RESEARCH ARTICLE

The NIH “BEST” programs: Institutional programs, the program evaluation, and early data

Rebecca N. Lenzi1 | Stephen J. Korn2 | Madeleine Wallace3 | Nancy L. Desmond4 | Patricia A. Labosky1

1Division of Program Coordination, Planning, and Strategic Initiatives, National Institutes of Health, Bethesda, MD, USA
2Office of Training & Workforce Development, National Institute of Neurological Disorders and Stroke (NINDS), National Institutes of Health, Bethesda, MD, USA
3Windrose Vision, LLC, Fairfax, VA, USA
4Previously at Division of Neuroscience & Basic Behavioral Science, National Institute of Mental Health (NIMH), National Institutes of Health, Bethesda, MD, USA

Correspondence
Patricia A. Labosky, Division of Program Coordination, Planning, and Strategic Initiatives, National Institutes of Health, 6001 Executive Blvd, Suite 8180A, Bethesda, MD 20892-950, USA.
Email: patricia.labosky@nih.gov

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Abstract
Biomedical research training has undergone considerable change over the past several years. At its core, the goal of graduate and postdoctoral training is to provide individuals with the skills and knowledge to become outstanding scientists and expand knowledge through the scientific method. Historically, graduate school training has focused on preparation for academic positions. Increasingly, however, a shift toward preparation for a wider range of career options has emerged. This is largely because most biomedical PhD graduates do not become Principal Investigators in academic laboratories. Here we describe an National Institutes of Health Common Fund program with the major goal of culture change for biomedical research training and training that prepares individuals for a broader expanse of careers in the biomedical research enterprise. These “Broadening Experiences in Scientific Training” (BEST) awards, issued in 2012 and 2013, provided support to institutions to develop innovative approaches to achieving these goals, as a complement to traditional training. Awardees were tasked with catalyzing change at their institutions and sharing best practices across the training community. Awardees were required to participate in a cross-site evaluation that assessed the impact of BEST activities on three main areas: (a) trainee confidence and knowledge to make career decisions, (b) influence of this added activity on time in training, and (c) ability of the institutions to sustain activities deemed to be beneficial. Here we present the fundamental approach to the BEST program and early evaluative data.

KEYWORDS
biomedical research careers, career development, education, graduate students, postdoctoral scientists, professional development, training

Abbreviations: ACD, Advisory Committee to the NIH Director; BEST, Broadening Experiences in Scientific Training; GREAT, Graduate Research Education and Training; IDP, Individual Development Plan; NEH, National Endowment for the Humanities; NIH, National Institutes of Health; NGLS, Next Generation Life Science; NRT, NSF Research Traineeship; NSF, National Science Foundation; OMB, Office of Management and Budget; TTD, time to degree.

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INTRODUCTION

The National Institutes of Health (NIH) is committed to supporting a sustainable and robust biomedical research workforce. The primary goal of NIH’s longstanding research training programs is to meet the nation’s need for biomedical researchers. And indeed, graduate programs that confer PhD in the biomedical sciences are primarily dedicated to training individuals for research careers. However, NIH recognizes that PhD graduates also contribute to the biomedical research enterprise in many important occupations beyond traditional, research-intensive, academic positions. There are no shortages of reports, analyses, and commentaries, including the Advisory Committee to the NIH Director (ACD) report from 2012,1-5 which highlight the many current challenges in training individuals for the biomedical research workforce. Importantly, although PhD recipients transition to a wide variety of career paths, trainees often lack knowledge of career options outside of academia.6 Moreover, the current training environment often does little to prepare trainees for diverse career pathways. Faculty are rarely equipped to help their trainees understand their career options, and often there is a lack of acceptance, or perceived lack of acceptance, in academia of non-academic research career paths. In turn, this lack of acceptance often inhibits honest discussions between trainees and mentors. Consequently, even though many biomedical PhD recipients pursue careers outside the academic research path, some cultural bias against and lack of knowledge about non-academic pursuits presents an unnecessary obstacle to graduates from pursuing meaningful, non-academic careers.

In response to recommendations made in the 2012 ACD report, the NIH Common Fund launched the “Strengthening Biomedical Research Workforce” program, which awarded the NIH Director’s Biomedical Research Workforce Innovation Award: Broadening Experiences in Scientific Training (BEST) awards in response to two grant competitions. Ten awards were made in 2013 and another seven awards were made in 2014.7,8 These non-renewable BEST awards were designed to facilitate the development of innovative approaches to broadening trainee understanding of, and faculty acceptance of, the many career pathways available following PhD training. Awardee institutions were encouraged to develop external partnerships with a variety of entities both outside and inside their institutions to provide both information and experiential training opportunities for graduate students and postdoctoral fellows. Overall, the major goal of the awards was to expose graduate students and postdoctoral scientists (henceforth called “trainees”) to the variety of career paths available to them by virtue of their scientific training. These programs were also intended to actively promote faculty acceptance of non-academic career paths. It was postulated that accomplishing these two goals would help trainees identify and actively pursue career paths best suited to their skills and passions, as well as legitimize non-academic pursuits to both trainees and faculty. The BEST awards were to accomplish these goals without lengthening the time to degree (TTD) for graduate students or time in training for postdoctoral scientists. Moreover, the BEST awards were designed to catalyze change, not as long-term funding sources.

The NIH outlined three program goals to be assessed with a cross-site evaluation. These were (a) changes in trainee understanding of the many career options available to them and confidence to explore non-academic career options, and a concomitant change in faculty attitudes toward non-academic career options, (b) influence of BEST programs on training time, and (c) development of infrastructure and sustainability to continue BEST activities in the absence of dedicated NIH support for these programs.

This manuscript provides a broad overview of the BEST awards, the programs developed, and the cross-site evaluation effort. We present some initial descriptive data on trainees’ confidence, development of infrastructure and sustainability, and association of BEST activities with TTD. The influence of BEST programs on faculty attitudes has been addressed by the awardees.9 Although it is premature to draw meaningful conclusions about the long-term outcomes of the BEST programs, the baseline information presented here provides insights into program activities and the attitudes and expectations of trainees and faculty.

METHODS

2.1 Methods of managing the program and the evaluation

The BEST program started in 2013, making 10 initial awards and holding a program “kick-off” meeting as generally required of NIH Common Fund programs. The award mechanism (DP7) is a research award and BEST programs were research project awards, not training awards. As such, trainee salary could not be applied to the budget of the DP7s. At the kick-off meeting, the awardees were reminded of the experimental nature of the program, and the consortium structure was established. Schedules for face-to-face annual meetings and a monthly teleconference were put in place. A second (and final) round of seven awards was made in 2014 and that group of awardees was brought into the consortium at the second annual meeting.10 A series of Working Groups was initiated with membership established: Annual Meeting Committee, Outreach and Dissemination, etc. One site, Vanderbilt University Medical Center, was awarded a competitive supplement to serve as a coordination hub, set up the
consortium website (NIHBEST.org) and run all the consortium meetings.

A cross-site evaluation plan was established to build an evidence base of what worked best in meeting the three program goals stated above. Three formal methods were used to collect program data from the awardees: (a) a Data Form completed by the BEST awardee institutions, (b) multiple surveys of graduate students and postdoctoral researchers at the BEST institutions, and (c) yearly teleconferences with BEST site coordinators to gather contextual information. Windrose Vision, a company specializing in program evaluation, was contracted to carry out the data collection. NIH staff, Windrose, and personnel at the awardee sites collaborated on the development of all data collection instruments (final versions in Supporting Information File 1). Data are divided into year of Common Fund program support, Year 1 (2013-2014), Year 2 (2014-2015), Year 3 (2015-2016), and Year 4 (2016-2017). Note that Year 1 included only the first 10 awardee sites and are not included in the data presented here; only Years 2-4 are reported to include data from all 17 sites.

2.2 Designation of comparison vs treatment groups

Each BEST program determined from which institutional departments and/or programs they recruited BEST participants. Because one purpose of the BEST program was to change institutional culture, trainees who did not actively participate in BEST activities were expected to be passively influenced by the program. Consequently, it was unrealistic to devise a true control for this experiment. Trainees who officially participated in at least one BEST activity were assigned to the “treatment” group; others at the institution who were eligible to participate but did not make up the “comparison” group. Because BEST activities are not yet concluded, the final treatment or comparison status for every trainee is not finalized.

2.3 Data form

The completed Data Form, submitted annually by each site (Supporting Information File 1), was designed to catalog details of BEST activities and institutional characteristics. Data definitions, particularly for types of activities, were agreed upon by the sites to facilitate global comparisons (Supporting Information File 2).

The Data Form had three sections: Section 1 described the program and logged individual participation in BEST activities—courses, externships, internships, peer mentoring, professional mentoring, networking events, clubs, visits to prospective employer sites, and single- and multiple-day seminars, workshops, certificate programs, and symposia. Trainees were assigned a unique evaluation ID (and thus de-identified) for this tracking. Activities were classified as existing, new, or enhanced with respect to each BEST award. These data were collected annually. Section 2 listed the number of graduate students and postdoctoral scientists by graduate program or department, the number of PhD recipients, faculty participation, number of external partners, and amount of non-NIH funding sources for BEST activities. These data were collected annually. Section 3, collected only once, served as baseline data for each award and included average elapsed time-to-degree, initial career paths of PhD recipients (research-intensive, research related, or other), and length of time in postdoctoral training for the 5 years preceding the NIH BEST award.

2.4 Surveys

Surveys (Supporting Information File 2) were developed to capture changes in trainees’ confidence and time in training, two of the evaluation outcomes noted above. We chose to use surveys to try to capture data about the trainees themselves and their knowledge and attitudes about career choices, fully aware that due to biases and recall issues, survey responses may not always accurately reflect reality. Trainees self-rated their confidence to (a) pursue their desired career path, (b) determine steps to pursue their desired career path, (c) seek support from professionals, (d) identify potential employers, and (e) achieve their career goals. Surveys were administered twice during training, upon entrance into eligibility to participate in BEST programming (entrance surveys) and at graduation or completion of postdoctoral training (exit surveys). Survey administration started in Year 2 of the Common Fund program, the second year of Cohort 1 program activities and the first year of Cohort 2 activities. In addition, post-exit surveys were administered 2 years after the exit survey to follow-up on the trainee’s career trajectory and provide information on the long-term influence of the BEST program. Sufficient numbers of exit and post-exit surveys have yet to be collected because most trainees are still in training positions; therefore, no exit or post-exit data are presented here.

2.5 Interviews and site visits

At the request of the awardee institutions, annual phone conversations were conducted to provide more contextual detail to the data gathered via the Data Form and surveys. These conversations included NIH staff, Windrose Vision staff, BEST principal investigators (PIs), local BEST site evaluator(s), and/or BEST program manager(s). Uniform questions (Supporting Information File 1) assessed
development of infrastructure and sustainability of BEST activities. In the first year of each institution’s award, NIH staff also performed in-person site visits meeting with institutional administrative leaders, faculty involved in BEST activities, trainees who participated in BEST activities, and the PI(s) and staff responsible for implementing the program. These site visits provided contextual information about each site and their planned activities and allowed discussion among all stakeholders about the program goals, implementation approaches and challenges, and preliminary examples and information about student and faculty attitudes. In the final year of each award, NIH staff conducted video site visit conferences with each awardee to understand any remaining challenges or accomplishments not yet reported.

3 | RESULTS

3.1 | Awardee sites

There was considerable diversity in the types, sizes, and geographical locations of the 17 awardee institutions. Sites included public and private institutions. One site restricted BEST activity participation to trainees from biomedical departments, although most designed BEST activities for trainees more broadly. Eight BEST programs included medical school departments, nine did not. One program was a collaboration between two universities. Some institutions had already invested heavily in career development before they received the award while others had minimal activity in this area. Several were in or near large metropolitan areas with access to a variety of non-academic partners, whereas others were geographically more isolated and relied on nearby resources and/or partnerships on their own campuses. In all, the program covered a broad spectrum of biomedical research institutions with considerable variation in their training environments.

3.2 | The BEST consortium

The BEST investigators and staff formed a national consortium and have actively interacted and coordinated efforts since awards were issued. The consortium held monthly online meetings to discuss ongoing collaborations and upcoming meetings or events. They also held in-person annual meetings with outside speakers, a group of external consultants, trainees, and NIH staff involved in coordinating the BEST program and the evaluation. At these meetings, PIs and staff discussed their approaches, data, and strategies to reach their goals. They also collaborated on projects. An initial project was to clearly articulate their common philosophy, which included providing opportunities for trainees to develop a strategic, skills-based approach to career planning to enable informed decision-making. Given the NIH goal of disseminating their findings, the consortium documented and shared their work via their website (nihbest.org). They developed an outreach approach to share their work with the larger training community. Examples include (a) a BEST Practices Workshop prior to the 2017 annual Graduate Research Education and Training (GREAT) group meeting (co-sponsored by the Burroughs Wellcome Foundation) to engage the broader academic community and share outcomes and knowledge from their programs, (b) a “Road Show,” to share their activities, curricula, and slides with other institutions, and (c) a partnership with the American Society of Biochemistry and Molecular Biology (ASBMB) to provide a series of career development webinars (Careers in Industry, Building Professional Relationships, Charting a Course to Career Success, Interviewing, Building C.V.s., Interviewing, and Compensation).

3.3 | Activities and participation

Each BEST institution developed its own program to achieve its defined goals. Most developed and implemented interventions focused on career and professional development skills, such as understanding career options, making use of Individual Development Plans (IDPs), networking, job search, understanding career options, making use of Individual Development Plans (IDPs), networking, job search, job search, and gradually opened program activities to more participants due to demand. As a research award, however, each awardee was expected to propose and test hypotheses about how well their program and interventions informed and prepared trainees for broad career options. The BEST awardees have begun to report on their individual experiences elsewhere.

Types of activities offered by BEST programs each year are shown in Figure 1A (Year 1 data not shown as discussed above). Experiential learning, often in the form of internships, was a major focus of BEST programs: 16 of the 17 sites offered internships by year 3, but only 14 sites offered them in year 4. The two sites that dropped the internships did so because of the excessive staff time required to organize them. Internship length differed among sites and provided highly variable experiences. One-third of the sites negotiated to have internship costs covered by an external partner. Individual BEST programs will
report on their experiences and have summarized some approaches on their website. Across all sites, the total number of activities offered generally increased from year 2 to 3 (Figure 1B). Single-day workshops were the most common activity and dominated the suite of offerings each year. Approximately 70% of activities were designated by the sites as “new,” meaning they did not exist prior to the BEST award. The other 30% were “existing” or “improved” (data not shown). BEST programs also offered courses of varying length and subject areas, with some required and others elective. Required courses were often used to facilitate integration of BEST activities into the graduate curriculum as requested in the original NIH funding announcement. Courses covered a variety of subjects including writing skills, presentation skills, development of “elevator talks,” and some science offerings such as bioinformatics and computer coding for biologists.

For some BEST activities, individual participation could be tracked; these activities attracted over 3000 trainees in each of years 2-4 across all 17 sites (Figure 2A). For these activities where trainee attendance was tracked, single-day workshops had the highest participation (eg, 1749 graduate students and 821 postdoctoral scientists in year 3 attended the 377 single-day workshops across the 17 sites) (Figure 3A,B). “Workshops” were defined as an event (online or in person) for the purpose of gaining knowledge or skills that involves hands-on activities and active participation by attendees (Supporting Information File 1).

Other BEST activities were open events (seminars, networking mixers) with individual attendance difficult to track; therefore, attendance was estimated by BEST program staff. Participation estimates for these untracked activities indicated that over 14 000 trainees attended open events in year 3 and almost 12 000 attended in year 4 (Figure 2B). Note that these estimates likely included many trainees from the comparison group (described above) illustrating a potential influence of the program on trainees who were not defined as part of the “treatment” group.
3.4 | Trainee confidence

Graduate student entrance survey data from years 2 to 4 were aggregated across sites for a total of 6265 graduate students; 56.5% of the respondents were women and 43.5% were men. The survey response rate was 45.5%. Questions were posed to assess their confidence across several measures including to (a) assess their ability to pursue their desired career path, (b) determine steps needed to pursue their desired career path, (c) seek advice from professionals in that career path, (d) identify potential employers relevant to their desired career path, and (e) achieve their career goals. In the entrance surveys, 83%-90% of all graduate students reported being moderately, highly, or completely confident across all five measures (Figure 4A). Postdoctoral scientist entrance survey results were similar to those of graduate students in self-assessed measures of confidence (Figure 4B). The response rate was 44.9% across 16 awardee sites (n = 4540) and 51% of respondents were women and 49% were men. Like graduate students, 86%-91% of all postdoctoral scientist respondents were moderately, highly, or completely confident on the same five measures (Figure 4B).

One of the often-cited challenges in career development is apparent tension between trainees and their faculty mentors around career planning, which can be perceived as an activity pulling them away from their research projects. To understand this tension better, trainees were asked to express their levels of agreement with the statement: “I am encouraged by my PI to pursue career development activities toward my career goals.” Both graduate students and postdoctoral scientists agreed or strongly agreed (67.7% and 66.4%, respectively) with this statement. Agreement was similarly high with the statement “I am encouraged by my PI to pursue my career goals” with 72.6% of graduate students and 73.2% of postdoctoral scientists reporting they strongly agreed or agreed.

3.5 | Individual Development Plan

The IDP, is becoming almost standard and is used to try to help trainees identify and work toward their career goals. All BEST sites used an IDP: in year 3 of the BEST program, 12 sites used both the online interactive tool myIDP and an IDP modified for their institution, 4 used myIDP alone, and one used...
its institutional IDP alone. However, from entrance surveys, only 37.7% of graduate students and 34.3% of postdoctoral scientists reported completing an IDP in the past 12 months. Interestingly, 10% of graduate students and 9.8% of postdoctoral scientists reported: “I do not know/I do not remember” for this question. This disconnect with the institutional requirements to complete an IDP is striking. Interestingly, conversations between NIH staff and trainees at site visits revealed that many BEST trainees completing the IDP did so in isolation from their mentors. A remarkable majority of those interviewed revealed that they were reluctant to discuss their career plans with their mentors, contradicting responses to the earlier survey result stating they felt their mentors were supportive of the pursuit of career planning activities. Moreover, filling in an IDP but not discussing the responses with a mentor ignores perhaps the most important purpose of the IDP.

### 3.6 Career familiarity

One goal of the BEST awards is to broaden exposure to career options for biomedical researchers. Sites reported on the career paths to which they provided exposure in their program activities. All included the career track “Industry,” and 16 out of 17 reported offering training on the academic PI track by (the one awardee not offering this noted it was well covered through other university services). To assess career familiarity among the trainees, surveys asked for their familiarity with the 20 careers designated in myIDP. Most graduate students (64%) reported they were either familiar with “all” or “most” of these career options (Figure 5A). At entrance, postdoctoral scientists reported slightly lower levels of familiarity with “all” or “most” of these career paths (Figure 5B).

#### 3.7 Career pathways considered

Entrance surveys asked respondents to rate the extent to which they are currently “considering” each of the 20 myIDP career paths. Note that these were 20 separate questions and respondents could report they were strongly considering all 20 careers paths, for example, and they were not asked to rank their choices. The career path most highly considered by graduate students was “Research in Industry” closely followed by “Combined research and teaching career,” and

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**FIGURE 3** A. Graduate student participation in BEST activities. B. Postdoctoral scientist participation in BEST activities.
“Principal Investigator in a research-intensive institution” (Figure 6A). Postdoctoral scientists reported near equivalent interest in consideration of “Principal Investigator in a research-intensive institution” and “Research in Industry” with over 70% of the respondents reporting they are “moderately,” “strongly considering,” or “definitely pursuing” these paths (Figure 6B). The percent of graduate students indicating they were not at all considering “Principal Investigator in a research-intensive institution” was 21.4%, whereas only 15.8% of the postdoctoral scientists made this choice.

3.8 | Time to degree and time in training

To establish the baseline training duration, each awardee institution provided information on time to PhD completion for the 5 years prior to their award. Using these data, the weighted median TTD was calculated at 5.6 years over the 17 sites (n = 8596). Similarly, postdoctoral weighted average time in training was reported as 2.29 years over 14 sites (n = 8815) for the 5 years prior to the BEST awards.

Due to the vagaries of definitions between institutional, academic years, and other issues, it was challenging to collect these data. Given these caveats, the weighted elapsed median TTD for both treatment and comparison groups was similar for the small fraction of trainees that has graduated to date (Table 1). Future exit and post-exit surveys will inform the postdoctoral time in training.

3.9 | Infrastructure and sustainability

The third outcome assessed in our program evaluation was establishment or further development of institutional infrastructure to continue BEST-like activities. One way to assess this is to determine whether the programs are exclusively dependent
on their BEST funds to fully support all their activities. Over the course of the award, the number of sites reporting non-NIH funding for their programmatic activities grew. In year 3, there were 50 different non-NIH sources of funding specifically designated for BEST activities at the 17 sites.

4 | DISCUSSION

The NIH BEST awards offered a unique opportunity to approach career and professional development as a research endeavor. The goal was to enable institutions to establish these activities, assess what works and for whom, and finally, share that information with the broader training community. This is a long-term endeavor, but the institutions are now well-positioned to continue the evaluation of their programs so that longer-term impact can be measured. The NIH cross-site evaluation reported here addresses the early stages of data collection and analysis. The data shared here represent a small fraction of what could be collected; most of the exit and post-exit surveys allowing for complete assessment of outcomes have yet to be administered. This manuscript summarizes the activities established and data collected to date. The predominant activity offered across all institutions was single-day workshops (Figure 1), defined as “an event (online or in person) for the purpose of gaining knowledge or skills involving hands-on activities with active participation.” Although it might seem trivial, one of the major challenges for all BEST program staff was finding times where trainees would attend activities. The robust attendance in these workshops (Figure 2) is likely due to the relative ease of attending a single-day workshop versus a longer commitment such as

FIGURE 5  A, Entrance survey familiarity with myIDP career paths for graduate students. B, Entrance survey familiarity with myIDP career paths for postdoctoral scientists
(non-required) courses, internships, and certificate programs. This may be especially true for postdoctoral scientists. The content of these workshops is obviously key to their success and something the sites are reporting on separately.18

Our entrance data suggest that many trainees in BEST institutions today are familiar with the many available career options (Figure 5), and most of these trainees reported high levels of confidence to achieve their career goals when first surveyed (Figure 4). A high proportion of trainees reported plans to pursue non-academic careers (Figure 6), in line with other reports of declining interest in academic positions.19 Many national reports and articles lament the state of biomedical research training and the lack of preparation for the full array of biomedical career options.1,4,20,21 However, our data suggest high levels of awareness of trainees about the realities of the current biomedical workforce landscape, and a serious interest in the many available options. The present results paint a much more promising outlook than many reports. It is clear from our data that trainees at these BEST awardee institutions are generally knowledgeable about more than the traditional academic research career path and are considering a broad array of career paths as possibilities. It is important to note that “entrance” data do not tightly correspond to training stage, but rather to time of entrance eligibility for BEST activities. This varies across different BEST programs.

**TABLE 1** Graduate student weighted elapsed median time to PhD

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<th>Year 2</th>
<th>Year 3</th>
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<tr>
<td>Awardee sites reporting (n)</td>
<td>9</td>
<td>14</td>
<td>9</td>
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<tr>
<td>Treatment</td>
<td>5.91 years</td>
<td>5.51 years</td>
<td>5.70 years</td>
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<td></td>
<td>(n = 82)</td>
<td>(n = 176)</td>
<td>(n = 135)</td>
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<tr>
<td>Comparison</td>
<td>5.76 years</td>
<td>5.59 years</td>
<td>5.69 years</td>
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<td></td>
<td>(n = 200)</td>
<td>(n = 502)</td>
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An important finding from our entrance surveys is that even though pursuing a biomedical research PhD is traditionally associated with a desire to pursue an academic research career, graduate student survey respondents selected “Research in industry,” more often as a career intention than “Principal Investigator in a research-intensive institution” (Figure 6A). Postdoctoral training is often traditionally associated with the desire to pursue a research career at an academic institution. However, among postdoctoral scientists a non-trivial fraction (15%) reported they were “not at all considering” pursuing that position. In summary, there were a broad variety of other careers being considered at this stage for both graduate students and postdocs (Figure 6); future analysis of exit and post-exit surveys will be needed to identify the careers ultimately pursued and attained.

By design, BEST activities were intended to be integrated with traditional programs and structured to not increase time in training.7 There are long-standing challenges around capturing accurate and uniform data on training duration for graduate students, and this is more complex and problematic for postdoctoral populations.22 Currently, there is no indication that BEST activities have affected time in training for the relatively small number of graduate student participants who have graduated, but future analysis with more students will be needed to rigorously test this. Anecdotal examples from survey comments and conversations at site visits and in interviews suggest that at least some BEST trainees become increasingly focused and motivated to complete their training and pursue their desired career path after participating in some of these career development activities, including internships. For example, one graduate student noted that a BEST event “helped me refocus on my ‘job’ now (to finish my PhD) and remind (sic) me that there are things post-grad school to work towards.” Another noted they were “much more conscious of my CV and motivated … to increase my work output.” Other trainees credited BEST for helping them eliminate career pathways, for example, noting that BEST “…. helped me realize that I am not at all interested in an industry career.” It will be important to assess whether if this anecdotally noted increased motivation translates into changes in training time for BEST participants over time. Furthermore, and possibly more importantly, it will be essential to assess changes in trainee productivity using traditional metrics (eg, publications). The exit and post-exit surveys will capture this information, and future analyses can determine if research productivity is affected by participation in BEST activities.

Currently, there is an increased willingness of, and associated pressure for, institutions to track and publicize trainee time in training and career outcomes for graduate students and postdoctoral trainees.23 In line with the recent Coalition for Next Generation Life Science (NGLS) efforts,24 many institutions are more transparent about their outcome data, publishing career outcomes, and TTD in manuscripts and on their websites.25 Although this is not a defined goal of the BEST awards, it is aligned with the philosophies put forward by the consortium10,17 and with recommendations of newly released reports and funding announcements.5,26 One collaboration among a group of BEST awardees resulted in development of a career taxonomy that was adapted and adopted by a broader group of organizations as a unified taxonomy for biomedical careers27 and is now used by a number of academic institutions and the NGLS. A more recent follow-up study from this collaboration of BEST sites tested the reliability of the taxonomy tool and present it in a user friendly format.28

An ambitious goal of the BEST awards was to sustain successful activities after the 5-year non-renewable awards end. All sites have accomplished this by either securing funding for BEST activities and associated staff or integrating the activities into their graduate programs. In most interviews with BEST PIs and staff, there were indications of strong and/or growing institutional enthusiasm for their BEST activities. Evidence of these activities taking root is the growth in the number of departments and programs participating each year (data not shown). With the BEST program, NIH is indicating support of a broad range of research related career paths, likely influencing broader acceptance of these BEST activities.

Many sites have, through their BEST program, developed collaborations with non-biomedical research departments. For example, WSU developed a collaboration with their Graphic Design Department to produce videos of interviews of BEST participants and activities; Vanderbilt and Chicago collaborated with their business schools on select courses and workshops, and several other institutions are planning to expand to their humanities departments after the end of their awards. Many BEST sites are actively collaborating with institutions that did not receive awards. The Rutgers BEST program has trainee participants from Princeton University, Rowan University, New Jersey Institute of Technology, Stevens Institute of Technology, and others. Chicago has engaged trainees from Northwestern, University of Illinois Chicago, Rush University, Chicago State University, Illinois Institute for Technology, and Argonne National Laboratories. BEST sites also collaborate extensively within the consortium. For example, Midwest-BEST is a regional alliance of several sites in the Midwest (WSU, University of Chicago, and MSU), UCSF, and UC Davis are collaborating on their internship program,29 and MSU and Vanderbilt have collaborated with NYU, UR, UNC, and UC Denver on a faculty survey to analyze changes in perception of their approaches.9 Sites report that new career services offices have formed, and their “BEST” offices obtained financial support from their institutions. Some programs received alumni funds, some have been integrated into existing offices of career development, and others are receiving funds from industry partners.
It is very challenging, if not impossible, to disentangle the effects of BEST programs with the overall culture change occurring in biomedical research training. The BEST programs are only part of the transformation occurring within the NIH training community and the broader scientific community. For example, Office of Management and Budget published guidance that NIH now uses, clarifying that graduate students and postdoctoral scientists have a dual role—they are both trainees and employees. NIH clearly recognizes that activities allowed on an NIH training grant can reach beyond bench research. If a graduate student or postdoctoral scientist is paid from an NIH research project grant (such as an R01 or P01), they can dedicate some effort toward training and career development. Additionally, NIGMS recently issued a revised funding announcement for their Predoctoral Institutional Research Training Grants (T32) indicating support for development and implementation of curricular activities aimed at broadening training to better prepare students for careers in a variety of venues, such as industry, government, or entrepreneurial enterprises.

Beyond NIH and biomedical research training, it is undeniable there is a changing tide in graduate training. The NSF Research Traineeship program “explore(s) ways for graduate students in research-based master’s and doctoral degree programs to develop the skills, knowledge, and competencies needed to pursue a range of STEM careers”. National Science Foundation (NSF) issued Supplemental Funding Opportunities similar to the BEST awards, called “Improving Graduate Student Preparedness for Entering the Workforce”. The supplements “provide graduate students with the opportunity to augment their research … with additional ‘mentoring’ activities and short-term training opportunities.” NSF also recently announced support for Non-Academic Research Internships for Graduate Students.

Changes are also permeating the larger academic community, as the National Endowment for the Humanities has offered awards similar to BEST with its Next Generation PhD. The BEST awardees have made great strides in collecting uniform and rigorous data on their approaches to career development for thousands of trainees which will provide a rich dataset for future analyses to understand the influence of these activities on trainees. Awardee sites are advancing our understanding of how to establish and maintain didactic and experiential opportunities to support a variety of career outcomes and their approaches and findings are beginning to be shared with the broader scientific training community through peer-reviewed manuscripts. In addition to publications, other efforts contribute to dissemination of approaches and findings. For example, in conjunction with the 2017 AAMC GREAT Group Professional Development Meeting, the BEST Consortium held a BEST Practices Workshop to share information learned from their programs, offering practical guidance on how to establish, implement, and evaluate these programs BEST sites are offering a suite of activities and workshops they are willing to bring to other institutions and/or share curricula, slide decks, and documentation for these activities, all of which are currently available at nihbest.org. We are developing a database where the complete de-identified evaluation data (all survey responses and data forms) will be available for download and independent analyses. In this way, we expect these cross-site evaluation data to be available and valuable to the entire scientific training community.

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CONFLICT OF INTEREST

The authors declare they have no conflicts of interest.

AUTHOR CONTRIBUTIONS

N.L. Desmond, S.J. Korn, P.A. Labosky, and M. Wallace designed the research; R.N. Lenzi and M. Wallace performed the research and analyzed the data; N.L. Desmond, S.J. Korn, P.A. Labosky, and R.N. Lenzi wrote the manuscript.

REFERENCES


SUPPORTING INFORMATION
Additional supporting information may be found online in the Supporting Information section.

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