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Research Article

Early Initiative of Structured Mentoring and Research for Social Disadvantage Trainees to Increase Diversity and Inclusion among Clinician Scientists

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Abstract

Background: There is a significant lag in integrating ethnically diverse healthcare trainees as clinician scientists. Although this gap is acknowledged, it is mostly focused physician scientists with a marked lag in dental scientists and the other healthcare fields such as the physician assistant program. We report on the outcome of three cohorts of underserved and economically disadvantaged trainees from a National Institute of Health Heart and Lung Blood Institute R25 summer training program with participants from four Rutgers Health Science schools. **Objective:** The goal was to support inclusivity within clinician scientist workforce through career development and education. **Methods:** We tested the hypothesis that early formal training with structured mentoring, research, career development, and didactic lectures will inspire trainees towards careers as clinician scientists. Trainees learned from the integration of research within the four health profession schools. We used a survey to assess how mentorship, research and career/educational development influence trainees' attitude for careers as clinician scientists. Career development included science communication, mentoring, data reproducibility, authorship, ethics in research, and models of healthcare institutional leadership. **Results:** >80% of the trainees continued their engagement in research with peer-reviewed publications, with confidence to engage in scientific discussion. Trainees developed a sense of belonging and a psychological safety net as they integrate with other groups of academic fields with confidence. Among 29 contacts, 87% responded. Less than 10% of incoming trainees indicated research in their career plans, which changed to >90% after one summer. **Conclusions:** Overall, this training program could serve as a `blueprint' for other programs to enhance careers in research, and to narrow the diversity gap among clinician scientists. Diversity among clinician scientists will enhance healthcare and disparities, and scientific innovation. Success would narrow the diversity gap among clinician scientists.

Keywords: Mentoring; Clinician scientist; Dental school; Economic disadvantage; Diversity; Training

Introduction

There is a significant lag in integrating ethnically diverse healthcare trained individuals as clinician scientists in academia, and at pharmaceutical and biotechnology companies involved in healthcare such as drug development. Academicians and other leaders have acknowledged a gap of clinician scientists in medicine, albeit more focused on physicians, generally referred as physician scientists [1]. Indeed, there is a consorted effort to increase the number of physician scientists in the workforce by the National Institutes of Health (NIH), other funding agencies such as past efforts by Howard Hughes Medical Institute, and most academic centers with medical schools [1,2]. However, there are also gaps among scientists in the workforce in health-related fields other than medicine. These include dentists, nurses, medical technologists and other health professions such as physical therapist and physician assistants. To this end, we included clinician scientists to encompass the various healthcare specialties in training and the workforce.

This study included trainees in four schools within Rutgers Health Science schools. The program is structured to encourage trainees to follow careers as clinician scientists. The trainees were medical and dental students, and from other health related programs such as those within the physician assistant track. The students participated in an R25 program, funded by the NIH – Heart Lung and Blood Institute (NHLBI). The innovation of this program is to ensure a strong workforce of diverse clinician scientist within the private and public sectors. We have taken advantage of Rutgers Health with eight interacting schools. The trainees are from the two medical schools, the sole dental program in New Jersey, and the school of health professions. The latter school trains students as physician scientist, medical technology, bioinformatics, and other related programs.

There are several advantages for our training program, which incorporates multiple health science schools. First, the combined schools will train students early to appreciate the power of collaborative interactions among different or related health disciplines. Trainees would appreciate the benefits of interdisciplinary collaboration in healthcare, and gain insights into the need for such interactions to effectively translate research outcomes to reduce health disparities, and to develop novel treatments, including repurposing of drugs. Second, as trainees interact with mentors among the participating schools, there is a tremendous benefit to all since faculty and students will learn about the varied research conducted at each health science school. A mutual benefit for the institution and the early trainees is to observe how scientific interactions could lead to research collaborations with new hypothesis that could be a new type of science. Third, trainees will learn to appreciate that the diseases that they will encounter could have more efficacious treatment with valuable information and perspectives provided by healthcare personnel from other disciplines. An example of such collaboration is the inclusion of dentistry as part of our program. Pathologies that are addressed by specialties in medicine occurs in a silo without the knowledge of the same disease in the oral cavity. As an example, cancers in the bone marrow use cellular support including mesenchymal stem cells [3]. Similar stem cells can be found in the gingiva where they support the same cancers that have been reported in bone marrow [4,5]. Thus, this program will encourage young dentists to follow the area of cancer research and to appreciate the value of collaboration with the medical oncologists. Both medical and dental trainees are included in this combined interdisciplinary program. This type of collaboration among different disciplines would address clinical pathophysiological conditions to benefit patient outcomes. More importantly, such interactions will encourage students in the health sciences to reflect on the importance of oral health as they conduct holistic reviews of patient's health.

Despite decades of efforts by academic institutions in the biomedical fields to address diversity in the workforce, there is an obvious significant gap with respect to racial and ethnic minorities [6]. The goals and benefits discussed above, once acknowledged, could lead to an increase in clinician scientists from those in racial/ethnic minority groups. However, unless the training programs agree that the diversity of their program must match the general population, there will be small stride to increase the numbers of clinician scientists of the aforementioned underrepresented populations. Indeed, there are positive efforts to close the gap between the relative representation of racial and ethnic minorities in medicine and research when compared to the general population. These efforts have been acknowledged to be of paramount importance to the development of a culturally competent healthcare workforce. Evidence has shown that improved diversity among the medical healthcare workforce contributes to higher satisfaction for patients from underrepresented groups, better educational experiences for trainees, and equitable research outcomes [7,8]. A diverse workforce in healthcare would lead to all individuals realizing that their racial and ethnic differences enrich the overall atmosphere, which will lead to respectful cultural interaction and self-expression. A major benefit of diversity among clinician scientists is the resulting awareness that clinical trials must be conducted to benefit all patients, regardless of racial and ethnic backgrounds. More importantly, a racially diverse healthcare workforce has been shown to enhance the issue of ethnic disparity in research designs. Indeed, the evidence suggested that scientists

who are Underrepresented Minorities (URMs) tend to incorporate research on disparities with emphasis on studies to compare URMs with their non-minority counterparts [9-12].

We have spent decades observing speakers at plenary sessions at national scientific meetings, including those that are targeted for basic and clinician scientists. Although anecdotal, there were relatively few URM speakers, reflecting the gap in academia and other fields that have clinician scientists in the workforce. However, many of these large scientific societies should be credited since they have initiated programs that provide fellowship to early career trainees with emphasis on diversity. The authors acknowledge that the lack of diversity among clinician scientists could be due to complex reasons. We propose that one method to bridge the disparities among URMs and disadvantage trainees towards careers as clinician scientists is to provide training programs where the trainees become part of a supportive learning community while fostering a psychological safety net for the trainees [13]. In this model, students have a space to learn from each other, and to reflect and discuss the environment of academic medicine and future goals [13]. This contributes to their psychological and emotional support and well-being, referred to as Psych-Emotional Support. This process involves listening and contributing to the experiences of self and others, feelings, and expressing belonging in groups, and gathering resources to develop skills to cope with stress management and academic and career difficulties. It also encompasses receptivity to feedback and critical self-reflection [13].

The basic concept discussed above was incorporated in a novel approach through an NIH-NHLBI R25 training program. This program serves as a gateway for socially and economically disadvantaged students towards careers as clinician scientists. This and similar programs at our institution, as well as those at other medical schools, have long-term benefits to narrow the gap of disparity among clinician scientists. Indeed, these programs serve as conduits to diversify the trainee workforce via communication and professional development skills, to complement research for trainees to compete for academic positions [14].

The diversity gap among clinician scientists is perhaps more noticed among basic and clinical research. Regardless, there is a significant gap in ethnic diversity and inclusion in all groups, which is likely caused by a complex set of reasons. In general, underserved and economically disadvantaged trainees face challenges in an environment that they mostly perceive as negative, with the high likelihood of trainees suffering from imposter syndrome. This becomes particularly evident because the disadvantaged students might not show the same level of perceived sophistication as compared to peers who come from higher socioeconomic status. The latter is represented by household income, parent's educational attainment and occupation, and their zip codes where they were raised [15,16].

More importantly, underserved and economically disadvantaged students would often hesitate to seek mentors to pursue research. Other studies have identified mentoring to be key for diverse students to reach programs of higher learning such as doctoral studies in science and engineering [17]. To this end, we have and continue to address this issue in a pilot program through an R25 mechanism. Specifically, to assess how the developmental and research aspects of the program and mentoring influence trainee attitude towards careers as clinician scientists. The program includes 10 weeks of research with one afternoon each week, dedicated to career and educational development. The program is structured to encompass receptivity to feedback and critical self-reflection. In this regard, we present a structured mentorship analyses on trainees' attitude towards careers as clinician scientists, and leadership. The outcome of this program is discussed in relation to long-term benefits to retain underserved and socially disadvantaged health science students in an academic track and preparedness for careers as clinician scientists [14]. We show the need for a robust research and developmental program to achieve the goal of narrowing the gap of inclusion and diversity among clinician scientists in the workforce.

Material and Methods

Ethical Statement

Rutgers Institutional Review Board approved the survey used in this report (Supplemental Information). The outcome of the survey was anonymous with no link to participants.

Study participants and program description

The survey was submitted to participants from three summer cohorts (2021-2023) of the Multidisciplinary Summer Research Education Program for Health Professional Trainees (R25) (Table 1). This program includes four participating Rutgers Health Science Schools - New Jersey Medical School (NJMS), Rutgers School of Dental Medicine (SDM), Robert Wood Johnson Medical School (RWJMS) and School of Health Professions (SHP). Most of the trainees completed at least one year of their respective program. Admitted trainees who have committed to one of the four participating schools were also qualified for the program. To this end, the R25 program was able to recruit rising/entering first year students from one medical school. The schedule for the dental school provided sufficient time for trainees to participate as rising third year. Rising third year dental trainees were accepted after discussion with they school to ensure that the research program does not affect their clinical training. Participants were enrolled based on self-description as an underrepresented minority (URM)

and/or if they were deemed to be socioeconomically disadvantaged. The total number of trainees equaled 30 with one student repeating the program twice. This student received the survey once, totaling 29 requests.

Rutgers Health Schools	Total
NJMS	16
RWJMS	4
RSDM	7
SHP	3
Race (Self-Described)	
African American/Black	11
Hispanic/Latino/Latina	15
White	1
Other	3
Gender (Self-Described)	
Male	16
Female	14
Financially Disadvantaged (Self-Described)	
Yes	26
No	4
Academic Class	
Rising First Year	3
Rising Second Year	24
Rising Third Year	3

Shown are the demographics of trainees - one dental student who was a rising second year repeated the program as a rising third year. The last row represents trainees from the dental program with time for summer research. One trainee repeated the program twice, hence the number of surveys=29.

Table 1: Demographics of participants.

Shown are the demographics of trainees - one dental student who was a rising second year repeated the program as a rising third year. The last row represents trainees from the dental program with time for summer research. One trainee repeated the program twice, hence the number of surveys=29.

The R25 Program aligns with NHLBI initiative to support research in the fields of cardiology, pulmonology, host defense, and hematology. The program also fits with Rutgers and NHLBI goals to foster diversity among future clinician scientists, through structured training of inclusive students. Enhancing diversity in the extramural scientific workforce is critical to the success of Rutgers mission and is consistent with the mandates of the 21st Century Cures Act [18].

Trainees are involved in 10 weeks of a structured curricula of 80% research and 20% time, devoted to education and professional development. The educational and development aspects of the curricula is described in detail in the results section.

Study survey

We structured the survey to determine if the program increased students' knowledge on the following: i) appreciation of biomedical research through a closely-mentored, basic or clinical research experience; ii) whether enhanced career development and educational activities added to students change in career pursuit towards research in mission-related areas of NHLBI; iii) if teaching students the value of inter-professional education, and in their clinical practice could lead to careers as clinician scientists in academia or elsewhere in other health-related fields. The program includes long-term mentoring of trainees to facilitate post-program career planning. Specifically, to continue mentoring the trainees after the 10-wk program, and to maintain contact until graduation, and beyond during post-graduate training as residents and fellows.

The survey comprised 52 questions (Supplemental Information) pertaining to demographics and the following domains: Psych-Emotional Support, Communication, Professional Development, Role Modeling, Prior Research Experience, and Mentorship. In these domains, 45 questions were rated on a five-point Likert scale from 1-5 as follows: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree. The items on the survey were adapted from previously published literature regarding assessing mentorship, including adaption of the Mentoring Functions Questionnaire (MFQ-9) [13,19,20]. The survey was designed to achieve a 95% confidence level for the proposed measurements.

Results

Structured developmental component

The long-term goal of the R25 training program is to narrow the diversity and inclusion gap among clinician scientists. To achieve this goal, we prepared trainees with a robust educational plan that incorporates research, did active lectures, workshops on science communication, and information on careers as clinician scientists (Figure 1). Trainees were exposed to various career paths through invited speakers who were clinical, basic and translational scientists, and healthcare leadership role models (Table 2). These broad fields were selected since they are important for the development of clinician scientists. The mentees were in their preclinical phase of training with limited clinical exposure, which limited them to make informed decision to follow a particular clinical specialty. We therefore invited speakers from broad areas of healthcare such as hematology/oncology, transplant, dentistry, pathology, and stem cells (Table 2).

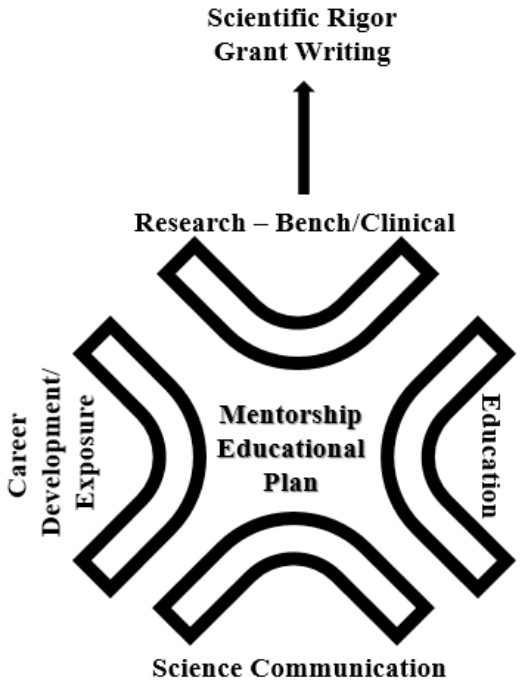

Figure 1: Shown is an overview of the R25 program with key components.

TOPICS	SPEAKERS					
	URM	Self-Described				
		M	F	LGBQT	Clinician Scientist	Disability
SCIENCE						
Pulmonary		+			+	
Oncology/Hematology		+			+	
Maternal Fetal Medicine	+	+		+	+	
Immune Therapy	+	+			+	
Organ Transplant	+	+			+	
Tropical Disease		+				+
Oral Immunology-HIV	+		+		+	
Dental Stem Cell			+		+	
RELEVANT TECHNIQUES						
CRISPR	+	+				
Flow Cytometry	+	+				
CLINICAL TRIAL/RESEARCH	+	+	+			

Table 2: Scientific Seminars, Demographics of Speakers.

Shown are the demographics of the speakers and the corresponding scientific topics. The speakers are also identified if they are clinician scientists.

Increased trainee knowledge in emerging relevant clinical-related subjects

Upon entering the program, trainees from all participating schools were aware of the potential clinical application of adult stem cells. However, when surveyed, the trainees were unaware of dental stem cells, including participants in the dental program. We addressed this gap in knowledge by including clinician scientist speakers with expertise in dental stem cells. This is one example showing how the program continues to address training from the four participating schools, and to include information on emerging technologies (Table 2).

We further enhanced trainee education on emerging technologies with lectures that address the translation of basic science research to clinical applications. We selected these lectures to incorporate the various clinical/scientific fields of the four health science schools. As an example, the potential for gene editing to correct mutant genes in humans was included in the lecture series describing special technologies such as CRISPR (Table 2). We also include flow cytometry since this method showed how the same techniques, used in basic research, could be applied as readouts in clinical trials, and clinical diagnosis in areas such as hematological malignancies (Table 2). To support trainees' interest in clinical research, we included speakers who are involved with clinical trials/research (Table 2). Trainees were given lectures on biostatistics and a workshop on science communication since these topics benefit all research, regardless of the field. Furthermore, the experimental evidence suggested that scientific communication could be important for retention of science faculty [21].

Exposure to non-academic clinical science careers

We considered it relevant for trainees to be aware that clinician scientists could have non-academic careers. We therefore organized visits to two large pharmaceutical companies in the surrounding region. Trainees met with leadership of those pharmaceutical companies who oversees global clinical trials. They also visited their research laboratories. During the visits, trainees interacted with their hosts who were predominantly clinician scientists. At debriefing with the coordinators and directors, followed by a formal survey, we learnt that visits to pharmaceutical companies benefited the trainees' knowledge. They gained clear insights into how clinician scientists at pharmaceutical companies participated in drug development and the paths for approval. The trainees expressed their pleasure to learn about team work in drug development. The trainees showed enthusiasm for potential careers beyond academia, including career paths that would provide opportunities for drug development. The leadership at the pharmaceutical companies were equally impressed with the trainees, proposing short-term internship opportunities. For example, the dental trainees were provided with the option to intern in the areas of biomaterial and development of medical devices.

Advancement to achieve diversity, equity, and inclusion (DEI)

Since the long-term goal of the program was to ensure that future clinician scientists are represented with respect to DEI, we invited clinician and basic scientist speakers who were from a diverse ethnic backgrounds, similar to the trainees (Tables 1 and 3). This initial approach to this complex issue was our attempt for trainees to learn that their careers could mimic those of the speakers. This approach was complemented by an educational curriculum that included robust mentoring by the speakers, which provided the trainees with confidence to interact with mentors of similar ethnic backgrounds (Tables 1-3). The enthusiasm of trainees to interact with diverse speakers was articulated by their statement indicating that the speakers provided them with a sense of belonging in an academic environment. They felt relieved that such interactions eliminated residual feelings of imposter syndrome.

TOPICS	INSTRUCTORS					
	URM	Self-Described				
		M	F	LGBQT	Clinician Scientist	Disability
IACUC	2	2	1			
IRB	2		3			
MENTORSHIP/ CAREER PLANNING	6	3	3		6	
COPYRIGHT/ AUTHORSHIP			3			
BIOSTATISTICS		3				
RESPONSIBLE CONDUCT OF RESEARCH		3			1	
GRANT WRITING			3			1
ALTERNATE CAREERS IN MEDICINE			1		1	
PROFESSIONALISM			3			1
MOLECULAR TECHNIQUES			3			3
SCIENCE COMMUNICATION		3	3			3
EQUITY IN MEDICINE	1	1				

Table 3: Demographics of instructions in the educational development component.

Shown are the varied educational components of the R25/MORESHP program. The numbers represent the total number of speakers within the specific topic. IACUC: Institutional Animal Care and Use Committee; IRB: Institutional Review Board.

The speakers combined their instructions in the form of seminars that focused on research and stories on their journey. Particularly, the clinician scientist speakers combined bench research with patient information to demonstrate the "power" of translational research. This approach allowed the students to appreciate the need for clinician scientists to be involved in research to advance patient care. The speakers discussed their path towards careers as clinician scientists while telling students about their struggles with information used to overcome adversity. This format allowed trainees to observe how established clinician scientists, including those who look like them, could achieve endless heights in their careers, despite in some cases, starting while disadvantaged economically. The speakers provide ample time for trainees to ask questions, which led to the students establishing additional mentoring with the speakers from other institutions.

Exposure to science administration

To highlight the program's goal to increase awareness and representation of diversity within all areas of the health care workforce, we did not limit the speakers to active clinician scientists. Rather, we included speakers who transitioned their careers to academic leadership. These included the President of Rutgers University, the Chancellor of Rutgers Health Science Schools, and the Dean of one of the two medical schools. Among these administrators, Rutgers President and the Dean self-identified as African American/Black. Additionally, one of the program directors who provided content to the developmental program is the Chair of Pathology Department of the two medical schools. She self-identified as Black. In summary, this section highlights our deliberate effort to predominantly invite speakers who mostly self-describe as URM, LGBQT, disabled, and females (Table 3).

Networking initiatives

In addition to teaching scientific research methods and communication, a major component of the program was to incorporate mentorship in academia, and networking with peers. The networking included those in academia and related healthcare companies such biotechnology and pharmaceuticals. Our framework was to ensure that focused mentorship and leadership training could form the basis where trainees create relationships with other program participants in health sciences, in particular those with diverse trainees including URMs. The inclusion of four health science schools, in conjunction with other summer programs for URM and with students who self-described as economically disadvantaged, highlights our effort to enhance interdisciplinary collaboration. Such links facilitated bonds and connectivity amongst future clinician-scientists in different health specialties, while providing mentorship and role model opportunities for the younger scientists. This type of connectivity also promotes critical thinking, often employed in clinical and academic settings.

The model used in the R25 program took advantage of the diverse Northeast Regional Alliance (NERA) program hosted at one of the two medical schools (NJMS). NERA MedPrep Scholars Program is a 6-week academic enrichment program targeting economically disadvantaged college/community college students in New Jersey interested in careers in medicine. Thus, these college students are engaged for 3 years during summer to prepare them for careers in health science programs. We recruited trainees who were alumni of the NERA program since they showed enthusiasm for research, as a result of the training as NERA scholars. Among the 29 cohorts in this program, 12 (41.4%) were former participants of the NERA program. This led to a continuum support in which trainees begun within an academic environment that fosters a psychological safety net that supports belongings. This program enhanced the established network of the NERA students with trainees of similar background in the R25 program, which established long-term collaboration with academic networks as well as social networks – Discord with future plans to establish a network in LinkedIn.

Advantage of Program Director/Coordinator-Student Interactions

In addition to one formal workshop in science communication, the program supplemented further and other methods to enhance the development of skills in scientific communication. This was achieved by individual meetings, as well as group communications where the trainees met with the two graduate student coordinators, the program directors, and members of the executive committee. The two coordinators are a senior doctoral student in biomedical research and a junior graduate student. The coordinators were selected because of their experience in translational research, and backgrounds in research. More importantly, the graduate student coordinators have conducted research side by side on the bench with clinician scientists, including one of the program directors. The senior graduate student coordinator have established research collaborations with faculty members who are clinician scientists, basic scientists, medical students, MD/PhD students, clinical fellows and residents. The backgrounds and matched age between the graduate student coordinators and trainees enhance trust for trainees to feel comfortable for honest interactions.

Each week, the program coordinators and students met informally at a designated lunchbreak. This relaxed atmosphere provided ease for the trainees to discuss their research. During this time, the trainees felt comfortable articulating problems with mentors or peers in the laboratory, as well as discussing technical and emotional challenges of research. The coordinators encouraged the trainees to call and visit any time, even on weekends, which mitigated issues that may arise in the research laboratories. The leadership team also met with individual participants, or as groups to discuss challenges, progress, and success in their research laboratories.

The directors also coordinated a holiday dinner with trainees from each cohort with the benefit of establishing network opportunities. This relaxed atmosphere allowed for the directors, executive committee, coordinators, and trainees to share experiences and successes within the program. The success of the networking event has led to an annual event for the program.

Introduction to grant writing

Each student was asked to develop a NIH format specific aim page, based on their research. The total number of aims depended on the depth of the student's research. The trainees were encouraged to seek help from their mentors and the program directors. Prior to the trainees meeting with the grant writing instructor for a workshop, each student met with one of the program directors for feedback. Students also shared their specific aim page with peers for constructive feedback. The consensus among the instructor and faculty members was that the submitted specific aim page parallel what would be expected by similar assignment from post-doctoral fellows.

Oral Presentations

During the weekly educational sessions, trainees were asked to provide updates on their research, formally with slides and informally using the methods taught in the science communication workshop. These forums include peers, program directors and coordinators. The trainees were asked questions from the group while the program leadership gauged trainee's progress. At the end of the program, each trainee provided a formal slide presentation of the research, along with abstracts. The latter is used to compile a digital folder, along with publications. The final presentations provided ample opportunities for cross-disciplined discussions. Specifically, this final exercise allowed for inter-professional discussions where trainees learnt the relevance of cross discipline knowledge to benefit patients. Some participants worked with their mentors to submit their findings to national and regional conferences, exposing them to the utility of research conferences for networking and to establish a network with others in research. The level of involvement of trainees with their research mentors have led to peer-reviewed publications (Table 4). Finally, the program coordinators led a debriefing session with participants, asking how they imagine using their summer experiences and newfound knowledge in the future. The program coordinators, along with the directors, documented feedback to improve the program while staying within the goals of the program.

PUBLICATION TYPE	AUTHORSHIP	
	FIRST	CO-AUTHOR
Original Article	1	2
Book Chapter		4
Review		3

Table 4: Co- authorship trainee publications.

Role of mentorship in students' attitude towards careers as clinician scientists

A survey was conducted to gain insights into the efficacy of the R25 program. Specifically, the goal was to identify if there were changes in the attitude of trainees towards careers as clinician scientists. Thus, the survey asked whether components of the program - research, career development and other educational activities - changed the students' knowledge and interest to pursue careers as clinician scientists. The latter career could incorporate basic, translational and/or clinical research. In this study, we sought to define what or how mentorship is perceived among the program participants. We broadly conceptualized mentorships to include the research advisor, peers in the laboratory, program directors, coordinators and the speakers that the students established a network [22,23].

After voluntary request, we acquired the responses using Qualtrics, which allowed for anonymity of the respondents. Among the 29 participants (Table 1), 26 subjects responded, equivalent to 90% response rate. Most of the evaluative statements received an average score, >4 out of a maximum of 5 on the Likert Scale. The highest mean (M) scores were for the following statements: "I feel like I belong in the field of science" (M=5.0), "I value the importance of mentorship" (M=5.0), and "My mentor has a strong work ethic" (M=4.83). We analyzed the data collected from the survey, which showed overwhelmingly a change in trainees' attitude with respect to plans for following careers in academia, and in some cases, to have research as part of their careers (Figure 2). In fact, 100% of the respondents felt that the 10-week program, combined with continued involvement, provided them with a clear understanding of the role and value of a clinician scientist.

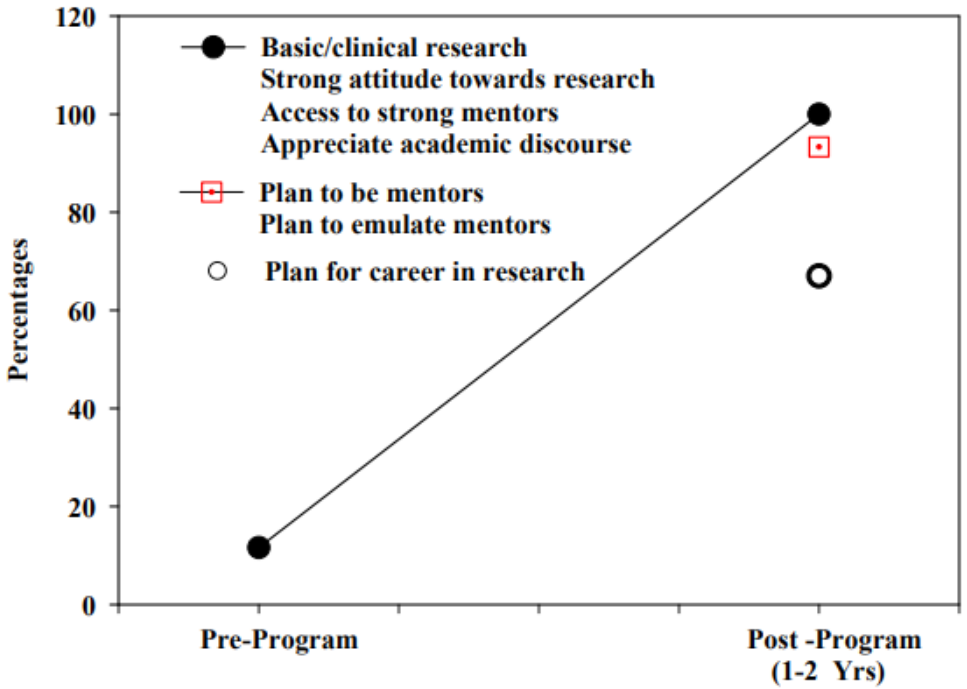

Figure 2: Shown is the outcome of the survey of participating trainees (n=29). The survey was anonymous. The graph shows the percentage differences in trainees before and after participating in the program.

The respondents categorized themselves within various mentorship relationships - formal, arranged by someone else (25%); informal, established by mentor or mentee (31%); within the same organization (25%) and initiated by the trainee (19%). At preprogram, none of the students participated in an external mentorship opportunity. More than half of the respondents participated in an informal or formal mentorship relationship and 25% participated in mentorship opportunities within their student organization at college (pre-professional undergraduate training). The formal relationship within the R25 training program did not inhibit students from having an informal mentorship relationship with the speakers, administrators or coordinators.

The survey using a Logarithmic Regression analysis was conducted across African American/Black and Hispanic respondents with participants measuring their perceptions and reflections after the program using a Likert Scale. In this study, African American/Black students were less likely to have research experience as compared to Hispanic students (p=.038). Hispanic students also reported they are more likely to be afraid of rejection when contemplating outreach to potential mentors (p=.025). The study showed no difference between males and females for any category.

As noted in Figure 2, there was a strong change in the trainees' attitudes towards research, which correlated with trainees' belief that they were exposed to strong mentorship. This evaluative conclusion was supported by high responses in which all students agreed or strongly agreed that their mentor or the principal investigators were accessible and supportive. Regarding the mentor's ability to motivate the trainees, 80% felt strongly about the positive attitude in which their mentor was interested in their success.

The outcome of the survey questions indicated that the mentors were engaged in the students' training. This was evident based on the overwhelming responses in which the trainees stated their desire to emulate their mentors (95%). These changes in attitude correlated with the trainees appreciating their ability to be engaged in academic discourse.

Role of the developmental component in students' attitude for careers as clinician scientists

The survey questions assessed the role of the developmental/educational aspect in changing trainees' strong responses for interests in following careers as clinician scientist. Compared to <10% reporting positive experience in the developmental aspect at preprogram, by the end of the program, 100% of trainees documented learnt aspects of the research and career development curricula (Table 5).

Categories	Pre-Program (%)	Post-Program (1-2 Yrs.)	Remarks
Mentoring			
- **Formal Program**	25	100	
Writing			
- **Manuscript**	5.8	Not assessed	See Table 3 for publications
- **Grant**	1.5	100	Developed specific aim page as per NIH format
IRB, IACUC, Lab Safety	5.8	100	
Responsible Conduct of Research	7.3	100	
Statistics	8.7	100	
Literature Review	8.7	100	Journal club; Scientific literature search, relevant to students' research projects

Table 5: Changes in Perception – Pre- Versus Post-Program.

Rutgers Health higher leadership in mentoring

The trainees who have completed the program received another level of mentoring from the chancellor of Rutger's Health who is a clinician scientist. In addition to a seminar with a wide audience, the chancellor met with the R25 students for dinner in a non-academic setting without the R25 leadership team. The three cohorts of students were invited but clinical rotations at distant hospitals and overnight rotations limited the students to 10. Despite this, each cohort of trainees was represented at the dinner. The meeting allowed the trainees from three summers to coalesce and share their reflections in a safe, friendly environment without the program directors and other school leadership, including their deans. Anecdotal discussion between the trainees and the program directors, or coordinators concluded the meeting strengthened comraderies and induced a stronger sense of belonging with the attitude that the leader of the health science program was interested in their careers. We followed up with a formal a formal survey in which the trainees responded to questions that were intended to reflect changes in their attitude after the dinner with the chancellor (Table 6). Overall, the responses showed positive outcomes after meeting with the chancellor. The relaxed interaction between the students and the chancellor enhanced trainees' confidence. The trainees showed enthusiasm with this opportunity. They felt supported because of the chancellor's mentorship and the leading role he has within the health science schools, supporting the informal input of this meeting.

Questions	Pre- Dinner	Post- Dinner
Dinner with leaders – E.g., Chancellor enhances my professional development	4	5
I feel that dinners like this are important	4	5
I feel positive that a busy chancellor is interested to meet me	3	5
I feel positive about acquiring the skills needed to be such a leader of a school similar to Rutgers Health Science	3	5
I am hesitant that I am important enough to speak with the Chancellor	5	1
I have developed networking skills to benefit from similar dinners	4	5

Table 6: Attitude after Dinner with the Rutgers Health Science Chancellor.

The columns show the average of eight respondents who attended the dinner with the Chancellor of Rutgers Health. The numbers represent the average score provided by each respondent. The trainees were provided with a ranking scale between 1-5, in which 1 = Completely disagree and 5 = Completely agree.

Discussion

This study reports on the outcome of three cohorts of trainees from an R25 training program with the goal to prepare health science trainees for careers as clinician scientists. The long-term goal of this R25 program is to contribute to inclusion and diversity among clinician scientists where there is a current significant gap [24]. Our training program is comprised of students from four Rutgers health science schools, which provides a training inter-professional network in health science. The immediate aim of this program for trainees to follow careers as clinician scientists is underway, with part of the outcome reported here. The data show strong positive outcomes with respect to the trainees' desire to follow careers in research, which differed from the attitude of the same trainees prior to entering the R25 program (Figure 2). The training combined career developmental aspects, which include scientific communication, mentoring, data reproducibility, authorship and ethics in both basic and clinical research. The outcomes and descriptions of the program presented in the results section underscore the benefits accrued within a short training period (Figure 2, Table 5). Although this study appears to describe the outcome during a short period, the program directors and coordinators continue to mentor the students. Joint activities such as one on one meeting with the health science chancellor included current and past cohort of trainees (Table 5). Remarkably, the trainees continued to be involved in research, seeking opportunities to be involved in studies and preparing review articles and book chapters that qualified them as coauthors for publications (Table 4). The change in attitude seemed to be mostly based on strong mentoring and exposure to the different aspects of academia, when compared with the answers at pre-program (Figure 2, Table 5).

The change in attitude of the program could not be attributed to trainees trying to enhance their resume for competitive residency since at the time of enrollment in the R25 program, the students who are in the medical and dental programs were in their preclinical phase of training. At the time of preparing this report, these students have not committed to a particular clinical subspecialty, e.g., surgery, internal medicine etc. While this might be more relevant to the medical students, there is relevance for trainees within the other programs. In the case of participants from the School of Health Professions, one trainee who was in the Physician Assistant program is now in a fellowship studying hematology/oncology and this decision was based on exposure to related research as part of the R25 program.

It was striking that the perception of trainees' attitude toward careers in academia focused on mentoring as a major contributor for their planned career goals. This was a significant improvement as compared to trainees entering the program. Some of these trainees were exposed to research in college while they were in preclinical/dental programs. The trainees stated that prior exposure to mentors and educational experience were superficial (Table 5). An interesting outcome of this study is the continued relationship the trainees developed with the diverse speakers (Table 2). This external student-speaker relationship allowed the trainees to gain nationally recognized mentors who could be additional guides as they traverse their careers.

The value of mentoring was reflected in the survey - most participants felt that they gained confidence with mentorship, which led to enhanced efficiency in their research laboratories. This was mostly due to confidence gained by the trainees to seek clarification or assistance in the laboratories. Indeed, other studies have shown that mentoring is considered a high-impact educational practice that serves as a valuable resource for students to receive practical advice, guidance, and socialization opportunities that are difficult to acquire through informal means [25-30]. The survey validated our anecdotal observation that mentorship is seen as a critical component of a research training experience. The survey acknowledged that students felt well-supported by their mentors, who were also the principal investigators of their research laboratories. The early exposure to robust mentoring is in line with studies showing a vital role for mentoring at the early phase of career, faculty development, and promoting equity, and diversity [31,32]. Our studies add to these findings by reporting the critical role of early mentoring at the onset of training.

Studies have shown that quality faculty-student mentoring relationships require flexibility and adaptability, clear expectations and communication, and honest feedback [29,33-39]. Together, these points created and fostered a successful mentoring culture within the program. In our R25 program, we were able to use these proven points to suit the health science to ensure goals of careers as clinician scientists and to ensure that trainees are on paths of interprofessional practice to benefit patients. Respondents reciprocated the authenticity of their mentors/Principal Investigators and the value of the R25 formal mentorship program - there was a significant correlation between Belonging to Science and Developing Mentor Skills (.907); wanting to mentor others (.931); and wanting to emulating mentor work ethic (.924). These findings support the need to motivate students to pursue science careers and amplify what has been agreed - belonging to science as a top priority. This research adds to the literature by examining the impact of utility value intervention to enhance students' perceptions that biomedical science [40].

Diversity in medicine and science is key to the success of the health profession in developing clinician-scientist. Our study found a strong statistical correlation between contributing to diversity: Feeling that I am Becoming a Scientist (.849) and listening to others' Point of View (.821). Therefore, research exposure, education, and promoting science to underserved and economically disadvantaged students is intertwined with the value of mentorship. These educational components are likely to propel students to strengthen their experience via further mentorship and mentor-mentee relationships. Students felt that they belonged in the field of science and valued the importance of the formal R25 mentorship relationship. Studies have shown that participating in well-designed mentoring programs displays higher grades, increased self-efficacy, greater career motivation, and higher academic and personal goals [25,28,30,39,41].

Mattering is the feeling of being significant, important, and of value to others [42]. Mentorship can support a sense of belonging for underserved and economically disadvantaged students. The value of mentorship is needed across the health science spectrum, including medical schools. A recent study reported on the need for mentorship across all levels of medical education since students are seeking mentorship to understand work/life integration and wellness of medical education [43]. This study also reported on a significant need for mentoring as the medical students reached clinical rotations [43]. Further outcome indicated that as students progressed through medical school, they expressed increased needs for personal mentorship and conversations regarding work/life integration and wellness (first year medical students/M1: 12.2%, M2: 18.8%, M3: 29.3%, M4: 51.7%). This contrasts our study in which the first and second year trainees stated >90% effective mentoring. We achieved this by initiating robust research, career development, educational and mentoring plan for the most vulnerable students who would not otherwise been exposed to this form of academic exposure. More importantly, social integration alone is insufficient to propel diversity among clinician scientists. It is imperative to incorporate research and other related career

development topics early, as described in this study. The question is why medical students answered the need for mentoring during the clinical years with more at year 4 [43]? The late stage correlated when students are preparing for residency application. In this regard, the need for both mentoring and research might be due to trainee's requirement to match in competitive residency. It would have been interesting to see the correlation between academic grades and board pass rates and scores with the increased need for mentoring. Enhancing diverse students for careers as clinician scientists must start early and this study showed a change in attitude.

Increased numbers of clinician scientists from underserved and disadvantaged background could benefit healthcare access and health outcomes, leading to minimization of healthcare disparities. Research studies reported that patients who feel understood and respected by their healthcare providers are more likely to adhere to treatment plans and achieve better health outcomes [44]. Overall, the findings suggest that mentorship is a critical component of the R25 research training experience, and the students felt that they were well-supported by their mentors/PIs. The study highlights the need for increased exposure to various types of research activities that students are less likely to experience. These include regulatory processes needed for research with human subjects and tissues and animals, data analyses, and grant writing. Early exposure, as indicated by the survey, strongly supported this type of research experience to "ignite" the pipeline and interest of students to follow careers as clinician scientists. A major insight from this study is the relevance to URM post-doctoral fellows [45]. Since these fellows already have extensive research experience, the involvement of mentorship by diverse faculty and the involvement of institutional leadership could be applied to this small cohort of scientists.

This study showcases how mentorship is needed across the health science spectrum (Figure 3). The R25 program supports that gap to facilitate, underserved and economically disadvantaged students with formal and informal mentorship to enhance social connections among health science trainees that encourages future academicians as clinician scientist. Notably, 100% of the students felt that they gained insight towards a path to an academic/ research career, and all felt that they understood the role and value of a clinician scientist. The study highlighted the potential for a positive impact on future generations of clinician-scientists, as the students showed a strong interest in becoming mentors themselves (93.3%).

In summary, increased numbers of underserved and economically disadvantaged students in training programs will result in further support of similar mentorship to continue similar students towards careers in academic medicine and research. This will ensure that continued diversity of clinician scientists, which will lead to better healthcare delivery. This will be achieved with improved cultural competence that could be relevant to healthcare disparities, diversifying perspectives and approaches to delivering healthcare as well as increasing the recruitment and retention of minority patients into clinical research and research that is more focus on minority health (Figure 3). Although there is much support for interdisciplinary science, we propose that training programs, as described in this report, will enhance inter- professional and -disciplinary training (Figure 3). This will intersect with different fields of health sciences to benefit all aspects of healthcare. Our training program was developed by acknowledging the challenges to excel in both bench research and patient care [46]. The structure of the described training program could be viewed as a "blueprint" for other training programs to enhance trainees to follow careers in research. Indeed, this study adds to the global challenges reported for medical students to remain in academia [47]. This study incorporate a further challenge of trainees with little to no experience in research, in addition to economic challenges. Reducing the current gap of inclusion among clinician scientist is fundamental for the future of healthcare since students and patients would benefit from ethnically represented clinician scientists.

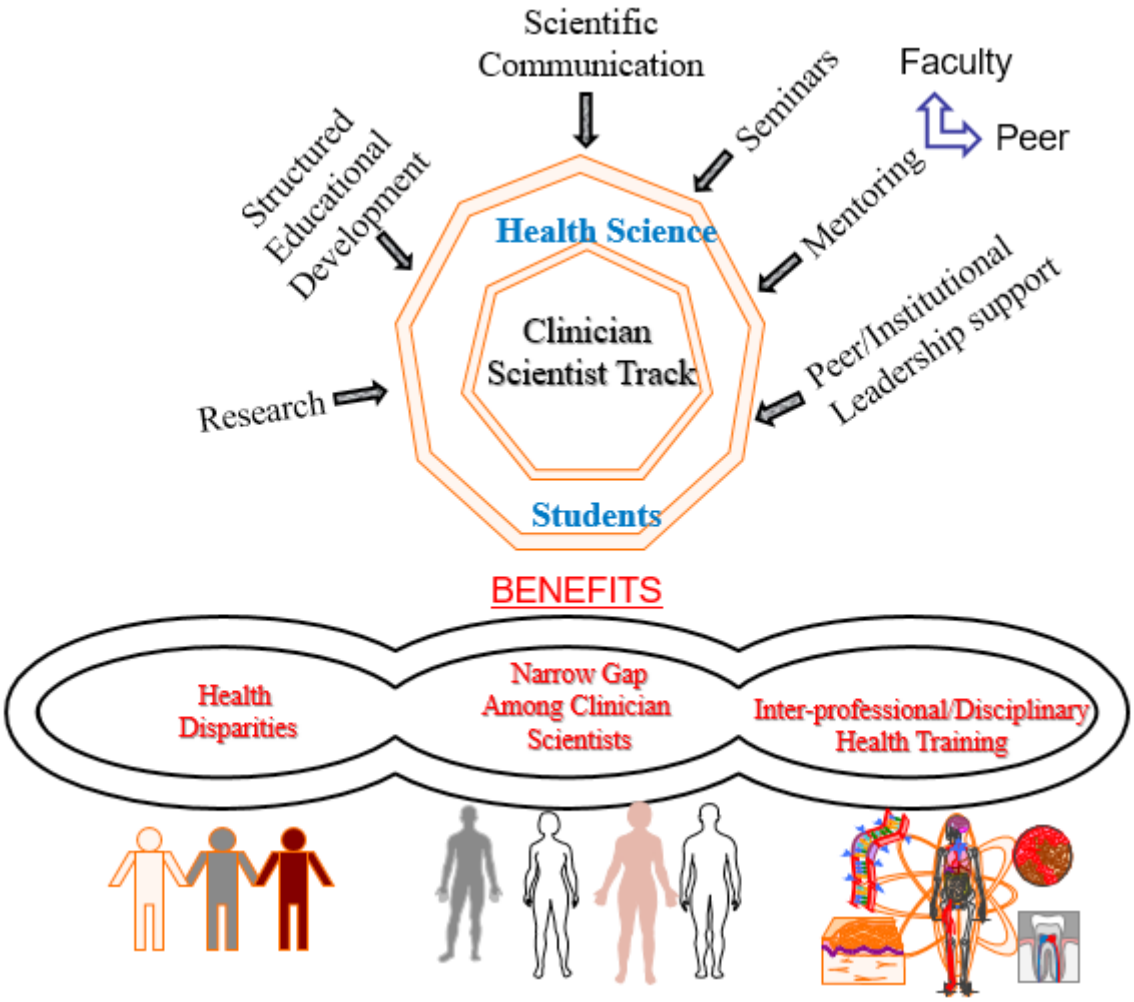

Figure 3: The figure summarizes the training program and describe the benefits that are expected as trainees populate institutions with clinician scientists.

Conflict

The authors declare no conflict of interest.

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Conflict

Authors' Contributions

H, X. B developed the survey, analyzed the data, and edited the manuscript; S. M. M. co-developed the survey, analyzed the data and prepared the first draft of the manuscript; L. S. S. developed the educational program, directed the program and edited the manuscript; A. P. analyzed the data and edited the manuscript; V. F. edited the manuscript; D. F. edited the manuscript;

V. T. contributed to the concepts, analyzed the data and edited the manuscript; M. S. De L. contributed to the concepts, wrote the manuscript and analyzed the data; P. R. conceptualized the study, develop the tables and figures, and wrote and approved the final manuscript.

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