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SPECIAL ARTICLE

Impact of the Cancer Prevention and Control Research Network: Accelerating the Translation of Research Into Practice

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The Cancer Prevention and Control Research Network (CPCRN) is a thematic network dedicated to accelerating the adoption of evidence-based cancer prevention and control practices in communities by advancing dissemination and implementation science. Funded by the Centers for Disease Control and Prevention and National Cancer Institute, CPCRN has operated at two levels: Each participating network center conducts research projects with primarily local partners as well as multicenter collaborative research projects with state and national partners. Through multicenter collaboration, thematic networks leverage the expertise, resources, and partnerships of participating centers to conduct research projects collectively that might not be feasible individually. Although multicenter collaboration is often advocated, it is challenging to promote and assess. Using bibliometric network analysis and other graphical methods, this paper describes CPCRN's multicenter publication progression from 2004 to 2014. Searching PubMed, Scopus, and Web of Science in 2014 identified 249 peer-reviewed CPCRN publications involving two or more centers out of 6,534 total. The research and public health impact of these multicenter collaborative projects initiated by CPCRN during that 10-year period were then examined. CPCRN established numerous workgroups around topics such as: 2-1-1, training and technical assistance, colorectal cancer control, federally qualified health centers, cancer survivorship, and human papillomavirus. This paper discusses the challenges that arise in promoting multicenter collaboration and the strategies that CPCRN uses to address those challenges. The lessons learned should broadly interest those seeking to promote multisite collaboration to address public health problems, such as cancer prevention and control.

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INTRODUCTION

Despite significant advances in the prevention, detection, and treatment of cancer over the past 25 years, cancer-related morbidity and mortality remain stubbornly high, especially among racial/ethnic minorities and other vulnerable populations.[1] In 2016, an estimated 1,685,210 Americans will receive a cancer diagnosis and 595,690 will die of cancer.[1]

To reduce this burden, the Centers for Disease Control and Prevention (CDC), in conjunction with the National Cancer Institute (NCI), initiated the Cancer Prevention and Control Research Network (CPCRN), a national network of academic, public health, and community partners that, since 2002, has conducted community-based research to[2,3]: accelerate the adoption and implementation of evidence-based cancer prevention and control; and enhance large-scale efforts to reach underserved populations.

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The CPCRN works with national, state, and local partners to reduce cancer risk, improve screening utilization, reduce cancer death, and mitigate health disparities by advancing the science and practice of dissemination and implementation. Over four cycles of funding, CPCRN has included between three and ten collaborating centers (Table 1). Presently, CPCRN consists of a coordinating center, collaborating centers, and hundreds of investigators representing disciplines including epidemiology, health behavior, medicine, nursing, nutrition, psychology, and sociology.

As a "network of networks," CPCRN operates at two levels. Each collaborating center conducts its own research projects in collaboration with state and local partners, but also conducts multicenter research projects with state and national partners. This dual focus distinguishes CPCRN from many federally funded research networks in which multicenter collaboration is often limited to information sharing or data coordination across locally implemented research projects. Although multicenter collaboration is encouraged in federally funded research networks, it is challenging to promote, as collaborating centers focus their attention and resources on their own center projects, as well as working on network projects.

This article describes the CPCRN's multicenter collaborative research projects and their accomplishments, documents the growth of multicenter collaboration within CPCRN over a 10-year period, and discusses strategies that CPCRN has used to promote multicenter collaboration. It concludes with recommendations for other multicenter research initiatives.

METHODS

A retrospective, longitudinal, descriptive design was used to analyze existing administrative and bibliographic data on cross-center collaborations.

The CPCRN employs an online reporting system to monitor and evaluate network activities and outcomes by collecting detailed information from collaborating centers twice yearly about individual-center and multicenter research activity, grant applications, publications, and presentations. The reporting system also collects narrative data on goals and accomplishments. To assess the growth of multicenter publications, authorship data from three bibliographic databases (PubMed, Scopus, and Web of Science) were collected for 309 unique CPCRN researchers identified in the CPCRN administrative database, using researchers' first initial and last name (PubMed and Web of Science) or Author ID (Scopus) and site-specific geographic identifiers. Searches were limited to the years 2004–2014. Bibliographic records were managed in EndNote 6.0. Duplicate and false-positive records were removed. Author-level data were extracted across all publications and multisite papers. Records for Medical Subject Heading term extraction were searched and downloaded on October 29, 2014.

To document the growth of multicenter collaboration, the number of multicenter grant applications submitted and funded, and the number of peer-reviewed journal articles published per year from 2004 to 2014, were counted. Both the total number of publications per CPCRN author by site and total number of multicenter publications are listed. Grant applications and articles were considered "multicenter" if they involved investigators from two or more centers. A co-authorship network analysis of

Table 1. CPCRN Centers, Members, Authors, Papers, and Years of Membership

Center[a]	Members	Authors	Papers	Papers per author	Multisite papers	Multisite papers per author	Year joined	CPCRN years	Multisite papers (authors per year)
Colorado	9	8	250	31.3	31	3.9	2009	5	0.78
Tex A&M	20	16	284	17.8	11	0.7	2009	5	0.14
Emory	22	21	606	28.9	33	1.6	2004	10	0.16
Harvard	15	14	465	33.2	78	5.6	2002	12	0.46
Morehouse	8	5	70	14.0	3	0.6	2004	5	0.12
UCLA	24	21	726	34.6	61	2.9	2004	10	0.29
UNC	37	31	1,013	32.7	81	2.6	2004	10	0.26
USC	27	25	872	34.9	34	1.4	2009	5	0.27
UT	50	39	901	23.1	76	1.9	2002	12	0.16
UW	44	36	773	21.5	103	2.9	2002	12	0.24
WUSTL	55	33	576	17.5	40	1.2	2004	10	0.12
Mean	28.3	22.6	594.2	26.3	50.1	2.3	2005	8.7	0.27

Note: Data are *n* unless otherwise noted.

[a]In order, centers were University of Colorado, Texas A&M University (Tex A&M), Emory University, Harvard University, Morehouse College, University of California at Los Angeles (UCLA), University of North Carolina at Chapel Hill (UNC), University of South Carolina (USC), University of Texas (UT), University of Washington (UW), and Washington University in St. Louis (WUSTL). Two researchers switched institutions, therefore, the 311 members indicated in Table 1 represent 309 unique researchers.

CPCRN, Cancer Prevention and Control Research Network.

multicenter publications was also conducted. Each record was assigned a center-level identifier and linked with unique article-level identifiers to construct co-authorship networks for each year. Custom Python scripts, R, version 3.0.2, and Excel were used to parse, process, and summarize data; Pajek, version 3.14 was used to visualize networks.

RESULTS

Cancer Prevention and Control Research Network Multicenter Workgroups

Since its inception, CPCRN has sponsored many multicenter workgroups. Five of the most productive ones are highlighted here.

2-1-1 workgroup. 2-1-1 is a nationally designated three-digit telephone information and referral service that connects callers to local health and social services.[4] These callers represent individuals with many basic needs and who are at increased risk for cancer and other chronic diseases based on their high rates of unemployment, low levels of income and education,[5] and African American or Hispanic race/ethnicity.

The workgroup's early studies demonstrated that 2-1-1 callers had lower rates of cancer screening and higher rates of smoking than U.S. adults, and showed that 2-1-1 callers were willing to complete a brief cancer risk assessment and accept referrals for cancer control services.[6,7] This work was highlighted in a Supplement Issue of the *American Journal of Preventive Medicine*, "Research Collaboration with 2-1-1 to Eliminate Health Disparities."[7] Later studies tested interventions among 2-1-1 callers, demonstrating the effectiveness of using proactive referrals and phone navigation to connect callers with cancer control services.[8] In an NCI-funded study, CPCRN researchers developed an intervention to promote smoke-free home policies to 2-1-1 callers and tested it in an initial efficacy trial in Atlanta, GA and two effectiveness trials in North Carolina and Houston, TX; all demonstrated intervention effectiveness,[9] and the intervention is currently being disseminated to over 2,000 people at 2-1-1 in Akron, OH, Cleveland, OH, Orlando, FL, Tulsa, OK, and Alabama. The team is also adapting and testing Spanish and Chinese versions.

Training and technical assistance. Building community and other partners' capacity to use evidence-based approaches has been an enduring focus of the CPCRN. This work is grounded in the Interactive Systems Framework for Dissemination and Implementation of Wandersman et al.[2,10] CPCRN members from eight centers conducted formative research on cancer control planners' capacity to use evidence-based approaches,[11] which evolved into the Capacity-Building Technical Assistance and Training workgroup that developed the *Putting Public Health Evidence in Action* curriculum and facilitator's guide delivered in 14 workshops to >600 practitioners nationwide (http://cpcrn.org/pub/evidence-in-action/). Multiple centers have built on the workgroup's curriculum to deliver and test local capacity-building interventions.[12–14] Workgroup members conducted a literature review to guide the design of capacity-building interventions[15,16] and collaborated on an NCI grant (4R01CA163526-05) to develop and test an online tool (IM Adapt) based on Intervention Mapping framework[17] that guides practitioners through a systematic process of selecting and adapting evidence-based interventions (EBIs) to fit their local community and context.[18] This project formed an advisory group with representatives from multiple CPCRN sites and is being beta tested.

Colorectal Cancer Control Program. In 2009, the CDC Colorectal Cancer Control Program (CRCCP) awarded a 5-year cooperative agreement to 25 states and four tribal organizations to increase population-level screening rates to 80% in participating states and tribes and, consequently, to reduce CRC incidence and mortality (www.cdc.gov/cancer/crccp/). CPCRN partnered with CDC to evaluate grantees' use of EBIs recommended in the *Guide to Community Preventive Services* (www.thecommunityguide.org/cancer/index.html).

The workgroup led development and implementation of an annual CRCCP grantee survey starting in 2011 to measure EBI implementation; this survey was one component of the CRCCP evaluation. Grantees used more EBIs over time, and generally used more client-oriented than provider-oriented EBIs. CRCCP evaluation findings led to significant changes in the program structure for 2015–2020.[19–21] CDC now requires all CRCCP grantees to partner with healthcare systems to implement EBIs. Future directions include collaborating with CDC to evaluate partner healthcare systems' implementation of EBIs and their impact on patients' CRC screening rates with a goal of implementing more provider-oriented EBIs.

Federally qualified health centers. CPCRN members partnered with federally qualified health centers (FQHCs) and state and national partners including primary care associations to advance the dissemination and implementation of cancer prevention and control programs with a focus on underserved populations.

The Practice Change and Development Model[22] and the Consolidated Framework for Implementation Research[23] guided development of a survey that was administered to FQHCs in seven states to develop and test measures and to assess correlates of implementation of evidence-based strategies to increase colorectal cancer screening. Analyses to assess the validity and reliability of the Consolidated

Framework for Implementation Research measures found they have structural validity, reliability, discriminant validity, and can be aggregated to the clinic level. Also, clinics within systems have more similar values for inner-setting domain constructs than clinics in different systems.[24] FQHCs implemented CDC-recommended evidence-based approaches at varying levels, which ranged from 30% to almost 60% implementing at least one evidence-based approach for increasing colorectal cancer screening. Results also showed higher Adaptive Reserve, as measured by the Practice Adaptive Reserve score,[25,26] is positively associated with implementation of Patient-Centered Medical Home colorectal cancer screening best practices by clinic staff. Poor electronic health record data quality and cumbersome systems may be significant barriers to implementation of evidence-based practices; most FQHCs reported that using electronic health record systems to measure and improve colorectal cancer screening was challenging.

The FQHC workgroup also conducted five focus groups and 21 in-person interviews with FQHC leaders in 14 states in a qualitative study of factors affecting implementation of evidence-based cancer control practices. FQHC leaders identified successes and barriers to implementing cancer control practice change in their clinics. Factors contributing to successful implementation included the ability to:

1. identify leaders, champions, facilitators, and implementers to play key roles;
2. offer training and capacity-building activities to motivate staff and gain buy-in;
3. provide staff incentives and rewards; and
4. incorporate systemization, auditing, and feedback into implementing practice change.

External factors, such as insufficient organizational resources, limited networks, and patients' influences, negatively influenced implementation.[27]

Cancer survivorship. As advancements in early detection and treatment continue, there are >13 million survivors alive today in the U.S., with an estimated 18 million at the end of the decade.[1] The Survivorship workgroup identified and facilitated opportunities to promote the translation and dissemination of evidence-based practices in cancer survivorship.

The Survivorship workgroup documented health promotion programs for cancer survivors in four states,[28] using the Reach, Adoption, Implementation, and Maintenance (RE-AIM) framework as a guide.[29] Data on program reach described a dearth of programs in rural areas. Program implementation data showed that psychosocial and physical activity programs were most commonly offered, whereas nutrition and weight management programs were offered less frequently, if at all. Cancer control planners in three of the participating states used the survey results to illustrate the opportunity to link research and public health practice.

The Survivorship workgroup identified self-management support interventions, such as the Chronic Disease Self-Management Program, as a potential strategy toward improving outcomes in other chronic conditions, but one that has yet to be widely applied to cancer survivorship in practice. Workgroup members implemented the adapted program for use with cancer survivors and tested its effectiveness in an RCT. Results support effectiveness in survivors, with effect sizes similar to those observed in other chronic disease populations, regardless of cancer type.[30] Based on the evidence from this collaborative work, the Chronic Disease Self-Management Program developers at Stanford now offer an adapted version for cancer survivors. Taken together, these research activities used key dissemination and implementation science to facilitate the translation of EBIs to cancer survivors.

Human papillomavirus vaccine. The U.S. Food and Drug Administration approved human papillomavirus (HPV) vaccination for adolescents and young adults nearly a decade ago. However, HPV vaccine uptake and completion of the three-dose vaccine series has been suboptimal. CPCRN identified promotion of HPV vaccination as an emerging public health issue shortly after the vaccine was first approved and formed its HPV vaccine workgroup.

Projects included development and cognitive testing of survey items that represent constructs known to affect vaccine acceptability and completion,[31] and summarization of measures of HPV vaccine knowledge, attitudes, beliefs, and acceptability, describing their psychometric characteristics.[32] These two projects provided valuable information on measures for assessing factors associated with HPV vaccination and evaluating the success of efforts to promote its use.

The CPCRN sites that focus on Latino populations conducted a survey to assess HPV vaccine initiation and correlates of initiation among Latina adolescent girls. Data were collected from caregivers of 444 girls in California (Los Angeles County), Washington (Yakima Valley), and Texas (Houston and Lower Rio Grande Valley). Low uptake of the vaccine (26%–37%) was documented across regions. Observed regional similarities and differences have been used to inform the implementation of HPV vaccination programs in Latino communities and healthcare systems serving Latino patients.[33] CPCRN sites developed an interactive application delivered via iPads that proved to be effective at

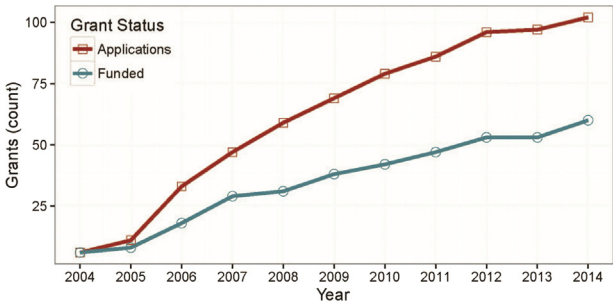

Figure 1. Multicenter collaboration in grants.

increasing HPV vaccination in Latina girls in Houston, TX,[34] and are evaluating an organization-level intervention to increase HPV vaccine uptake among ethnic minority adolescents in Los Angeles, CA.

Growth of multicenter collaboration. The CPCRN investigators have been highly successful in leveraging their collaborating center funding to advance research in the adoption and implementation of evidence-based cancer prevention and control. Since 2004, CPCRN investigators have received 513 grants for their cancer control work, exceeding $484 million. Of the 513 grants, 42 were multicenter grants exceeding $59 million. The number of multicenter grants rose steadily over time (Figure 1).

The CPCRN members also have been highly prolific contributors to the scientific literature on evidence-based cancer prevention and control. From 2004 to 2014, CPCRN investigators have published 6,534 articles, including 249 multicenter CPCRN publications. The number of multicenter publications rose steadily over time (Figure 2). Collaborating centers participated in an average of 2.3 multicenter scientific articles per collaborating center author, with some collaborating centers participating in more multicenter publications than others (Table 1).

Most of CPCRN's multicenter publications focused on cancer prevention and control. Of the 240 multicenter publications indexed in PubMed, 164 (68.3%) matched keyword searches for Medical Subject Heading cancer terms (Figure 2). The six most frequently occurring topical Medical Subject Heading terms assigned to multicenter publications overall were *mass screening* (38%), *neoplasms* (35%), *health knowledge, attitudes, practice* (26%), *colorectal neoplasms* (25%), *breast neoplasms* (18%), and *health promotion* (17%).

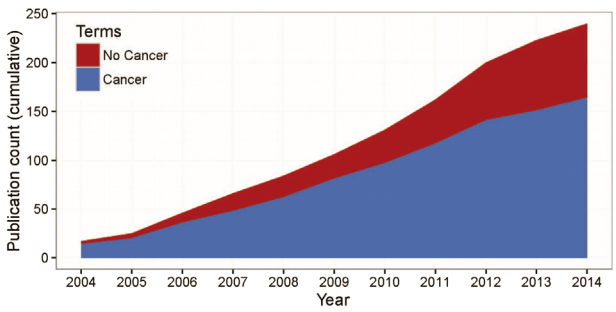

Figure 2. Multicenter collaboration in scientific publication.

Co-authorship network analysis indicates that the density of multicenter collaboration on scientific publications grew over time. In network analysis, density indicates the connectedness of nodes in a network (i.e., collaborating centers in CPCRN) and was measured by counting the number of ties that are present out of the total possible number of ties: A density of 1 would indicate that each center collaborated with every other center, and a density of 0 would indicate no collaboration among centers occurred. From 2004 to 2014, the density of the CPCRN collaboration network grew from 0.18 to 0.93. The greatest increases occurred immediately after new centers joined CPCRN: After Emory, Morehouse, University of California, Los Angeles, University of North Carolina, and Washington University in St. Louis joined CPCRN in 2004, network density increased from 0.18 to 0.33 in 2005 and to 0.49 in 2006. After Central Texas, Colorado, and University of South Carolina joined in 2009, density increased from 0.58 in 2009 to 0.73 in 2010. In other years, increases in network density were much lower (range, 0.02–0.07; mean, 0.04). In summary, this analysis clearly shows a pattern of more extensive collaboration between member centers over time (Figure 3).

CHALLENGES AND LESSONS LEARNED

This paper describes the key accomplishments of CPCRN in advancing collaborative research in cancer prevention and control. The analysis of multicenter grants and publications showed increased collaborations between centers each year. Over time, all centers were engaged in collaborations with other centers and in several cases the entire network collaborated on projects. Achieving collaboration is important, but not the end goal. The main goal was to advance the science in key areas related to the CPCRN mission. Yet, it was through multicenter collaboration that the CPCRN leveraged the expertise, resources, and partnerships of participating centers and conducted research projects that had an impact beyond what individual centers could have achieved on their own. One of the biggest challenges faced was generating collaborations, given that CPCRN involved hundreds of investigators located across a wide geographic distance. Another challenge was vetting new ideas, given that investigators had lots of ideas and were often strongly attached to them.

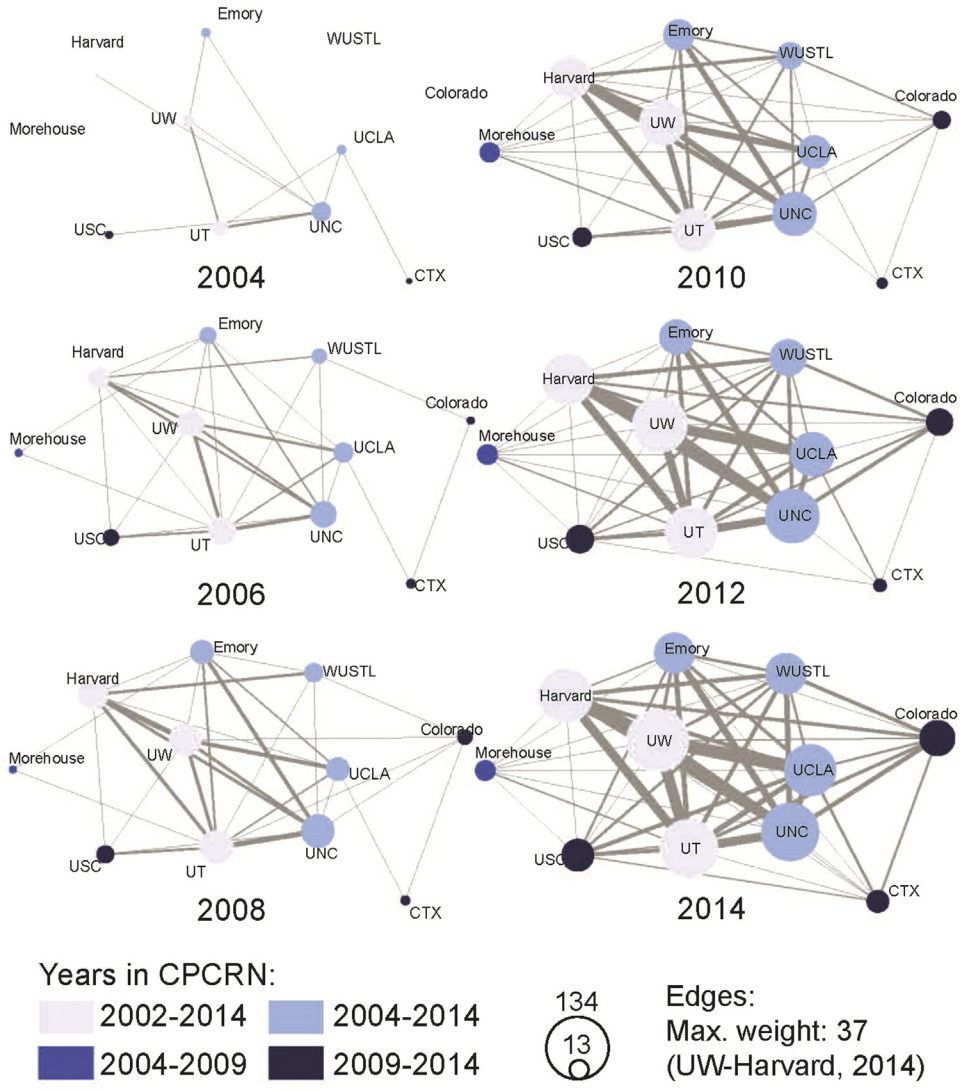

Figure 3. Cumulative multi-center publications between CPCRN member sites, 2004–2014.
CPCRN, Cancer Prevention and Control Research Network.

The level of multicenter collaboration, and the impact that multicenter projects achieved, was due in no small part to the ideas, expertise, energy, and commitment of the investigators that CPCRN attracted. Yet, multicenter collaboration was no fortuitous accident. CDC built multicenter collaboration into the design of CPCRN by explicitly stating in its Request for Applications that collaborating centers were expected to generate and commit resources to multicenter collaborative projects. CDC and NCI program officers reinforced this expectation through their active participation in monthly CPCRN Steering Committee calls and annual meetings; their ongoing participation in cross-center project conference calls also underscored the importance of progress, productivity, and impact through multicenter collaboration.

In addition, the CPCRN Coordinating Center created processes and developed resources to support multicenter communication, coordination, and provided logistic support and research services to support multicenter collaboration. For example, the coordinating center formulated a set of principles, processes, and criteria to facilitate the identification, vetting, and selection of cross-center project ideas. Priority was given to workgroup ideas that had clear deliverables—typically one or more manuscripts, a grant application, or development of an intervention. Ideas that had been piloted at one local center were often more successful as multicenter projects because they could be readily adapted elsewhere through sharing of materials such as IRB applications, protocols, and survey measures. The Coordinating Center facilitated collaboration by supplying toll-free

conference lines, web conferencing software, and website resources, including an online calendar listing conference call schedules; an online directory of network members and "e-mail workgroups" function; and online collaboration tools with sophisticated features.

Research services included scientific consultation on project ideas; review of grant proposals; development of IRB templates; development of online surveys; and feedback on manuscripts, reports, and presentations. Importantly, the Coordinating Center developed an online reporting system that collected detailed information about every cancer plan or policy, research activity, grant application, publication, and presentation by collaborating centers and workgroups. The Coordinating Center, Steering Committee, and the funders used these data to monitor performance, with particular attention focused on multicenter collaboration.

CONCLUSIONS

In conclusion, CPCRN has flourished by building a strong infrastructure[35] needed for collaboration and addressing timely and important cancer control topics. Many challenges still remain in addressing cancer disparities, and this will continue to be a focus of the network going forward.

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SUPPLEMENTAL MATERIAL

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