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Student-centered Pipeline to Advance Research in Cancer Careers (SPARCC): Diversifying the Clinical Cancer Research Workforce

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Abstract

A lack of diversity in the clinical cancer workforce causes undue burden limiting research and patient care advancements. Recruitment and retention of individuals underrepresented in medicine/research can enhance patient-provider concordance. The Student-centered Pipeline to Advance Research in Cancer Careers (SPARCC) uniquely prepares underrepresented minority students to quickly transition into the clinical research workforce and seek advanced graduate degrees. Experiential learning theory and culturally responsive pedagogy ground SPARCC's rigorous competency-based curriculum incorporating cancer care, clinical trial development, social supports, and mentored research experiences. Concurrent mixed-methods analysis includes evaluations of workshops, clinical-practicums, and pre-, post-, and 6-month-post-knowledge, attitudes, and practices. Analysis of data included stepwise multivariate regression analysis, Spearman's rho correlations, and assessments of inter-item reliability via Cronbach's alpha (IBM® SPSS® 24.0). Inductive content analysis coded phrases and analytic patterns were distilled enhancing descriptions of experiences. From January 2019 to March 2019, 62% of applications came from underrepresented minorities. Ten students were accepted, 90% identified as underrepresented minority. All ten students completed the pre-, post-, and 6-month-post-evaluations. Overall scores increased significantly from pre-evaluation to 6-month-post-evaluation. Evaluation data came from 431 responses of 60 workshops, with a mean score of 9.1 (10-point scale). Students completed three clinical practicums, which received an overall mean score of 8.2 (10-point scale). A robust curriculum, structured recruitment, diverse faculty, and comprehensive evaluations made SPARCC a compelling strategy for supporting underrepresented minority students to seek immediate employment as clinical research professionals or application to advanced graduate degree programs.

Keywords Pipeline program · Underrepresented minority students · Clinical cancer research

Introduction

Diversifying the clinical cancer research workforce has the capacity to address racial and cultural discordance between patients and care teams, which is critical due to the prevalent health-related disparities in the USA [1, 2]. Evidence suggests patient care improves when care teams share racial/ethnic identities with patients [2–4]. Given the benefits of this concordance, it is urgent to increase the number of underrepresented minority (URM) clinical cancer researchers, physicians, and staff [5]. National statistics demonstrate sluggish growth in recruitment and retention of URM (i.e., Hispanic or Latino, Black or African American, American Indian or Alaska Native Asian, Native Hawaiian, or Other Pacific Islander) into scientific research and healthcare occupations [6, 7]. Reasons vary, but include environmental, contextual, and structural factors. Accessibility to mentors in science, technology, engineering, and mathematics (STEM) and mentors who match a student's race/ethnicity or gender is critical for increasing URM into STEM careers [8, 9]. Thus, pipeline programs are developed to mitigate systemic, educational inequality [10]. In 2018, the National

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Cancer Institute (NCI) funded the Student-centered Pipeline to Advance Research in Cancer Careers (SPARCC) to recruit and prepare URM undergraduate students to become clinical research professionals (CRPs) and seek advanced degrees in clinical cancer research.

Grounded in experiential learning and culturally responsive pedagogy [11, 12], SPARCC is an intensive 8-week summer program to design and manage clinical cancer trials, understand nuances of cancer prevention and care, conduct research, and explore career pathways. Because of the explicit career integration, SPARCC permits rapid transition to the research workforce, reducing common financial burdens graduating students face. Accepted students or "scholars" engage in hands-on daily workshops and clinical practicum rotations. Concurrently, scholars complete a culminating research project to address a cancer-related health disparity, formally presented at the end of the 8 weeks.

This article describes the programmatic development, recruitment strategies, and process and outcome evaluations of SPARCC's first year. Process evaluation determined efficacy through scholars' experiences during workshops and clinical practicum rotations. Outcome evaluations determined how SPARCC influenced the students' knowledge, attitudes, and practices (KAPs) of clinical research and impacted professional trajectories. This research sheds light on how to design pipeline programs to incorporate URM students into complex multidisciplinary research teams through robust experiences.

Methods

SPARCC was designed to diversify the cancer workforce and address issues of lacking diversity in clinical trial enrollment. The curriculum is framed by the Joint Task Force for Clinical Trials Competency Domains [13], integrating social determinants of health and culturally responsive care [14]. SPARCC faculty aligned these competencies with content expertise and methods of instruction to address the complexity of clinical cancer research. To support incoming scholars, SPARCC faculty were mindfully recruited (Table 1). A SPARCC-centric professional development workshop delineated culturally responsive pedagogy and provided tangible teaching resources. As an institutional commitment to diversity, inclusion, and equity, many SPARCC faculty completed National Coalition Building Institute (NCBI) training (https://ncbi.org/) and all faculty are required to remain current in human research protection training.

To recruit URM scholars, we established dedicated partnerships formally recognized for their diverse student populations: institutions of higher education (IHE): community colleges, designated Hispanic-serving and women-only universities, and minority-led groups such as the Society for Advancement of Chicanos, Native Americans in Science (SACNAS), and Area Health Education Centers (AHEC). All partners provided feedback on recruitment materials and identified key personnel to support recruitment efforts through academic advising, social media, and email. In-person recruitment sessions led by program directors occurred at each of the partner institutions during times that were conducive to the student population. Sessions included recommendations of how to submit a competitive application and how to request a letter of support. Interested students completed a comprehensive online application including a current resume, course transcripts, one letter of recommendation from a supervisor or faculty member, and an essay to demonstrate alignment with SPARCC's goals. A rubric was used to evaluate each component of submitted applications.

SPARCC is free, and scholars receive an electronic tablet, daily meals, career counseling, travel reimbursement, and a living stipend. To establish a collegial, welcoming environment, the first week of SPARCC includes professional development and community building activities. Scholars create a LinkedIn professional networking account to encourage self-promotion and confidence to network [15]. LinkedIn is also a tool to observe SPARCC alumni progression after graduation. Scholars complete two research training programs: Human Subject Research Protections training through the Collaborative Institutional Training Initiative Program (CITI) and Opening Doors to Community Research [16]. Scholar critical reflection and discussion of character strengths are examined through the VIA Character Assessment (https://viacharacter.org).

Daily workshops and afternoon clinical practicum rotations demonstrate the breadth and depth of cancer treatments, patient care, and intersection of clinical research. Workshops include 160 h of hands-on activities facilitated by SPARCC faculty. Each scholar completes three different 2-week clinical practicum rotations, with opportunities to observe surgeries, chemotherapy infusions, patient recruitment, palliative care, and genetic counseling.

A concurrent mixed-method approach was used to holistically evaluate SPARCC. Scholars evaluated personal knowledge, attitudes, and practice (KAPs), daily workshops and facilitators, clinical practicum rotations, and culminating research experience. SPARCC faculty evaluated scholars during clinical practicum rotations. This multidimensional evaluation provided "analytic texture" and triangulation of data [17]. Just before beginning SPARCC, scholars completed an online 17-item pre-KAP survey (scale: 1 = strongly disagree to 7 = strongly agree) and three free-text questions.

Table 1 SPARCC 2019 faculty, staff demographics, and academic affiliations

Role	n	Gender		Academic Rank		Underrepresented Minority Groups	
Faculty Appointment	39	Female	26	Assistant Professor	11	African American/Black	4
				Associate Professor	8		
				Professor	7		
		Male	13	Assistant Professor	2	African American/Black	2
				Associate Professor	5		
				Professor	6		
Staff Appointment	30	Female	25	[redacted]		African American/Black	5
		Male	5			African American/Black	1
						Hispanic/Latino	1
Academic Affiliations	Academic Affairs American Cancer Society and Patient Advocates Cancer Center Clinical Trials Office Cancer Center Pharmacy Center for Bioethics and Medical Humanities Center for International Blood and Marrow Transplant Research Office of Community Engagement Office of Diversity and Inclusion Department of Microbiology and Molecular Genetics Genetic Counseling Graduate School Gynecologic Oncology Human Resources - Talent Development Institute for Health and Equity Interventional Radiology Medical Oncology Otolaryngology Medical Interpretation and Health Literacy School of Public Health Palliative Care Medicine Pathology and Laboratory Medicine Pediatric Oncology Pediatric Clinical Trials Office Psychiatry and Behavioral Medicine and Microbiology & Immunology Radiation Oncology Radiology School of Pharmacy Surgical Oncology						

Upon the conclusion of SPARCC, scholars completed an immediate post- and 6-month-post-KAP survey. They evaluated workshop sessions with a six-item survey and one free-text question (scale: 1 = poor to 5 = outstanding). At the end of each clinical practicum rotation, the scholars evaluated the 2-week rotation with a six-item survey and three free-text questions (scale: 1 = poor to 5 = outstanding). SPARCC faculty overseeing the clinical practicum rotations evaluated the scholars with a four-item survey (scale: 1 = does not meet expectation, 4 = exceeds expectation). All evaluations included an overall (global) rating on a 10-point scale (1 = poor, 10 = excellent).

Comparative analysis of evaluation data was performed with a Friedman analysis of variance (ANOVA) with the Bonferroni correction. If statistical significance was obtained, Wilcoxon's signed-rank non-parametric tests for ordinal-scale data followed for pairwise comparisons. Relational analysis included Spearman's rho correlations. Stepwise multivariate linear regression was used to evaluate the workshops. The analysis was completed with IBM® SPSS® 24.0 (Armonk, NY, USA).

Qualitative data were acquired through the free-text spaces in each evaluation tool. These spaces allowed the scholars and faculty to identify what facilitated or hindered learning, how content was understood, and what impacted the scholars' SPARCC experience and career trajectory. Through inductive content analysis, one author independently reviewed all submitted evaluations, coding key phrases, terms, and written observations. Analytic patterns were further distilled into specific themes found across evaluations to detail the scholars' experiences. All research components of SPARCC were approved by the institutional review board.

Results

From January 2019 to March 2019, 39 undergraduates submitted a complete application; 62% (24/39) self-identified as URM and 77% (30/39) were female. In March 2019, we selected ten individuals after tabulating and ranking the individual rubric scores. Of those, 90% (9/10) self-identified as URM: 40% (4/10) African American/Black, 40% (4/10) Hispanic/Latino, 10% (1/10) American Indian; 90% (9/10) were female. The results section is organized by each SPARCC evaluation.

All 10 scholars completed the pre-training, post-participation (immediately at the conclusion of SPARCC), and 6-month post-training survey of KAPs. Eleven of 17 items (65%) showed statistically significant changes across the three time periods when analyzed with the Friedman ANOVA after a Bonferroni correction (Table 2). Follow-up pairwise comparisons indicated significant increases in pre-training to post-training for all 11 items, with no significant decrease from post-training to 6 months post-training. In addition, all 11 changes from pre-training to 6-months post-training were significant. Free-text responses acquired 6 months after training, the SPARCC alumni emphasized the program's impact on their lives, relationships, and careers. One scholar wrote, "SPARCC opened my eyes to all the opportunities that are just there for us to take, and [SPARCC] has given me awesome peers. I know we will be able to help each other down the road." Another scholar shared, "My experience in SPARCC has been one of the top-three life-changing events during my college years." The value of mentoring and advising was recognized as well: "I have done many summer programs, but not a single one helped me with career advising as SPARCC did. I really was made aware of the variety of opportunities in clinical research, from [CRPs] to nurses, MDs, and PhDs."

In addition to KAPs, scholars also completed 431 evaluations for 60 workshops. The overall mean rating for the workshops was 9.1 (10-point scale). Only four workshop sessions fell below the overall global rating of 8/10. The feedback provided about those less popular sessions indicated a desire for interactivity with peers, in-depth discussion, and less repetitive content. After participation in the highly rated workshops, scholars identified increased knowledge of complex content due to the facilitators' methods to actively engage the cohort, satisfaction when a variety of teaching strategies were used, facilitators' deep content knowledge, and notably the impact of facilitator's vulnerability sharing personal stories of career advancement.

The scholars gave the clinical practicum rotations an overall rating of 8.2 (10-point scale). The six individual practicum rotation items all yielded median scores from 4.0 to 5.0 (Table 3). The written responses observed collegiality, "I enjoyed the cooperation between pharmacists, techs, and nurses, and how they work together for the patient's safety." Another scholar shared, "The physicians did a wonderful job explaining the parts of patient care and clinical trials they are involved in with [CRPs]." These rotations exposed scholars to unfamiliar fields, "I never knew that there [was] imaging research until this rotation," Across all evaluations, scholar feedback identified knowledge gain and advancement.

Faculty who oversaw clinical practicum rotations evaluated the scholars as mean (sd) = 9.2 (1.1) out of 10, with individual items of *engaged in appropriate ways when promoted* median (ir) = 4.0 (1.0), *completed tasks when asked* 4.0 (1.0), and *modeled a high standard of professionalism* 4.0 (0.0). Two individual items predicted the overall global rating ($R^2 = 0.56$, $p < 0.001$), with the best predictor being *SPARCC Scholar engaged in appropriate ways when prompted* (beta = 0.54)

Table 2 Knowledge, attitudes, and practices (KAP) of scholars

Item	Median (interquartile range)			Pairwise Sig (*p*)		
	Pre	Post	6 months	Pre–post	Post–6 months	Pre–6 months
I am familiar with the CRP career pathway	5.0 (2.2)	7.0 (0.0)	7.0 (0.0)	0.004*	1.000	0.004*
I understand what a clinical research professional does	5.0 (2.3)	7.0 (0.0)	7.0 (0.0)	0.007*	0.317	0.004*
I intend to pursue (or am currently in) a career in research	6.0 (1.3)	7.0 (1.2)	6.0 (2.2)	NA	NA	NA
I intend to pursue an advanced degree in the next 5 years	7.0 (0.0)	7.0 (0.0)	5.0 (0.0)	NA	NA	NA
I am knowledgeable about cancer diagnosis and treatments	5.0 (1.0)	6.5 (1.0)	6.0 (1.2)	0.004*	0.102	0.010*
I am aware of issues relating to medical mistrust among underserved populations	6.0 (0.3)	7.0 (1.2)	7.0 (0.0)	0.020*	0.157	0.007*
I have an understanding of different types of research design	5.0 (1.0)	6.5 (1.0)	6.5 (1.0)	0.005*	0.705	0.015*
I often read published research in peer-reviewed journals	5.0 (1.0)	6.0 (1.0)	6.0 (1.3)	NA	NA	NA
I understand how medical drugs are developed and regulated	4.5 (2.0)	7.0 (1.0)	6.5 (1.0)	0.005*	0.317	0.005*
I am aware of how data are acquired and managed during a clinical trial	5.0 (2.0)	7.0 (1.0)	7.0 (1.0)	0.006*	0.655	0.004*
I believe that I am a leader in a professional working environment	6.0 (3.0)	6.0 (1.2)	6.0 (2.0)	NA	NA	NA
I enjoy collaborating with others	7.0 (0.0)	7.0 (0.0)	7.0 (0.0)	NA	NA	NA
I find it easy to ask questions to clarify my understanding	6.0 (1.2)	7.0 (1.0)	7.0 (1.0)	NA	NA	NA
I can list the social determinants of health	3.5 (2.3)	7.0 (1.0)	7.0 (1.0)	0.011*	1.000	0.007*
I am knowledgeable about the role of the IRB in research	3.5 (2.5)	7.0 (0.0)	7.0 (0.0)	0.007*	0.317	0.007*
I can explain the guidelines of good clinical practices	3.0 (1.5)	6.0 (1.3)	6.0 (1.2)	0.006*	0.792	0.005*
I am familiar with culturally responsive strategies used with patients and patient families	5.0 (2.3)	7.0 (1.2)	7.0 (1.0)	0.005*	0.317	0.007*

*Friedman analysis of variance analyzed across all three scores (not shown in table) with Bonferroni correction by dividing the traditional significance cut point of $p \leq 0.05$ by the number of items (17). If statistically significant ($p \leq 0.003$), this resulted in determining the significant differences in pairwise scores via Wilcoxon Signed-Rank tests (shown in table). Nonsignificant Friedman analysis of variance resulted in not applicable (NA) for each pairwise difference

followed by *SPARCC Scholar modeled a high standard of professionalism (reliable*, *collegial*, *respectful with patient interactions*, *and overall maturity)* (0.30). Faculty provided feedback, commonly identifying characteristics of engagement and professionalism. One faculty said, "The scholar demonstrated strong interpersonal skills with staff and patients as evidenced by the level of engagement, questions, and insight." Another described a scholar as having "a bright future and will do very well in whatever endeavor they choose."

At the conclusion of the first cohort, two scholars were immediately interviewed for, accepted, and began new staff positions as CRPs; two continued to pre-medical post-baccalaureate programs; and six were accepted to and continued to advanced degree programs (Table 4).

Discussion and Conclusion

We developed SPARCC to address the critical need to improve diversity among clinical cancer professionals to ultimately diversify clinical research participants. Due to historical medical mistrust [1–4], patients can be hesitant to

Table 3 Clinical practicum rotation evaluations

How well did the faculty/staff during this rotation . . .	Median (interquartile range)
Serve as role models	4.0 (1.0)
Demonstrate a positive attitude toward teaching and learning	5.0 (1.0)
Foster my interest in research	4.0 (2.0)
Encourage my professional goals	4.0 (1.0)
Provide a learning experience to understand excellence in patient care	5.0 (1.0)
Make me feel that I belong in this field	4.0 (2.0)

Table 4 2019 SPARCC career trajectory and undergraduate degree

Gender	n		Career Trajectory After SPARCC	n
Female	9		Clinical Research Professional	2
			Pre-Medical Post Baccalaureate Program	2
			Advanced Degree Program, Master's	3
			Advanced Degree Program, Medical School	2
			Advanced Degree Program, Doctorate	1
			Scholar Undergraduate Degree	**n**
Male	1		Biomedical Engineering	1
			Biomedical Sciences	3
			Cell/Cellular and Molecular Biology	1
			Chemistry	2
			Genetics and Genomics	1
			Nursing	1
			Sociology	1

n = 10 Total number of 2019 Scholars

participate in clinical cancer trials if faced with racially or culturally incongruent care teams during recruitment. The resulting homogeneity in research cohorts can lead to results that are misleading or apply to only a narrow segment of the population. It is therefore imperative to diversify the clinical cancer workforce so that clinical trials in cancer care can improve the health of all patients. Presently, URM students face daunting challenges when pursuing careers in medicine and biomedical research. Particularly, the sociopolitical structure of education of inadequate teaching and dearth of URM mentors results in lower scientific self-efficacy, further exacerbating a "confidence gap" [18, 19].

Now the first SPARCC cohort has graduated, it is important to highlight key findings to inform pipeline program design and implementation. Programs must have a structured, robust recruitment strategy. By establishing dedicated partnerships with minority-serving IHEs, a distinct pathway into clinical cancer research emerged. The intimate setting of SPARCC encouraged scholars to establish mentoring relationships with locally and nationally recognized faculty and a robust peer-mentoring system. Data acquired from the KAPs and workshop evaluations showed that the curriculum successfully conveyed the complexities of clinical research while emphasizing health disparities, as knowledge of key areas increased during SPARCC and were maintained 6 months after the program ended. These findings indicate how SPARCC addressed barriers by structuring a diverse and inclusive network of researchers and clinicians to provide real-world skills to burgeoning leaders in clinical cancer careers. This was achieved through educational experiences, mentorship, and professional development opportunities supporting CRP careers and advanced degrees. SPARCC will follow and engage alumni to maintain the pipeline to successful CRP employment and advanced degree completion. We provide letters of recommendation and supplemental clinical shadowing and engage SPARCC alumni through recruitment presentations, workshop facilitation, and supplemental research.

Because the CRP pathway is not widely recognized outside medical centers, SPARCC underscores CRP career advancement from clinical research associate to research manager and regulatory affairs specialist. Moreover, the Association of Clinical Research Professionals (ACRP) launched a campaign in 2020 to raise awareness of the career pathway among diverse student populations (https://careersinclinicalreserach.org). Few CRP-specific training programs exist, and commonly, individuals enter a CRP role with little knowledge of professional expectations [20–22]. This approach is not adequate to navigate the increasing complexity of cancer clinical trials and is especially unsuitable for recruiting diverse participants.

SPARCC's strengths include robust, daily evaluations with perspectives from students and faculty before, during, and after the program. Continuous engagement through LinkedIn, alumni events, mentorship, and career counseling solidifies our dedication to scholar success. Longitudinal analysis of SPARCC, the graduates, faculty, and emerging and sustained networks will inform of long-term impact. Limitations include a small sample size, impacting generalizability. Although there is some temporal precedence in this

study design in that the intervention preceded post-measures, other confounding elements which cannot be controlled for can contribute to changes in pre-post scores, and therefore, statistical associations are not equated to causation. Increased recruitment and larger cohorts in subsequent years will continue to inform results. Ongoing relationships with undergraduate college faculty and advisors support transitional mentoring for students situated in the next phase of their career [23].

The design and implementation of a multifaceted pipeline program that incorporates rigorous educational and clinical enrichment, social supports, and research opportunities encourage URM students to seek clinical cancer research careers. These opportunities enrich student skills, experience, and awareness to seek immediate employment as clinical research professionals and support those who wish to pursue advanced degree graduate degrees.

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Data Availability Not applicable.

Code Availability Not applicable.

Declarations

Ethics Approval/Human Participant Compliance Statement All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Bioethics Committee of the Medical College of Wisconsin Institutional Review Board (PRO00031976).

Consent to Participate Due to the minimal risk of this study, no consent documents were required per the Institutional Review Board requirements.

Consent for Publication Due to the minimal risk of this study, no consent documents were required per the Institutional Review Board requirements.

Conflict of Interest The authors declare no competing interests.

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