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Increasing the representation of minority students in the biomedical workforce: The ReTOOL program

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Introduction

Improving quality cancer care and outcomes in the United States requires the recruitment of oncology professionals from diverse backgrounds [1]. For this reason, targeted strategies must include an expanded effort to improve workforce diversity in oncology [2]. There are several documented advantages that favor developing a cadre of racially and ethnically diverse, well-trained biomedical scientists. These advantages include (1) an increase in the capacity for scientific research among underserved populations; (2) the ability to address cultural appropriateness of the conceptualization, design, and implementation of research ideas; (3) the ability to effectively and respectfully deliver healthcare interventions for diverse populations; and (4) the ability to ultimately eliminate health disparities [1–3]. It is thus not surprising that the significant underrepresentation of racial/ethnic minority cancer scientists, in fields spanning from basic research to behavioral science, has been linked to limited progress in eliminating cancer disparities [1] and the under-representation of minority participants in biomedical research [4–7]. The urgent need to identify, recruit, train and mentor the next generation of cancer scientists is clear. However, developing a successful and sustainable recruitment and training program to address this problem is challenging.

In 2012, the University of Florida (UF) and Florida A&M University (FAMU) formed a partnership focused on creating opportunities and promoting prostate cancer (CaP) research careers for Black students through the Florida Prostate Cancer Research Training Opportunities for Outstanding Leaders (Basic ReTOOL) Program. Funded by the

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Department of Defense (W81XWH-12-1-0083), the Basic ReTOOL program was developed to address specific barriers impacting underrepresented minority (URM) trainees with respect to biomedical research careers. The barriers include: (1) the lack of committed role models [8]; (2) inadequate mentoring [9]; (3) insufficient preparation, such as limited knowledge in content areas [8]; (4) low expectations from others, for example faculty advisors and mentors [8]; and (5) unfamiliarity with scientific culture and idioms [8]. By 2017, the ReTOOL program has expanded to: (1) cover all areas of documented cancer disparities in Blacks, including prostate, breast, colorectal, lung and pancreatic cancer disparities; (2) offer training opportunities to minority students from all historically black colleges and universities (**HBCUs**) in Florida; and (3) successfully secure funding to continuously provide research training opportunities for minority students in Florida.

This article describes the lessons learned from administering the ReTOOL program for five (5) years, especially what we have come to recognize as the successful components in developing a pipeline of URM trainees for biomedical research career. Using a logic systems analysis approach (see Figure 1), the essential components of the ReTOOL program includes inputs, processes, outputs, outcomes, tracking and evaluation [10]. The program inputs and outputs are discussed in this paper, focusing on both the basic ReTOOL program and the Advanced ReTOOL Academy I program. The basic ReTOOL program is for URM students with no research experience. In turn, students with at least one semester of research experience are eligible for the Advanced ReTOOL Academy I program.

ReTOOL Program Inputs

Inclusive-focused institution

When research training activities take place at a majority institution, the institution must continuously strive for organizational cultural competence. Some of the desired institutional characteristics are: (1) An institutional strategic plan that includes diversity and inclusion; (2) Clear long-term and short-term goals and/or objectives for diversity and inclusion at all levels; (3) Responsible leader(s) to lead the implementation of diversity and inclusion goals/objectives and activities; (4) Commitment to the recruitment, retention, and graduation of URM students; (5) Commitment to the recruitment and retention of ethnically-diverse faculty and staff; (6) Funding commitment for research training; (7) Creating an environment that is responsive to URM trainees; and (7) Institutional assessment that includes diversity and inclusion metrics for continuous improvement. UF continuously strive to be an inclusive-focused institution through these organizational cultural competency characteristics to foster an inclusive and comfortable environment for ReTOOL trainees.

Majority-Minority institutions partnership

One of the cornerstone inputs for the ReTOOL program has been the initial and continuous partnership between FAMU and UF. UF and FAMU were ideally suited as partners to start the ReTOOL program in 2012. As one of the premier **HBCUs** in Florida, FAMU is committed to achieving excellence in education and research. FAMU brings a pool of outstanding URM students to the ReTOOL program who are well prepared for the summer training program. In turn, UF brings access to top cancer scientists and uniquely

collaborative environments that develop students into future researchers. At UF, students have access to more than 200 research, service and education centers, bureaus and institutes.

Extramural Funding

Developing and maintaining a cadre of racially and ethnically diverse, well-trained biomedical scientists requires continuous funding. The ReTOOL program has received continuous funding since 2012 by the US Army Department of Defense (W81XWH-12-1-0083 and W81XWH-14-1-0243) and the NIH/National Cancer Institute (P20CA192992 and R25CA214225). The Department of Defense awards funded the Basic ReTOOL program, which provided summer research training for URM students with no previous research experience. The NIH/National Cancer Institute (NCI) P20 award funded the Advanced ReTOOL program, which provided students with previous research experience additional summer research experiences. In 2017, the ReTOOL program was expanded to the Comprehensive ReTOOL program through the NIH/NCI R25 award. UF faculty continue to work with Florida HBCU faculty to submit highly competitive grant applications for additional funding, including the NIH **Ruth L. Kirschstein National Research Service Award (T32)**.

Intramural Funding

Maintaining a successful research program requires the commitment of all partnering institutions, including the provision of leveraged funding to support URM trainees. The UFHCC provided \$400,000 to support the ReTOOL program for three years, from 2014–2017. This UF leveraged funding is a strong indicator of UF’s commitment to increasing the number of URM cancer scientists in Florida and its commitment to the UF-FAMU partnership. In addition, FAMU provided \$6,000 to support the training of an additional ReTOOL trainee in 2015 due to the high number of qualified trainees from FAMU.

Faculty Advisors

ReTOOL program key personnel includes a faculty advisor at each participating institution. Faculty advisors play a critical role in recruiting, supporting and preparing students for the ReTOOL program. The importance of faculty advisors was underscored when the ReTOOL program application submission changed from submission through the faculty advisor to online portal submission in 2015. Changing the application submission to online submission reduced student consultation with HBCU faculty advisors. Prior to the online submission, all applicants consulted with their respective HBCU faculty advisors. Upon implementation of the online application, the majority of the students completed the application without even consulting with their HBCU faculty advisors, resulting in a weakening of the overall quality of the applications. To address this, we introduced another application component for the program in 2017, a letter of certification from the HBCU faculty advisor. To acquire the letter of certification, the HBCU faculty advisor must review and approve the student application.

Committed Mentors

A backbone of this research training experience is access to committed and outstanding mentors. ReTOOL mentors have active cancer research projects that a trainee can join immediately, but still provide an opportunity to meet the unique experiential needs for each trainee. The ReTOOL program has rigid criteria to qualify as a mentor: (1) An active research portfolio with at least one extramurally funded award; (2) Previous experience in training students; (3) Willingness to train URM students; and (4) Commitment to mentor the trainee for a minimum of one year.

Culturally Competent Staff

The ReTOOL program coordinator and program assistants are involved in the recruitment of students at all participating institutions, assist students with their applications, conduct the orientation for trainees at UF, actively support students throughout the summer program, coordinate the research showcase at the end of the summer program, and follow up with students for program evaluation. Given that the program staff constantly interact and communicate with trainees and alumni, it is crucial that they are culturally sensitive and capable of supporting the trainees in a culturally responsive manner. Ideally, program staff who come from similar racial/ethnic background are desired. However, a staff who is capable of functioning and relating with people from diverse racial and ethnic background is also capable of supporting an URM research training program.

Standardized program requirements

Within the last 5 years, the ReTOOL program has evolved to a structured 6-credit hour course. Students can earn up to six academic credit hours for participating in the ReTOOL summer research training program by signing up for an independent study or research experiences course with their home institution or UF mentor. The ReTOOL research training course is titled *Introduction to Oncology Research* at UF. The program starts with a one-week independent reading (IR) component on the Institute of Medicine report on “Genes, Behavior, and the Social Environment” [11]. The IR component is followed by a didactic curriculum (DC) component during the second week of the program. Subsequently, trainees are placed in a research environment for 13 weeks to foster learning, provide positive mentor/mentee interactions, and complete pilot projects.

Structured Curriculum

Several central themes emerge from the literature that provides guidance on promoting successful academic and research careers to increase underrepresented minorities in science: (1) provision of hands-on research experiences; (2) interactions between aspiring and established scientists; (3) networking; (4) mentoring; (5) collaboration; (6) commitment; (7) program structure and consistency; (8) peer linkages; and (9) information about career opportunities [12–18]. In addition to these activities, the ReTOOL curriculum also include independent readings, active community outreach activities, and research dissemination.

Student Ambassadors

From our experiences, we found that ReTOOL alumni were best at recruiting outstanding applicants for the program, especially hard-to-reach URM students. At the beginning of the ReTOOL program, we had difficulties recruiting Black males for the program. To address this problem, we recruited the first two Black male trainees in the program to be ReTOOL ambassadors at their respective institutions. The impact of the ReTOOL ambassadors was immediate, with about 40% Black males subsequently enrolled in the ReTOOL program annually. ReTOOL ambassadors represent the program at their home institutions. In addition to personally recruiting students who may be hard to reach, they organize the program orientation sessions, professional development seminars, research seminars, and Journal club sessions.

Motivated Pool of Diverse Trainees

The ReTOOL program targets a diverse pool of URM students at UF and all the HBCUs in Florida. Students are recruited from multiple programs, including previous ReTOOL trainees. In addition, we target unique programs such as the STEP-UP (Successful Transition through Enhanced Preparation for Undergraduate Programs), Honor's Program, AIM (academics-based program for students with low test scores), University Scholars' Program, The Florida-Georgia Louis Stokes Alliance for Minority Participation (FGLSAMP) Program, and McNair Scholars Program.

Eligible applicants are students in a health science/science/social-science program or relevant discipline, such as pharmacy, nursing, allied health, public health, biology, chemistry, biochemistry, psychology, anthropology, or sociology. In addition, students must have a minimum GPA of 3.0, strong recommendation letters and be in good standing at their home institutions.

ReTOOL Program Processes

Pipeline Approach

The ReTOOL program employs a pipeline approach for the training of URM students through continuous training awards based on *lifetime* mentorship. Recruitment efforts target students with the potential to become outstanding cancer researchers as early as their freshman year. Trainees who complete the basic ReTOOL program in their first or second year of college are invited to return the following summer for the Advanced ReTOOL Academy I program during their junior or senior year in college. Students in the Basic and Advanced ReTOOL programs are assigned experienced cancer scientists as mentors and role models. With the goal of establishing long-term mentoring relationships, these committed mentors provide opportunities for trainees to learn new skills and improve their knowledge.

Trainee Recruitment

The primary target for the recruitment efforts are URM undergraduate students. The ReTOOL program is widely advertised beginning in the fall semester (August). Using the ReTOOL promotional materials, program information is disseminated through the ReTOOL program's website, targeted mailings and posters to relevant departments, and direct e-mails

to potential applicants. We also use the social media to recruit students, including “tweets” about the programs and Facebook and LinkedIn groups with alumni, current trainees, and potential applicants.

ReTOOL program staff conduct recruitment workshops at the HBCU institutions to promote the program and assist potential applicants with the application process. The recruitment workshops are held between September and October. The workshop provides an overview of the program, its benefits, mentors’ expertise and research interests, required qualifications, didactic curriculum, summer research activities, and how to apply for the program.

Structured Application System

In the first three years of the ReTOOL program, the application process involved the submission of completed applications to the home institution’s faculty advisor. In 2015, the program moved to an online application system hosted by UF. This has significantly improved the application process, including the interview process. The application portal opens in November and closes in January. The program manager conducts a preliminary screening of applicants to identify students who meet the selection criteria. Program directors, at least two faculty mentors and the home institution faculty advisor subsequently interview students who pass the preliminary screening. All interviewers provide their evaluations for each candidate using the ReTOOL program evaluation form. The selection of students is based on each student’s academic achievement, recommendation letters, performance during the interview, and potential research interest match with at least two mentors. Candidates are categorized into three groups with the best students in Group 1. Group 1 students are accepted into the program, Group 2 students are placed on a waiting list, and Group 3 students are denied admission immediately. Group 2 students are placed on a ranked waiting list for consideration if a selected student does not accept the award. Once there is an opening, students are usually selected on the waiting list based on their ranking. Trainees are selected to maximize diversity (e.g., gender, institution) and research experiences.

Trainee-Mentor Matching

Using research keywords provided by trainees and active project summaries of mentors, trainees are matched with their mentors. Prior to 2017, mentors selected the students they were interested in working with based on the performance of the students during the interviews. We have changed this process, starting with the 2018 cohort, due to the large pool of mentors for the program. With the large pool of mentors, with about a ratio of 1 student to 2.5 mentors, ReTOOL trainees will be able to select their mentors based on their professional aspirations and research focus. Once students are admitted into the program, they will select up to three mentors (rank-ordered) from the diverse pool of outstanding scientists. Subsequently, the program staff will work through the choices to match trainees with a primary mentor.

Orientation Program

The ReTOOL program includes a structured orientation program for trainees. Once students are accepted into the program, they are sent an orientation package that includes critical

information about the program. The ReTOOL program starts the first week in May with trainees arriving in Gainesville (UF) on the Friday before the program begins for orientation. The program manager assists trainees: (1) to move into an on-campus housing; (2) with a tour of the UFHCC, Health Sciences library, and other UF resources; (3) to set up meetings with their mentors; and (4) to obtain UF ID badges. The Florida MiCaRT Center organizes a welcome reception on Friday of the first week. Attendance of the opening reception is required for all program trainees, program directors, faculty advisors and mentors with a keynote address by an accomplished scientist.

Structured Didactic Curriculum

The structured didactic curriculum includes: (1) Development of an Individual Development Plan by trainees; (2) Health Disparities lecture that examines the social, societal, and genetic/epigenetic factors that are fundamental in creating disparities in health; (3) Introduction to Clinical and Translational Research lecture that provides the fundamentals of clinical and translational research; (4) Cultural Competency and Communication lecture to increase the awareness, knowledge, and skills required to function effectively as scientists in the context of cultural differences; (5) Oncology Overview lecture that covers the basic principles of medical oncology, radiation oncology, and surgical oncology and the evaluation, staging, and treatment of malignancies; (6) NIH Training for Good Clinical Practice or Collaborative IRB Training Initiative (CITI) online course in human subject protections; and (7) Weekly Seminar on Research Topics in Oncology. The seminar provides a unifying activity for all trainees and also serves multiple purposes, including: journal club, career development presentation, student presentations of progress on their research experiences, literature critique and guest presentation by experts. Examples of previous guest presentations are networking for effective collaboration, scientific writing and dissemination, developing successful mentor-mentee relationship.

Hands on research experience

A primary aim of the ReTOOL program is for trainees to get a minimum of 10 to 13-week hands-on research experiences under the supervision of a mentor. Up until 2017, trainees selected research topics of mutual interest to them and their mentors without any synergy among the trainees. From 2018, a key requirement for a research topic is that it must address cancer disparities in Black populations and be guided by the IOM report on Genes, Behavior, and the Social Environment [11]. With this requirement, each trainee's research project will contribute to achieving the goal of addressing the still unexplainable disproportionate burden of cancer seen in Blacks. Trainees will now study the unique relationships among biological, behavioral and environmental factors, and the interactive pathways contributing to the etiology of disparity in cancer risk and mortality among Blacks and/or designing interventions based on the risk factors.

The ReTOOL hands-on research experiences provide students a sense of accomplishment and enhances their self-confidence to conduct cancer research. Simultaneously, the experiences provide students an opportunity to sharpen their research skills and improve their knowledge.

Community Engagement Activities

An innovative feature of the ReTOOL program is community outreach/service learning experience, which allows trainees to give back to the community most affected by cancer. In addition, trainees gain a better understanding of the impact of cancer in underserved communities. All ReTOOL trainees participate in 4-hour service learning experience every week. This includes community outreach activities, reflection paper on how to incorporate the experiences in research, presentation of study results in the community and presentations of community activities. The ReTOOL program works with several non-profit organizations, including international organizations, for trainees' community engagement activities. Examples of trainees' outreach experiences include providing cancer health education, assisting with program evaluation of community health programs, providing support at community health events, assisting community-based organizations in developing and maintaining websites, and managing social media campaign for community-based organizations.

Structured and Continuous Mentoring

Another unique feature of the ReTOOL program is the mentoring plan, which was developed by program directors. The plan includes specific guidelines for (1) mentor qualifications, roles and expectations; (2) mentee responsibilities; (3) mentor-mentee meeting report; and (4) career development plan evaluation. Each mentor works with the respective mentee to delineate the mentoring activities at the beginning of the summer experience. Prior to 2017, mentees were matched with one UF mentor who is committed to mentoring them for a minimum of one year. Based on the feedback provided by ReTOOL trainees the program was modified in 2017 to ensure that trainees receive continuous mentoring.. Each trainee will now have three mentors, the UF mentor as the primary mentor, one of the three ReTOOL program directors as a secondary mentor, and the home institution mentor as a secondary mentor. The assignment of a mentoring team to each trainee is expected to enhance the mentee's research activities during and after the summer research experience. UF and home institution mentors are expected to provide continuous mentoring for a minimum of one year. In turn, the program directors are committed to providing continuous mentorship through regularly scheduled quarterly conference calls with mentees, email correspondents and face-to-face meeting at national conferences when possible. A key strength of the ReTOOL program is the commitment of the mentors to URM students. The mentoring team available to each trainee ensures continued interaction prior to and beyond the timeframe of the summer program.

Continuous Professional Growth

In order to successfully create opportunities and foster careers focused on eliminating cancer disparities for URM students, the ReTOOL program provides continuous professional growth support for all trainees. Based on the UF Clinical and Translational Science Institute (CTSI) Translational Workforce Development (TWD) career development model and our past experiences with the ReTOOL program, we developed a structured 4-step process for professional growth in 2017. The four steps will be implemented in 2018 and includes self-assessment, career awareness, introductory experiences, and career mentoring. The self-

assessment step will include trainees completing an Individual Development Plan (IDP) on myIDP. This will allow trainees to: (1) Evaluate their skills, values, and interests; (2) Conduct a self-assessment to identify a primary and alternative career options; (3) Set specific goals to prepare them for the selected career paths; and (4) Discuss their goals and strategies with their primary mentors and subsequently put the plan into place. For the career awareness step, trainees will be provided online access to participate in the UF CTSI Career Development Seminars and Professional Skills workshops. The next step is the introductory experiences step, whereby trainees will be exposed to other career options by spending time with other scientists and clinicians. The ReTOOL program has introduced a “*Spend a Day with a Scientist*” program, which that will allow trainees to select up to 2 scientists to shadow. Finally, each trainee will be assigned to one of the ReTOOL program directors who will serve as his/her career coach for the career mentoring step.

Networking

“*Your network is your net worth*” is emphasized throughout the ReTOOL program. The trainees and the ReTOOL program share the responsibility for networking. The ReTOOL program is responsible for creating diverse networking opportunities for trainees while trainees are responsible for taking the initiative to approach and talk to clinicians and scientists. Trainees are advised to develop and print business cards to facilitate networking. During the summer training program, the ReTOOL program provides trainees opportunities to attend grand rounds, seminars, lab meetings, symposiums and conferences organized at UF. In addition, trainees are provided funding support to attend regional, national and/or international conferences. Presenting at these conferences, especially poster presentations, provide unique opportunities for networking. Whenever possible, ReTOOL program directors and mentors observe trainees when they are networking and provide feedback on their mentoring skills. In addition, trainees are encouraged to observe program directors and mentors to sharpen their networking skills. The opportunities provided within the ReTOOL program assist URM students to enhance their networking skills.

Interaction with Scientists

Interaction with scientists addresses two of the four barriers that have been documented to impact increasing the pool of URM trainees in biomedical research careers, the lack of committed role models and lack of familiarity with scientific culture and idioms [8]. ReTOOL trainees are placed in a scientific environment that fosters their interaction with researchers across a broad spectrum, from graduate students to established scientists. Trainees’ interactions with scientists model appropriate professional behavior and provides a clear observation of what is required to be successful. These interactions also serve as catalysts in building trainees’ confidence, establishing productive relationships with scientists, developing professional demeanor, engaging in networking, and creating bonds with scientists.

Collaboration and Peer Linkages

To foster team science spirit, ReTOOL trainees are encouraged to collaborate with each other and develop peer linkages. Over the years, we have observed a culture of peer support and socialization among trainees. In addition to supporting each other by sharing helpful

information for their academics and career development, trainees participate in self-organized social events. These activities provide an inclusive environment for trainees, reducing feelings of isolation through formal and informal social networks [12].

Conclusion

Since the implementation of the Basic ReTOOL program in 2012, the program has evolved to a comprehensive training program that focuses on cancer research, while it fosters and implements synergistic summer research projects targeting cancer disparities. Annual tracking and evaluation has contributed significantly to continuous improvement. For example, one of the challenges that we had to address very early on was the representation of Black male students who are significantly underrepresented in biomedical research. We developed a special recruitment strategy for Black male students through the Student Ambassador program. By targeting young Black male students, the ReTOOL program continues to fill the special need of increasing minority males in oncology research workforce.

In addition to offering trainees outstanding research training experiences, ReTOOL trainees contribute significantly to the literature on cancer disparities. Of significant importance is the new focus of ReTOOL projects on the within-group differences among Blacks relative to the genetic, behavioral and/or environmental risk factors that are more prevalent in Blacks of African ancestry. Ultimately, the research projects of ReTOOL trainees will bring us closer towards achieving a long-term goal of developing ethnically sensitive, targeted approaches that will eliminate the cancer disparities experienced by Blacks.

The program impact of the ReTOOL program is an increase in the pool of underrepresented minority candidates with scientific and academic career progression paths focused on reducing cancer health disparities. The success of the ReTOOL summer training program however revealed a critical need for programs focused on minority post-baccalaureate students, pre-doctoral students, post-doctoral fellows and early stage investigators. To address this, the ReTOOL program is in an expansion phase in order to create a pathway for workforce diversity from college freshman year up till early stage investigator. Another next step is the expansion of the ReTOOL program to include other underrepresented minorities in Florida, especially Hispanic students. This requires strong partnership with Hispanic-Serving Institutions and is one of the future goals of the ReTOOL program. Finally, the ReTOOL team is exploring institutional partnerships to strengthen and institutionalize the ReTOOL program. A unique opportunity is partnership with the clinical translational science institute (CTSI) workforce program. For example, the CTSI Translational Workforce Development (TWD) Program at UF serves as a hub for translational science education at UF. It provides educational opportunities that facilitate the training of clinical and basic science investigators, clinical trialists, laboratory technicians, study coordinators and other related personnel required to establish and support multi- and interdisciplinary clinical and translational researchers and research teams. The UF CTSI-TWD program currently does not have any research opportunities for undergraduate students, post-baccalaureate students, and post-doctoral fellows; offering a great opportunity for expansion partnership. The

ReTOOL program continues to look for expansion opportunities both vertically and horizontally.

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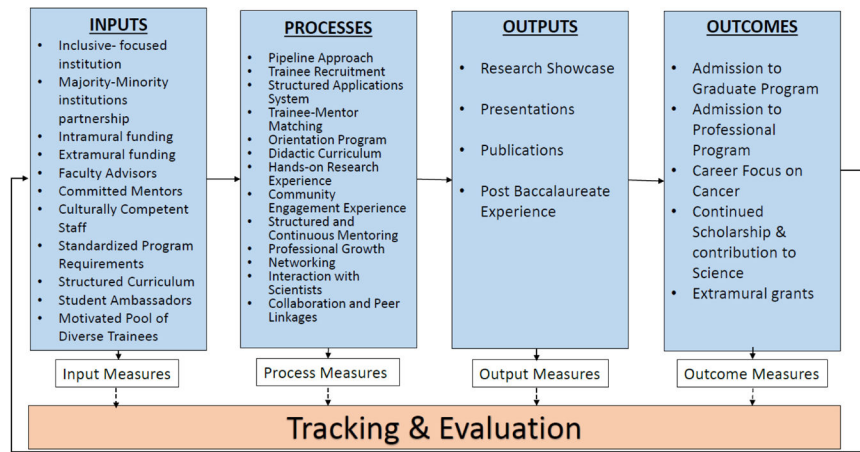


Figure 1.
ReTOOL Model Framework

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