PBRN) study. *J Am Board Fam Med* 2015;28:649–57.
116. Metsemakers JFM, Hoppener P, Knottnerus JA, Kocken RJJ, Limonard CBG. Computerized health information in the Netherlands: a registration network of family practices. *Br J Gen Pract* 1992;42.
117. Van Weel C, Schers H, Timmermans A. Health care in the Netherlands. *J Am Board Fam Med* 2012;25 Suppl 1.
118. Lobet MP, Stroobant A, Mertens R, et al. Tool for validation of the network of sentinel general practitioners in the Belgian health care system. *Int J Epidemiol* 1987;16:612–8.
119. Volmink JA, Furman SN. The South African Sentinel Practitioner Research Network organization, objectives, policies and methods. 1991; *undefined*. Published online.
120. Truyers C, Goderis G, Dewitte H, Akker MV, Buntinx F. The Intego database: Background, methods and basic results of a Flemish general practice-based continuous morbidity registration project. *BMC Med Inform Decis Mak* 2014;14:48.
121. Chuan TN, Gan GL. Primary care research—a blueprint for action for Singapore. *Asia Pac J Public Health* 2001;13:49–53.
122. Volmink J. SASPREN - A new development in family practice research in South Africa. *South African Med J* 1996;86.
123. Department of Health. Research and Development Directorate. *Best research for best health. introducing a new national health research strategy*. Comprehensive NHS research network. London: Department of Health; Version 2; 2006. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/568772/dh_4127152_v2.pdf.
124. Trent Focus Group. *Trent focus. for the promotion of research and development in primary health care. Annual report 1999–2000*; 1999.
125. Dovey SM, Tilyard MW. The computer research network of the Royal New Zealand College of General Practitioners: An approach to general practice research in New Zealand. *Br J Gen Pract* 1996;46.
126. Okkes IM, Groen A, Oskam SK, Lamberts H. Advantages of long observation in episode-oriented electronic patient records in family practice. *Methods Inf Med* 2001;40:229–35.
127. Selby K, Cornuz J, Senn N. Establishment of a representative practice-based research network (PBRN) for the monitoring of primary care in Switzerland. *J Am Board Fam Med* 2015;28.
128. Schilling LM, Kwan BM, Drolshagen CT, et al. Scalable Architecture for Federated Translational Inquiries Network (SAFTINet) technology infrastructure for a distributed data network. *eGEMs (eGEMs)* 2013;1:11.
129. Dulin MF, Tapp H, Smith HA, et al. A trans-disciplinary approach to the evaluation of social determinants of health in a hispanic population. *BMC Public Health* 2012;12.
130. Chmiel C, Bhend H, Senn O, et al. The FIRE project: a milestone for research in primary care in Switzerland. *Swiss Med Wkly* 2011;141:1–7.
131. Rizza A, Kaplan V, Senn O, FIRE study group, et al. Age- and gender-related prevalence of multimorbidity in primary care: the Swiss FIRE project. *BMC Fam Pract* 2012;13:113.
132. Maro JC, Platt R, Holmes JH, et al. Design of a national distributed health data network. *Ann Intern Med* 2009;151:341.
133. Gill JM, Klinkman MS, Chen YX. Antidepressant medication use for primary care patients with and without medical comorbidities: A national Electronic Health Record (EHR) network study. *J Am Board Fam Med* 2010;23:499–508.
134. Adams J, Peng W, Steel A, et al. A cross-sectional examination of the profile of chiropractors recruited to the Australian Chiropractic Research Network (ACORN): A sustainable resource for future chiropractic research. *BMJ Open* 2017;7:e015830.
135. O'Regan A, Hayes P, O'Connor R, et al. The University of Limerick Education and Research Network for General Practice (ULEARN-GP): practice characteristics and general practitioner perspectives. *BMC Fam Pract* 2020;21:25.
136. Wasserman RC, Slora EJ, Bocian AB, et al. Pediatric research in office settings (PROS): A national practice-based research network to improve children's health care. *Pediatrics* 1998; 102:1350–7.
137. Pirota M, Temple-Smith M. Practice-based research networks. *Aust Fam Physician* 2017;46:793–5.
138. Peterson KA, Fontaine P, Speedie S. The electronic Primary Care Research Network (ePCRN):

- a new era in practice-based research. *J Am Board Fam Med* 2006;19:93–7.
139. Deshefy-Longhi T, Swartz MK, Grey M. Establishing a practice-based research network of advanced practice registered nurses in southern New England. *Nurs Outlook* 2002;50:127–31.
 140. Rosser WW, Green L. Update from ASPN. *Can Fam Physician* 1989;35.
 141. Wasserman R, Serwint JR, Kuppermann N, Srivastava R, Dreyer B. The APA and the rise of pediatric generalist network research. *Acad Pediatr* 2011;11:195–204.
 142. Morinis J, Maguire J, Khovratovich M, McCrindle BW, Parkin PC, Birken CS. Paediatric obesity research in early childhood and the primary care setting: The TARGet Kids! research network. *IJERPH* 2012;9:1343–54.
 143. Green LA, Wood M, Becker L, et al. The Ambulatory Sentinel Practice Network: Purpose, methods, and policies. *J Fam Pract* 1984;18.
 144. LeBailly S, Ariza A, Bayldon B, Binns HJ. The origin and evolution of a regional pediatric practice-based research network: practical and methodological lessons from the Pediatric Practice Research Group. *Curr Probl Pediatr Adolesc Health Care* 2003;33.
 145. Koskela TH. Building a primary care research network—lessons to learn. *Scand J Prim Health Care* 2017;35.
 146. Nuttall J, Hood K, Verheij TJ, et al. Building an international network for a primary care research program: Reflections on challenges and solutions in the set-up and delivery of a prospective observational study of acute cough in 13 European countries. *BMC Fam Pract* 2011;12:78.
 147. Solberg LI, Mayer TR, Seifert M, Cole PM. The Minnesota AFP research panel: A model for collaborative practicing family physician research. *Fam Med* 1983;15:139–42.
 148. Beasley JW, Cox NS, Livingston BT, et al. Development and operation of the Wisconsin Research Network. *Wis Med J* 1991;90.
 149. Fleming DM. Weekly Returns Service of the Royal College of General Practitioners. *Commun Dis Public Heal* 1999;2:96–100.
 150. AAFP. Affiliated PBRNs—National Research Network. Accessed August 13, 2020. <https://www.aafp.org/patient-care/nrn/nrn/pbrns.html>.
 151. Golden RE, Klap R, Carney DV, et al. Promoting learning health system feedback loops: experience with a VA practice-based research network card study: VA Card Study Promotes Learning Health System. *Healthcare* 2021;8:100484.
 152. Clothier HJ, Fielding JE, Kelly HA. An evaluation of the Australian Sentinel Practice Research Network (ASPREN) surveillance for influenza-like illness. *Commun Dis Intell* 2005;29.
 153. Lionis C, Petelos E, Papadakis S, et al. Towards evidence-informed integration of public health and primary health care: experiences from Crete. *Public Heal Panor* 2018;04:699–714.
 154. Australian Government Department of Health and Ageing. *Primary Health Care Research, Evaluation and Development (PHCRED) Strategy Phase Three: 2010–2014.*; 2010.
 155. Department of Health. Research and development for a first class service: R&D funding in the new NHS. Published 2000. Accessed May 25, 2016. www.dh.gov.uk/prod_consum_dh/idcplg?IdcService=GET_FILE&dID=16702&Rendition=Web.
 156. NHS Executive. *Department of Health. information for health: an information strategy for the modern NHS 1998–2005. A National Strategy for Local Implementation.*; 1998.
 157. Ried K, Farmer EA, Weston KM. Aims and objectives for the SARNet research network. *BMC Fam Pract* 2006;7:Additional file. https://static-content.springer.com/esm/art%3A10.1186%2F1471-2296-7-8/MediaObjects/12875_2005_139_MOESM1_ESM.pdf.
 158. The Netherlands Organization for Health Research and Development (ZonMw). Program Primary Focus. Accessed January 31, 2012. <http://www.zonmw.nl/en/programmes/primary-focus/programme/>.
 159. Funding of research and research-training; stimulating practice-based research by the Netherlands Research Council on Health Research ZonMW. Accessed March 10, 2004. <http://zonmw.collexis.net/default.asp?key=prog>.
 160. Fontaine P, Mendenhall TJ, Peterson K, Speedie SM. The “Measuring Outcomes of Clinical Connectivity” (MOCC) trial: investigating data entry errors in the electronic Primary Care Research Network (ePCRN). *J Am Board Fam Med* 2007;20.
 161. Birtwhistle RV. Canadian Primary Care Sentinel Surveillance Network: a developing resource for family medicine and public health. *Can Fam Physician* 2011;57.
 162. The Netherlands School of Primary Care Research. Netherlands School of Public Health and Care Research. Accessed September 20, 2021. <https://www.researchschoolcare.nl/>.
 163. National Institute for Health Research. *Clinical Research Network. income distribution from NIHR CRN industry portfolio studies.*; 2014. <http://www.nihr.ac.uk/funding-and-support/documents/Study-Support-Service/Early-contact-and-engagement/Costing-Templates/LCRN Guidance S12 - Income Distribution Model Guidance v2.0.pdf>.
 164. National Institute for Health Research. *Clinical Research Network. five year strategic plan for research delivery: 2012–2017.*; 2012.
 165. Leitch S. New Zealand needs a practice based research network. *J Prim Health Care* 2016;8:9.

166. Kljakovic M, Seddon T, Reinken J, McLeod D. The rise and fall of a general practice information network. *N Z Fam Physician*. Published online 1992;73–6.
167. van Weel C, Rosser WW. Improving health care globally: a critical review of the necessity of family medicine research and recommendations to build research capacity. *Ann Fam Med* 2004;2 Suppl 2: In: Vol.
168. Evans TW, Department of Health. Research and Development Directorate. *Best Research for best health. a new national health research strategy*. 2006;6.
169. Olsen DP, Dixon JK, Grey M, Deshefy-Longhi T, Demarest JC. Privacy concerns of patients and nurse practitioners in primary care—an APRNet study. *J Am Acad Nurse Pract* 2005;17.
170. Fagnan LJ. meta-network Learning and Research Center Meta-LARC. Grantome, U.S. National Institute of Health. Published 2015. Accessed November 29, 2020. <https://grantome.com/grant/NIH/P30-HS021639-02>.
171. Clinical and Translational Science Awards (CTSA) Program. Clinical and Translational Science Awards (CTSA) Program | National Center for Advancing Translational Sciences. Accessed September 20, 2021. <https://ncats.nih.gov/ctsa>.
172. HIPAA. Health Insurance Portability and Accountability Act of 1996 (HIPAA) | CDC. Accessed September 20, 2021. <https://www.cdc.gov/phlp/publications/topic/hipaa.html>.
173. Patient Protection and Affordable Care Act. Patient Protection and Affordable Care Act - HealthCare.gov glossary | HealthCare.gov. Accessed September 20, 2021. <https://www.healthcare.gov/glossary/patient-protection-and-affordable-care-act/>.
174. PCORI. PCORI | Our story. Accessed September 20, 2021. <https://www.pcori.org/about-us/our-story>.
175. Metsemakers JFM. Unlocking patients' records in general practice for research, medical education and quality assurance: the registration network family practices. 1994; Published online.
176. Graham DG, Spano MS, Stewart TV, Staton EW, Meers A, Pace WD. Strategies for planning and launching PBRN research studies: a project of the Academy of Family Physicians National Research Network (AAFP NRN). *J Am Board Fam Med* 2007;20.
177. Fleming DM, Crombie DL. The incidence of common infectious diseases: The weekly returns service of the Royal College of General Practitioners. *Health Trends* 1985;17.
178. Adams J, Steel A, Chang S, Sibbritt D. Helping address the national research and research capacity needs of Australian chiropractic: Iitroducing the Australian Chiropractic Research Network (ACORN) project. *Chiropr Man Ther* 2015;23.
179. Mehta P, Adams J, Sibbritt D, Jones T, Leaver A, Verhagen A. *Introducing the Collaborative Australian Physiotherapy Research Initiative (CAPRI) project*; 2021. <https://osf.io/rfy95/download>.
180. van der Lei J, Duisterhout JS, Westerhof HP, et al. The introduction of computer-based patient records in the Netherlands. *Ann Intern Med* 1993;119:1036–41.
181. Culpepper L, Froom J. The international primary care network: Purpose, methods, and policies. *Fam Med* 1988;20.
182. Australian Association for Academic Primary Care Inc. The APCReN Story, Two Years on. Published online 2015; 5:Issue.
183. Boffin N, Bossuyt N, Vanthomme K, Van Casteren V. Readiness of the Belgian network of sentinel general practitioners to deliver electronic health record data for surveillance purposes: Results of survey study. *BMC Fam Pract* 2010;11:50.
184. Laux G, Koerner T, Rosemann T, Beyer M, Gilbert K, Szecsenyi J. The CONTENT project: a problem-oriented, episode-based electronic patient record in primary care. *Inform Prim Care* 2005;13.
185. Taggart J, Liaw ST, Dennis S, et al. The University of NSW electronic practice based research network: disease registers, data quality and utility. *Stud Heal Technol Inform* 2012;178.
186. Slora EJ, Thoma KA, Wasserman RC, Pedlow SE, Bocian AB. Patient visits to a national practice-based research network: comparing pediatric research in office settings with the national ambulatory medical care survey. *Pediatrics* 2006;118: e228–e234.
187. Froom J, Culpepper L. Otitis media in day-care children: a report from the International Primary Care Network. *J Fam Pract* 1991;32.
188. Cole AM, Stephens KA, Keppel GA, Lin CP, Baldwin LM. Implementation of a health data-sharing infrastructure across diverse primary care organizations. *J Ambul Care Manage* 2014;37:164–70.
189. Primary Care MultiEthnic Network (PRIME Net). Center in Practice-Based Research and learning. 2020. Accessed November 29, 2020. <https://pbrn.ahrq.gov/sites/default/files/docs/page/PRIMENet.pdf>.
190. Pace WD, Cifuentes M, Valuck RJ, Staton EW, Brandt EC, West DR. An electronic practice-based network for observational comparative effectiveness research. *Ann Intern Med* 2009;151:338.
191. Trinh L, Macartney K, McIntyre P, Chiu C, Dey A, Menzies R. Investigating adverse events following immunisation with pneumococcal polysaccharide vaccine using electronic General Practice data. *Vaccine* 2017;35:1524–9.
192. de Lusignan S, van Weel C. The use of routinely collected computer data for research in primary

- care: Opportunities and challenges. *Fam Pract* 2006;23.
193. Stephenson E, O'Neill B, Gronsbell J, et al. Changes in family medicine visits across sociodemographic groups after the onset of the COVID-19 pandemic in Ontario: a retrospective cohort study. *C Open* 2021;9.
 194. Galvin S, Callan A, Cormican M, et al. Improving antimicrobial prescribing in Irish primary care through electronic data collection and surveillance: A feasibility study *Epidemiology and research methodology in primary care. BMC Fam Pract* 2015;16.
 195. Cole AM, Stephens KA, Keppel GA, Estiri H, Baldwin L-M. Extracting electronic health record data in a practice-based research network: lessons learned from collaborations with translational researchers. *eGEMs (eGEMs)* 2016;4:4.
 196. UTOPIAN | Department of Family & Community Medicine. About UTOPIAN. Accessed September 19, 2021. <https://www.dfcm.utoronto.ca/about-utopian>.
 197. Lieberman MI. Medical Quality Improvement Consortium (MQIC). Presentation. Published 2006. <https://www.amia.org/sites/amia.org/files/2006-Policy-Meeting-Medical-2006-Policy-Meeting-Quality-Improvement-Consortium.pdf>.
 198. Coleman N, Halas G, Peeler W, Casalang N, Williamson T, Katz A. From patient care to research: a validation study examining the factors contributing to data quality in a primary care electronic medical record database. *BMC Fam Pract* 2015;16:11.
 199. Peterson KA, Delaney BC, Arvanitis TN, et al. A model for the electronic support of practice-based research networks. *Ann Fam Med* 2012;10.
 200. Kadhim-Saleh A, Green M, Williamson T, Hunter D, Birtwhistle R. Validation of the diagnostic algorithms for 5 chronic conditions in the Canadian Primary Care Sentinel Surveillance Network (CPCSSN): a Kingston Practice-Based Research Network (PBRN) report. *J Am Board Fam Med* 2013;26:159–67.
 201. Williamson T, Green ME, Birtwhistle R, et al. Validating the 8 CPCSSN case definitions for chronic disease surveillance in a primary care database of electronic health records. *Ann Fam Med* 2014;12:367–72.
 202. Burt RS. Social contagion and innovation: cohesion versus structural equivalence. *Am J Sociol* 1987;92.
 203. Liu W, Sidhu A, Beacom AM, Valente TW. Social Network Theory. *The International Encyclopedia of Media Effects* 2017:1–12. In: Wiley.
 204. Darbyshire J, Sitzia J, Cameron D, et al. Extending the clinical research network approach to all of healthcare. *Ann Oncol* 2011;22.
 205. Pace WD, Fagnan LJ, West DR. The Agency for Healthcare Research and Quality (AHRQ) Practice-based Research Network (PBRN) relationship: Delivering on an opportunity, challenges, and future directions. *J Am Board Fam Med* 2011;24:489–92.
 206. Rhyne RL, Fagnan LJ. Practice-based research network (PBRN) engagement: 20+ years and counting. *J Am Board Fam Med* 2018;31.
 207. Fagnan LJ, Davis M, Deyo RA, Werner JJ, Stange KC. Linking practice-based research networks and clinical and translational science awards: new opportunities for community engagement by academic health centers. *Acad Med* 2010;85:476–83.
 208. Riley-Behringer M, Davis MM, Werner JJ, Fagnan LJ, Stange KC. The evolving collaborative relationship between Practice-Based Research Networks (PBRNs) and Clinical and Translational Science Awardees (CTSAs). *J Clin Transl Sci* 2017;1:301–9.
 209. Binienda J, Neale AV, Wallace LS. Future directions for practice-based research networks (PBRNs): A CERA survey. *J Am Board Fam Med* 2018;31.
 210. Spears W, Tsoh JY, Potter MB, et al. Use of community engagement strategies to increase research participation in practice-based research networks (PBRNs.). *J Am Board Fam Med* 2014;27.
 211. Tapp H, Dulin M. The science of primary health-care improvement: Potential and use of community-based participatory research by practice-based research networks for translation of research into practice. *Exp Biol Med* 2010;235.
 212. Curro FA, Robbins DA, Millenson ML, Chester HC, Naftolin F. Person-centric clinical trials: An opportunity for the good clinical practice (GCP)-practice-based research network. *J Clin Pharmacol* 2013;53:1091–4.
 213. Robbins DA, Curro FA, Fox CH. Defining patient-centricity: opportunities, challenges, and implications for clinical care and research. *Ther Innov Regul Sci* 2013;47:349–55.
 214. Griffiths F, Wild A, Harvey J, Fenton E. The productivity of primary care research networks. *Br J Gen Pract* 2000;50.
 215. Abbott S, Gunnell C. Developing R&D capacity in primary care nursing: report of a research project. *Prim health care res dev* 2005;6:95–100.
 216. Tasche M, Oosterberg E, Kolnaar B, Rosmalen K. Inventarisatie van lacunes in huisartsgeneeskundige kennis. *HUWE* 2001;44:709–13.
 217. Green LA, Hames CG, Nutting PA. Potential of practice-based research networks: Experiences from ASPN. *J Fam Pract* 1994;38.
 218. Trent Focus Group. *Trent focus. for the promotion of research and development in primary health care. Annual Report 1997–1998*; 1998.

219. The Folsom Group. Communities of solution: The Folsom report revisited. *Ann Fam Med* 2012;10:250–60.
220. Green LW. Making research relevant: If it is an evidence-based practice, where's the practice-based evidence? *Family Practice* 2008;25:i20–i24.
221. Beasley JW, Starfield B, Van Weel C, Rosser WW, Haq CL. Global health and primary care research. *J Am Board Fam Med* 2007;20:518–26.
222. Westfall JM, Roper R, Gaglioti A, Nease DE., Jr. Practice-based research networks: strategic opportunities to advance implementation research for health equity. *Ethn Dis* 2019;29:113–8.
223. Tapp H, White L, Steuerwald M, Dulin M. Use of community-based participatory research in primary care to improve healthcare outcomes and disparities in care. *J Comp Eff Res* 2013;2:405–19.
224. Nease D, Greiver M. 2021 PBRN conference: “embracing diversity, equity, and inclusion.” *Ann Fam Med* 2021;19:470–1.
226. Smith H. The Federation of Primary Care Research Networks: a national initiative to enhance networking locally. *Prim Heal Care Res Dev* 2000;1:3–4.
227. Practice-Based Research Networks | UK Center for Clinical and Translation Science. Accessed October 1, 2021. <https://www.ctcs.uky.edu/about-ctcs/cores/community-engagement-and-research/practice-based-research-networks>.
228. TAFP - Introducing the meta-network for practice-based research. Accessed October 1, 2021. <https://www.tafp.org/news/tfp/spring-2010/research-network>.
229. van Staa TP, Dyson L, McCann G, et al. The opportunities and challenges of pragmatic point-of-care randomised trials using routinely collected electronic records: evaluations of two exemplar trials. *Health Technol Assess* 2014;18:1–146.
230. Haggerty T, Cole AM, Xiang J, Mainous AG, Seehusen D. Family medicine-specific practice-based research network productivity and clinical and translational sciences award program affiliation. *South Med J* 2017;110.
231. Mold JW, Lipman PD, Durako SJ. Coordinating centers and multi-practice-based research network (PBRN) research. *J Am Board Fam Med* 2012;25.
232. Lionis C, Duijker G, Angelaki A, et al. Practice-Based Research Network in Primary Care: A lacking story and learning points from an empirical model on Crete. In: *1st Joint Meeting of the European General Practice Research Network and European Rural and Isolated Practitioners Association 17th - 20th October 2013.*; 2013.
233. AHRQ. PBRN Registry | Practice-Based Research Networks | Agency for Healthcare Research and Quality. 2019. Accessed October 13, 2020. <https://pbrn.ahrq.gov/pbrn-registry>.
234. Jones C. *An environmental scan of practice-based research networks.*; 2006. Accessed August 16, 2020. <https://www.yumpu.com/en/document/read/23017131/an-environmental-scan-of-practice-based-research-networks>.
235. Dutch College of General Practitioners (NHG). *Overview of underresearched areas in family medicine.* 2004. Accessed March 9, 2004. http://nhg.artsennet.nl/content/resources/AMGATE_6059_104_TICH_L866838437/AMGATE_6059_104_TICH_R1196231005919511.
236. Adams J, Steel A, Moore C, Amorin-Woods L, Sibbritt D. Establishing the ACORN National Practitioner Database: strategies to recruit practitioners to a national practice-based research network. *J Manipulative Physiol Ther* 2016;39:594–602.
237. Evans TW. Best research for best health: a new national health research strategy. *Clin Med (Lond)* 2006;6:435–7.
238. Australian Primary Care Research Network. APCReN, the APCReN story, two years on. Newsletter. 2015;5:Issue. Published online 2.
239. National Institutes of Health - US Department of Health and Human Services. National Institute of Environmental Health Sciences. NIH roadmap and roadmap-affiliated initiatives. Published 2011. Accessed December 17, 2016. <https://www.niehs.nih.gov/funding/grants/announcements/roadmap/>.
240. Archive Agency for Healthcare Research and Quality. US Department of health & Social Services. Agency for healthcare research and quality: Reauthorization fact sheet. Published 1999. Accessed December 17, 2016. <https://archive.ahrq.gov/about/ahrqfact.htm>.
241. Department of Health and Human Services. Institutional clinical and translational science award (U54): Part I overview information. Accessed September 10, 2008. <http://grants.nih.gov/grants/guide/rfa-files/RFA-RM-07-007.html>.
242. NIH. Workshop proceedings: inviting public participation in clinical research: Building trust through partnerships. Published 2008. Accessed September 10, 2008. [ports/October_2004_COPR_WORKSHOP_Proceedings.pdf](https://www.nih.gov/sites/default/files/2004_COPR_WORKSHOP_Proceedings.pdf).
243. American recovery and reinvestment act of 2009. pub. L. 111-5, 123 stat. 115. Published 2009. Accessed December 15, 2016. <https://www.congress.gov/bill/111th-congress/house-bill/1/tex>.
244. Wallace LS, Angier H, Huguet N, et al. Patterns of electronic portal use among vulnerable patients in a nationwide practice-based research network: from the OCHIN Practice-based Research Network (PBRN). *J Am Board Fam Med* 2016;29:592–603.
245. DeVoe JE, Likumahuwa-Ackman SM, Angier HE, et al. A Practice-Based Research Network (PBRN) roadmap for evaluating COVID-19 in community health centers: A report from the OCHIN PBRN. *J Am Board Fam Med* 2020;33:774–8.

246. Gaglioti AH, Werner JJ, Rust G, Fagnan LJ, Neale AV. Practice-based Research Networks (PBRNs) bridging the gaps between communities, funders, and policymakers. *J Am Board Fam Med* 2016;29.
247. Hickner J, Green LA. Practice-based Research Networks (PBRNs) in the United States: growing and still going after all these years. *J Am Board Fam Med* 2015;28:541–5.
248. Anderson S, Allen P, Peckham S, Goodwin N. Asking the right questions: scoping studies in the commissioning of research on the organisation and delivery of health services. *Health Res Policy Syst* 2008;6:7.
249. Munn Z, Peters MDJ, Stern C, Tufanaru C, McArthur A, Aromataris E. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol* 2018;18:1–7.
250. Temple-Smith M, Novy K, Manski-Nankervis J-A, Lau P, Sanci L, MACH. A Snapshot of Australian Practice Based Research Networks in Primary Care.; 2021.

Appendix

Table 1. Inclusion and Exclusion Criteria for the Scoping Review

Inclusion Criteria	
1.	Peer-reviewed journal articles published between 1/1/1965 and 12/31/2020 in English language that refer to one or more primary care PBRNs and include information about their establishment.
2.	Articles that refer to research projects conducted by PBRNs that also provide information about their establishment.
3.	Reports, editorials, letters, commentaries, conference papers and web pages that may provide complementary information on an already identified PBRN.
4.	Information on PBRN establishment was included after defining primary care-linked PBRNs based on the scope of primary care in each particular region or country.
Exclusion Criteria	
1.	Articles that focus on specific research studies, data collection or database/technology development in PBRN settings, without providing information about the PBRN's establishment.
2.	Articles in which the identity of the PBRN can't be determined (eg, due to blinding).

Abbreviation: PBRNs, Practice-Based Research Networks.

Table 2. Overarching Thematic Framework for the Establishment of Practice-Based Research Networks (PBRNs) Focusing on the Themes of the External Environment and Stakeholders at the Intersection between the Internal and External Environment Described in This Article

Theme	Subtheme	Key Elements
(i) Internal Environment of PBRN	(i) Foundation	(i) Setting up mission, purposes, goals, objectives and aims
	(ii) Practitioner Participation and Motivation	(i) Recruitment (ii) Membership (iii) Levels of member engagement (iv) Intrinsic motivators to participate and benefits for practitioners (v) Extrinsic motivators to participate and benefits for practitioners
	(iii) Academic Participation and Attitudes	(i) Type of affiliation and advantages – disadvantages of affiliation (ii) The role of academics and academic departments in developing, hosting and sustaining the network (iii) Academic contribution to governance and leadership (iv) Contribution of academic research expertise (v) Academic support for research culture development and practitioner empowerment (vi) Academic initiative to link medical students and residents to PBRN activity (vii) Benefits for academia from PBRN collaboration
	(iv) Network Infrastructure and Operations	(i) Initial Partnerships to Establish PBRNs and Centers of Operations (ii) Infrastructural Funding (iii) Key Activities at Establishment (iv) Relationships Building Between Academics and Practitioners in the Field (v) Governance (vi) Organizational Leadership (vii) Methodology of prioritizing the Research Agenda (viii) Topics of PBRN research (ix) Data gathered from networks & Data management (x) Quality improvement (QI) activities (xi) Learning environment (xii) Communication
(ii) Stakeholders at the intersection between the internal and external environment	(i) Patients and Community Stakeholders	(i) Patient-centeredness and community engagement in PBRNs (ii) Relationship building with patient or community groups as an essential part of research (iii) Quality improvement activities guided by patient feedback (iv) Involving patients or community members in PBRN governance (v) Integrating CBPR methodology into PBRN research (vi) Community Engaged Research methodology in PBRN research (vii) Motivation of community members for research participation (viii) Community engagement in health policymaking through PBRN activity
	(ii) Other Healthcare Stakeholders	(i) Identification, engagement and contribution of healthcare stakeholders (ii) Relationship building with healthcare stakeholders (iii) Other aspects of working with healthcare stakeholders
(iii) External environment	(i) National Health System	(i) The impact of primary health care structure on PBRN development
	(ii) Institutional/ Governmental Support, National/State Policy and Regulatory Environment	(i) Decision-makers (ii) National policy (iii) Regulatory environment (iv) Interaction with policymaking (v) Community impact on public health policymaking through PBRN

Continued

Table 2. Continued

Theme	Subtheme	Key Elements
	(iii) Professional Organizations	(i) National professional organization contribution and support (ii) International professional organizations contribution
	(iv) External Funders	(i) External funders contributions
	(v) Leveraging Previous Research and PBRN Experience and Interacting with Other Networks	(i) International experience (ii) National experience (iii) Leveraging previous research expertise (iv) Leveraging PBRN practice models (v) Leveraging experience from peer networks (vi) Interacting with other networks (vii) Developing networks of PBRNs
(iv) HIT and HIT Vendors	(i) HIT applications sustain the infrastructure (ii) HIT applications facilitating or supporting the PBRN operation (iii) HIT vendors contribute to sustainability (iv) HIT vendor in the partnership of the network (v) Challenges from the variety of EHR systems	

Note: In this Table, the shadowed part corresponds to themes, sub-themes, and key elements presented in a previous study.
Abbreviation: EHR, Electronic Health Records; HIT, Health Information Technology.