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Outcomes of National Career Development Program that Promotes the Transition to Independent Scientist

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Abstract

Purpose—The loss of new investigators from academic science is a “crisis” placing the future of biomedical science at risk. Failure to obtain independent funding contributes significantly to attrition from the NIH career path. The purpose of this paper is to describe the components and outcomes of the Advanced Research Institute (ARI) in Geriatric Mental Health, an NIMH grant-funded national program that targets successful transition of new investigators to independence.

Method—The authors first describe the program participants and key components. They then compare the record of federal grant funding, derived from the NIH Reporter database, of the first four cohorts (2004–2007; n=42) to those of all NIMH mentored career development (K) awardees funded 2001–2005 (n=404).

Results—As of January 2010, 45.2% of Scholars had achieved R01 funding. Nearly 70% obtained some NIH grant (not including K or small grants). Among all NIMH mentored K awardees, ARI Scholars were 2.36 ($p=0.048$) more likely to achieve an R01; outcomes were similar ($OR=2.42$, $p=.045$) when including R34s.

Conclusions—Based on objective outcomes, the Advanced Research Institute (ARI) in Geriatric Mental Health offers an effective model to promoting successful transition of new investigators to independence. While organized around a specific public health and scientific need, ARI’s components are generalizable to other fields. Further, the inclusion of biological, clinical and services researchers into a single program promotes translational science. Thus ARI is one tool to stemming attrition from the NIH career path and promoting the next generation of science.

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“New investigators are the innovators of the future - they bring fresh ideas and technologies to existing biomedical research problems, and they pioneer new areas of investigation. Entry of new investigators into the ranks of independent, NIH-funded researchers is essential to the health of this country’s biomedical research enterprise.”

National Institutes of Health. Statement of Commitment
to New and Early Stage Investigators, 2010

In their 2005 report, *Bridges to Independence*, the National Academy of Science described the loss of new investigators from academic science as a “crisis” and one of the most critical problems facing the National Institutes of Health (NIH).¹ This loss of new investigators has social and economic costs, and places the next generation of science at risk. Contributing to high rates of attrition from the NIH career path are failure to obtain independent research funding as well as a growing time lag between training and funding. By 2004, investigators who received their first NIH R01 research grant were, on average, 42 years old.² The purpose of this paper is to describe the components and outcomes of an ongoing, innovative research career development program, the Advanced Research Institute in Geriatric Mental Health (ARI), that specifically targets the vulnerable period when new investigators seek their first R01.

NIH and other organizations have initiated programs to address many of the systemic barriers to the successful transition to independent scientist. For example, loan repayment programs are designed to reduce the impact of financial disincentives between academia and private practice or industry on educational indebtedness.³ Similarly, NIH recently strengthened its career development programs with new policies and funding opportunities to facilitate receiving an R01 award earlier in an investigator’s research career.^{4, 5}

Mentoring has been identified by the Institute of Medicine and others as key to reducing individual-level barriers to bridging the transition to independence.⁶ The NIMH National Advisory Council report, *Investing in the Future*, states, “Effective mentoring, which is often lacking, is one of the elements essential for the development of a successful research career.”⁷ Mentors are usually described as senior individuals who are willing to give time, interest and emotional support to further the career of a junior person.^{8, 9} NIH had systematically addressed mentoring in earlier career phases through predoctoral and postdoctoral training programs and mentored career awards. Research finds that having local and/or long distance mentor(s) also contributes significantly to the productivity and success of more advanced mentees,^{10, 11, 12} and reduces attrition of medical school faculty, especially among women and minorities.^{13, 14} Mentors help newly trained researchers to plan and negotiate their career path. And while they cannot ‘fix’ the systemic barriers to career development, they can help new investigators respond strategically to these challenges and make themselves more competitive relative to other researchers.

The focus of the Advanced Research Institute in Geriatric Mental Health (ARI) is the transition from new investigator (e.g., NIH mentored career development awardees and comparably prepared junior faculty) to independent investigator. ARI was established to address critical shortages of independent investigators in geriatric mental health. Supported by an ongoing NIMH R25 grant since 2004, ARI is multidisciplinary and participants span the spectrum of translational, interventions, and services research in late life mental health. The short-term objective is to promote the mentee’s career advancement with the tangible outcomes of achieving independent research funding (e.g. R01) and assuming more responsibilities of scientific citizenship such as mentoring, service (e.g., reviewing grants and articles), and leadership (e.g., organization symposia, serving on scientific advisory boards). The long-term goal is to expand the nation’s capacity to conduct research on the

significant, but complex, problems related to mental illness in the fast growing elderly population.

Below we describe the major elements of ARI and the outcomes of the first four ARI cohorts. We also report outcomes of ARI graduates by considering the hypothesis that ARI participants have been more likely to obtain an NIH R01 compared to other NIMH mentored career development (K-series) awardees.

Methods

The Advanced Research Institute (ARI) in Geriatric Mental Health is organized around a unifying theme with public health significance: Late life mental health and illness. The rapid aging of America and the increasing life expectancy of individuals with mental illness underscore the acute need for research that will reduce the public health burden of mental illness in older individuals and the people who care for them.^{15, 16,17} The IOM and others emphasize the importance of strengthening the scientific workforce to meet this need.¹⁷ Timely research questions with high public health impact span the spectrum of biological,^{18, 19} interventions²⁰ and services research.²¹

ARI faculty members represent a wide range of disciplines. This breadth is useful for the program as it provides more perspectives on scientific critiques and development, offers opportunities for translational (T1, T2, T3) development, and is consistent with the direction of science and kind of reviews Scholar scan expect from NIH Study sections.^{22–27} It also offers greater access to consultants from outside a Scholar's home institution with a range of needed expertise.

Program Leadership and Faculty/Mentors

ARI is led by a Program Director and a five-person Steering Committee. The Program Director recruited the original set of mentors (n=8) from NIMH K02 and K24 (Independent Investigator Career Development) awardees who conducted research in geriatric mental health and demonstrated a commitment to mentoring. Additional mentors, many with K02/K24 awards, have been invited to join the program as it grew in size or relevant expertise was needed. The most recently recruited mentors have been ARI graduates. Mentors have continued with the program after their K has ended. To date, 17 independent investigators from 12 different institutions have served as mentors. Additional faculty attend the annual three days Spring Retreat. In total, 28 different investigators have participated as ARI mentors or faculty during the first seven years, representing 16 different institutions: Cornell, Dartmouth, Duke, Emory, Harvard, Johns Hopkins, Smith College, UCLA, UCSD, UCSF, U. Iowa, U. Massachusetts, U. Pennsylvania, U. Pittsburgh, U. Toronto, and Washington U.

Program Scholars

ARI targets new investigators who have potential to achieve R01-level independent research. ARI participants, known as Scholars, fit the NIH definition of a new investigator as an "individual who has not previously served as a principal investigator on any Public Health Service-supported research project other than a small grant (R03), an Academic Research Enhancement Award (R15), an exploratory development grant (R21), or certain research career awards..."²⁸ Almost all Scholars have also met NIH criteria as an Early Stage Investigator: a New Investigator who is within 10 years of completing his/her terminal research degree or medical residency (or the equivalent).²⁸

Applicants submit their CV, a draft grant application or prospectus, two letters of reference, and a letter describing their goals for participating. Applications are reviewed by the ARI

Steering Committee who look for commitment to geriatric mental health research, strong recommendations, evidence of scientific citizenship and a significant track record of early career competitive funding, publications and rewards. The selection process includes ensuring that the program can match a qualified applicant with an appropriate mentor. Mentors are asked to review the application and agree to the match before a Scholar is accepted into the program. Scholars participate for up to 2 years, with total of 16 active Scholars each year.

Program Components

ARI targets three general barriers to the transition to independence that can be modified through mentoring and consultation: 1. *Inadequate grant-preparation skills*, reported in surveys of medical school faculty as the greatest career development need regardless of gender, department and academic rank;²⁹ 2. *Poor time management* including day-to-day challenges in negotiating competing demands as well as attending to career timetables;^{8, 9, 30} and 3. *Poor access to statistical and other expertise* needed to address the increasingly multidisciplinary aspects of biomedical research. The program addresses these barriers through the following activities:

Mentoring

ARI Mentors provide general guidance to ARI Scholars on career development with specific attention to grant preparation.³¹ Mentors guide Scholars in, for example, formulating scientific questions, study design; acquiring preliminary data; identifying needed consultants (e.g. biostatistics; economics), grant preparation (e.g., critique drafts); work strategy (e.g., the balance between clinical and research activities; promotion timetables); and their development as mentors to junior colleagues.

Scholars and Mentors develop a “Mentoring Plan” that provides a structure to their responsibilities and an associated timetable with deadlines for both the Scholar (e.g., finish analyzing pilot data; submit draft to Mentor) and the Mentor (e.g., critique draft; meet by telephone). This plan is updated regularly and monitored by the ARI leadership.

Annual ARI Spring Retreat

The ARI Spring Retreat is the formal forum in which Scholars meet with their Mentors, other program faculty, and consultants (e.g., statisticians, NIH program officers, senior advisors). The Spring Retreat is structured to provide group and personalized opportunities for Scholars to make significant advancement in the development of their own research applications and, more generally, for honing grant development skills, targeted career planning and technical consultation. The 3 1/2 day retreat includes:

- a. *Seminars*: Although minimizing the amount of didactic teaching, ARI’s group size (N=16) allows seminar-style discussions on key topics such as R01 grant writing strategy, responding to reviewer critiques, update on NIMH priorities, and working effectively with mentors.
- b. *Workgroup Presentations*: Each scholar presents his or her grant application in a small group consisting of four Scholars, their mentors, a statistician, and an NIMH program officer and/or Advisory Board member. Scholars orally present their grant proposals for feedback and discussion. Scholars are expected to incorporate this and other feedback into their presentation to the same group the following day.
- c. *One-on-One meetings*: Scholars meet individually with mentors each day and at least once with a statistician, an NIMH program officer, and other faculty with

relevant expertise. These meetings focus on specific substantive or methodological questions, career development issues, and, the mentoring plan.

- d. *Writing Time:* Time is made available for Scholars to work on their grant applications and respond to the feedback and suggestions in preparation for the next day's group presentation.

Web-Based Research Presentations

Throughout the year, Scholars are encouraged to convene, with assistance of ARI, a web-based meeting of workgroup augmented by home mentors or others to review updated applications or responses to grant summary statements.

Targeted Networking Workshops

ARI supports a biannual "NIMH Day" where Scholars have the opportunity to meet one-on-one with NIMH program officers for research guidance. On alternative years, the program supports workshops to facilitate networking of Scholars with relevant experts.

Other Resources

ARI makes available a limited amount of funding for use by Scholars. The funds are most commonly used to support collection of extra feasibility data and consultation with methodologists. Proposed uses of these funds are reviewed by the ARI leadership for consistency with the Mentoring Plan. ARI also supports an annual face-to-face meeting between a Scholar and mentor.

Milestones and Oversight

Scholars are formally reviewed twice annually, including: 1. "Self-Evaluations" submitted to the Steering Committee each fall, and 2. Daily assessments of each Scholar's progress during the Spring Retreat's faculty meetings. The Program Director also monitors the Scholars' mentoring plans and holds an end of year phone discussion with the Scholar's mentor. The overarching purpose of these reviews is to identify ways in which the program can further meet the Scholar's needs. The annual evaluations are also used to assess whether the Scholar is taking sufficient advantage the program to continue a second year. A general expectation for retention is that scholars are prepared to submit a NIH application within six months, if they have not done so already.

The progress of past participants is tracked by annual surveys that assess academic promotion, leadership roles, mentoring, as well as grant funding and publications. Objective information on federal grant funding is obtained from public data bases, as described below.

Results

Program Participants

To date, ARI has enrolled seven cohorts of ARI Scholars (2004–2010). The number of Scholars in each Cohort has been 12, 9, 10, 11, 8, 9, 10 respectively, for a total of 69 Scholars over the first seven years. The 69 Scholars came from 35 different institutions. Scholars can participate in the program for a maximum of two calendar years, and the program supports 16 first-and second-year Scholars annually.

The typical academic rank of Scholar is mid-term Assistant Professor in a Department of Psychiatry. To date, the composition of Scholars includes: 42/69 (61%) women; 17/69 (25%) ethnic/racial minorities; and 49% (34/69) have MD degrees (including 5 MD/PhDs), with the rest having PhDs or other doctoral degrees. The majority (47/69; 68%) hold/have

held NIH mentored career development (K) awards. K awardees typically apply to the program in the third or fourth year of their award.

Process

In addition to their time together during the Spring Retreat, interaction throughout the year between Scholars and Mentors has varied in type and frequency. The program encourages face-to-face contact through, for example, visits to the Mentors lab or at professional conferences. Scholars report in their “Self-Evaluations” that additional contact ranges from regularly scheduled bi-weekly telephone conversations alternate week conversations to email exchanges as needed. All describe concentrated periods when mentors are reviewing their research plans and grant applications for upcoming deadlines. Local mentors were often included in conversations. Scholars uniformly report that the amount of mentor contact has met their needs and that mentors have been fast to respond when contacted and generous with their time.

Most Scholars have attended at least one targeted workshop. In recent years, ten Scholars presented updated research plans by web conferences attended by, on average, 4 ARI and local faculty members.

Approximately 60% of Scholars remained with the program for two years. Of the remainder, about half graduated having successfully achieved grant funding in their first year while the others withdrew early. Decisions to withdraw were made in consultation with the mentor and Program Director and usually reflected changes in the Scholar’s immediate career priorities (e.g., maternity leave, changing institutions, competing demands). Occasionally, a Scholar was matched with a new mentor in the second year, once because of interpersonal problems but usually to expose mentees to a different set of expertise.

Scholar Grant Outcomes

NIH Grant funding achievements for the first four ARI cohorts are shown in Table 1. This group (n=42) entered the program between 2004 and 2007; all graduated from the program by January 2009. Information on NIH grant awards was extracted from the NIH Reporter database as of January 2010.³² Across the four cohorts, 45.2% (19/42) of the ARI Scholars achieved an R01 by January 2010. Nearly 70% had obtained some NIH grant funding (not including career development or R03 small grants) during this period. With the exception of the first ARI cohort, funding success rates tended to increase with the amount of time since participating in ARI. Grant funding outcomes did not vary by Scholars’ academic degree (MD vs. no MD), gender, self-reported minority status, or history of an NIH mentored career development award.

Success rates also did not differ significantly by type of research categorized as biological, interventions, or services research. There was a trend, however, for biological scientists to be more likely to achieve an R01 than other Scholars (7/11 biological (63.3%) vs. 12/31 other (38.7%), $p=.16$; however there was no difference when the outcome included the R34 mechanism (63.6% biological vs. 54.8% other, $p=.61$) or any NIH grant (63.6% biological vs. 71.0% other, $p=.65$).

Comparison of Scholars to other NIMH K Awardees

In the absence of a randomized trial design, we sought available observational data on an appropriate comparison group to evaluate our hypothesis that ARI participation increases the likelihood of obtaining an NIH R01. The ARI program purposely recruits and selects highly accomplished new investigators judged as having the capacity and drive to benefit from the program’s opportunities and resources. To minimize this “selection bias”, we

compared the subset of ARI Scholars who were K awardees to other NIMH mentored K (K series) awardees from the same time period. The rationale is that all K awardees have already been “selected” through a competitive process that evaluated their potential success in developing into an independent investigator and achieving R-level funding.

We used the NIH Reporter database to identify the 404 NIMH K mentored awardees whose first year of funding was in 2001–2005, a time period consistent with ARI Scholars from the 2004–2007 cohorts who entered the ARI program in years 3 or 4 of their K award.³² The analysis compared the subset of these K awardees from ARI Cohorts 2004–2007 (n=24) to other K awardees (n=380). We also determined NIH grant funding using the NIH Reporter database as of January 2010.

Table 2 compares success rates of ARI scholars to other K awardees with respect to achieving funding as a principal investigator on an NIH grant. Among NIMH mentored K awardees, a significantly higher percentage of ARI Scholars achieved R01 funding than achieved by other K awardees (54.2% vs. 33.2%; $X^2 = 4.41$, $P < .036$). In logistic regression analyses controlling for year of first K funding, ARI Scholars were 2.36 times more likely to obtain an R01 than other K awardees ($p = .048$). As shown, this pattern persisted when the outcome was expanded to include the R01, R24, and R34 mechanisms, with 58.3% of ARI Scholars vs. 36.6% other K awardees achieving one of these grants ($X^2 = 4.54$, $P < .033$; $OR = 2.42$, $p = .045$ controlling for year of K award). Similarly, when the outcome included any NIH grant (other than a career development award or R03 small grant), 66.7% of ARI Scholars vs. 45.5% other K awardees were successfully funded ($X^2 = 4.48$, $P < .034$; $OR = 2.42$, $p = .045$ controlling for year of K award).

Discussion

The principal finding of this paper is that the Advanced Research Institute in Geriatric Mental Health (ARI) is associated with an over 2-fold increase in the likelihood of Scholars subsequently becoming a principal investigator of an NIH research grant. ARI's focus on a transitional period in the scientific career path is consistent with the National Advisory Mental Health Council's (NAMHC) recommendation in their 2008 report, *Investing in the Future*, “The transition points between different stages of the research career continuum represent windows of vulnerability where promising trainees may be lost, or where continued research progress may be delayed...”⁷ ARI's focus on the transition from new investigator to independent scientist responded to the growing loss of investigators at this stage of the career path noted by the National Academy of Science's *Bridges to Independence Report* as well as the critical need to expand the pool of scientists focused on reducing the burden of mental illness in late life.¹

Of significant note, while grant funding is the most tangible indicator of the program's impact, ARI's overall goal is keep people in academic research careers and to assume responsibilities of academic citizenship. To date, all but two Scholars (both from the first cohort) remain in academia and are rising through the academic ranks on schedule and are contributing nationally as contributors to the peer-reviewed scientific literature, grant reviewers, leaders of national organizations, and mentors of more junior trainees and new investigators.

Although biological scientists had a somewhat higher rate of R01 funding, this difference was diminished when R34 funding was included as an outcome. This trend is consistent with the purpose of the R34 mechanism to support intervention development making it less relevant to biological scientists. Indeed, the only type of NIH obtained by the biological Scholars was the R01. Thus we view the R34 as a meaningful outcome of ARI, especially as

this type of grant has been equally difficult to obtain (e.g., NIMH R01 2004–2009 average annual success rates for R34 was 18.0% and for R01 was 19.1%).³³

ARI's NIMH funding is consistent with the NIMH's comprehensive model of career development programs. In the field of geriatric mental health, NIMH supports investigator-initiated career development programs for medical students (e.g., "M-STREAM: Sustained Training and Research Experience in Aging and Mental health"), postdoctoral trainees (e.g., single site geriatric psychiatry T32s and a multi-site mental health services research training program), early career transition ("SRI: Summer Research Institute of Geriatric Mental Health", now in its 16th year) and mentored and independent scientists K awards.^{34–36} This support both sustains the successful transition of developing scientists through critical stages of the career path and promotes the complex science needed to meet a significant and growing public health need. At the same time, each of these programs is funded through investigator-initiated grants and rely on participation by a national network of senior investigators, thereby demonstrating the essential commitment of the field to the next generation of geriatric mental health researchers and the goal of reducing the burden of mental illness in an aging population.

A limitation to any outcome analyses of programs, such as ARI, that target advanced trainees, is the selection bias inherent in recruiting individuals with demonstrated potential for future success. The analyses presented in this paper attempted to reduce this bias by comparing the subset of ARI Scholars who were K awardees with other K awardees of the same time period. Thus the comparison group had already been selected through a competitive process and had experienced comparable time trends in the availability of NIH funding, generally, and to new investigators specifically. A residual limitation to this strategy is that the K awardees who apply to ARI represent the larger subgroup of K awardees who remain committed to a research career midway through their K program. This potential bias is partially mitigated by including in the comparison group the small number of K awardees who achieved their R01 funding in the early years of their award and would not have been eligible for the ARI program.

Three general factors are relevant to the program's success. First is the commitment of program faculty to work across disciplinary and institutional boundaries towards the career advancement of the next generation of investigators. ARI mentors represent a national, multidisciplinary network of researchers in geriatric mental health. These individuals, while remaining dedicated to their own research, give generously of their expertise and wisdom thereby enhancing the entire field of research ("raising the whole boat"). The faculty, therefore, serve as role models of successful researchers, mentors, and scientific citizens. Their impact is evident not only by the funding achievements of ARI Scholars, but also by the number of previous ARI Scholars who now serve as mentors locally and in ARI or other national mentoring programs.^{34, 35, 37}

Second, ARI's mentors and consultants focus on specific skill areas are consistent with recommendations of scientific leaders³⁸ and other successful programs:³¹ 1. *Grant-preparation skills*, including mastery of more than just the technical components of grant preparation but also the art --from designing innovative but methodologically sound approaches to problems with public health significance to ensuring adequate pilot data, providing reasoned arguments, and engaging departmental and NIH program support. 2. *Time management* including day-to-day negotiation of competing demands to ensure sufficient time to research-related activities, and timetables associated with both grant preparation (e.g., pilot data acquisition, writing, internal review) and academic promotion^{8, 9, 30} and 3. *Access to statistical and other expertise* is integrated into every

aspect of the ARI program, from mentor matching to the Spring Retreat to individually arranged consultations.

Third, the program's structure combines an intensive retreat with mentoring that is sustained over a sufficient period of time to complete the steps needed to accomplish the transition to independent investigator. These two structural elements are augmented, when needed, by individualized opportunities for consultation and supplemental resources for grant development. In the case of ARI, this structure, as well as the organizational infrastructure needed for recruitment, planning and implementation, are made possible by NIMH funding.

Organizing an advanced career development program around a specific subfield of mental health such as geriatrics is useful as it promotes multidisciplinary science that spans the translational spectrum, thereby potentially accelerating scientific progress and impact. However, the key elements of the program, discussed above, should generalize more broadly.

Conclusions

The Advanced Research Institute in Geriatric Mental Health (ARI) provides a potentially generalizable model to promote the successful transition of new investigators to independence. ARI provides an infrastructure for a national, interdisciplinary network of senior investigators to mentor the next generation across the spectrum of translational, interventions and services research. As tangible evidence of its success, ARI Scholars were 2.36 times more likely to obtain R01 funding than comparable new investigators during the same time period. Thus the program is contributing to the long terms goals of promoting innovative research that will have a significant impact on the problems of mental illness and the delivery of mental health services in older adults. It also provides a model for the development of independent scientists needed to address mental health problems across the age span.

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Table 1

ARI NIH Grants Cohorts 1–4, as of January 2010

ARI Scholars	Total N	R01		NIH R01/R24/R34 [†]		Any NIH Grant [‡]	
Total	42	19	45.2%	24	57.1%	29	69.1%
By Cohort:							
2004	12	5	41.7%	8	66.7%	9	75.0%
2005	9	7	77.8%	7	77.8%	8	88.9%
2006	10	3	30.0%	4	40.0%	7	70.0%
2007	11	4	36.4%	5	45.5%	5	45.5%

[†] Categories of Grants are cumulative

[‡] Career development awards and R03 small grants excluded.

* p < .05

Table 2

NIH Grant Funding (Principal Investigator) to NIMH K Awardees First Awarded in 2001–2005 (N=404) as Of January 2010

	Total n	NIH R01: n (%)	NIH R01/R24/R34 [†] : n (%)	Any NIH grant ^{†‡} : n (%)
ARI Scholars[§]	24	13(54.2) [*]	14(58.3) [*]	16(66.7) [*]
Other K awardees	380	126(33.2)	139(36.6)	169(44.5)

[†]Categories of Grants are cumulative

[‡]Career development awards and R03 small grants excluded.

[§]ARI Cohorts 2004–2007

^{*}*R01 (Column 1):* $X^2 = 4.41$, $df=1$, $p = .036$; OR: 2.36, $p = .048$ controlling for first year of K award; *R01/R24/R34 (Column 2):* $X^2 = 4.54$, $df=1$, $p = .033$; OR: 2.42, $p = .045$ controlling for first year of K award; *Any NIH grant (Column 3):* $X^2 = 4.48$, $df=1$, $p = .034$; OR: 2.45, $p = .047$ controlling for first year of K award