

Bridging Postdoctoral Training and a Faculty Position: Initial Outcomes of the Burroughs Wellcome Fund Career Awards in the Biomedical Sciences

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ABSTRACT

Purpose. To describe the experiences of recipients of the Burroughs Wellcome Fund's Career Awards in the Biomedical Sciences Program (CABS) and highlight selected outcomes of the award's first set of graduates.

Method. Since 1999, all active CABS recipients have been surveyed with the goal of assessing the program's implementation and the career progress of award recipients. Data were collected on multiple variables that are indicative of establishing an independent research career (e.g., time spent on research, external grant support, and scholarly publications), along with the views of individuals about the program and how the award had affected their careers.

Results. As evidenced by current employment and research funding, 77% of 1995–1999 grantees had been successful in securing tenure-track faculty positions in

research-intensive institutions. Of those with faculty appointments, 78% had built research programs that attracted external support. In addition, 95% credited the award with facilitating their searches for faculty jobs, 70% believed that it had shortened the time required to obtain such positions, and 82% cited the award as enhancing their ability to attract research funds. They also perceived the award as allowing them to pursue research ideas that might have been considered as risky or premature by more traditional research sponsors.

Conclusion. The CABS program has helped participants to launch careers as active and independent investigators. Grantees also credit it with allowing them to pursue research ideas that might otherwise have been considered impractical to support.

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In 1994, the Burroughs Wellcome Fund (BWF) established the Career Awards in the Biomedical Sciences (CABS)

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program. Aimed at fostering the development of active and productive careers in biomedical research, this program facilitates the critical transition from postdoctoral training to a tenure-track faculty position for talented young scientists. To accomplish this, the grant provides up to a total of five years of funding to support the combination of advanced postdoctoral study and the first three years of faculty service. The expectation is that by the completion of the grant period, recipients will have established productive research programs—ones that can compete successfully for government and other external support. Since its inception, the CABS program has awarded more than \$75

million to U.S. and Canadian universities to support 166 scientists.

The impetus for the CABS program in the early 1990s was the increasing difficulty newly trained scientists had obtaining faculty positions. Several factors, including a growth in the production of doctoral scientists that outpaced the increase in faculty openings, had contributed to this situation. Between 1987 and 1995, the annual number of biomedical PhDs awarded by U.S. universities increased by approximately 50%, while the number of faculty positions at academic institutions remained stable.¹ The result was an academic marketplace beset by growing underemployment, rising numbers of

researchers holding temporary posts, and frustration and disenchantment among postdoctoral fellows over the lengthy time required to obtain jobs.²⁻⁴ For somewhat different reasons, the attractiveness of a career in academic medicine also may have eroded, as indicated by the chronic underrepresentation of MDs and other physician-scientists in full-time research careers.⁵⁻⁷

Governmental and philanthropic organizations have long sponsored programs aimed at preparing talented individuals to pursue careers as scientists. For the most part, these efforts have targeted one career stage, such as postdoctoral training or the initial years as a faculty member. For example, the National Institutes of Health (NIH) have provided institutional training grants and fellowships for postdoctoral study, along with career development grants (K awards) for newly appointed faculty. An individual who has successfully obtained a junior faculty appointment also can apply for nongovernmental funds to support the building of a research program that will attract funds from major research sponsors (e.g., the Pew Scholars Program in the Biomedical Sciences and the Searle Scholars Program). However, few have tried to help bridge the gap between career stages.

The CABS program was partly modeled after the Lucille P. Markey Charitable Trust Scholar Award. Established in 1985, the Markey Scholars Award was unique in providing salary and research support for up to three years of postdoctoral training followed by five years in a faculty position. Between 1985 and 1991, 113 young investigators participated in this program, which was discontinued in 1998 when the Trust paid out its full assets. With the discontinuation of the Markey program, the CABS has been one of the few programs based on this model of facilitating the movement of advanced postdoctoral scientists to tenure-track faculty positions. (For more information on the CABS program, see Appendix.)

Within the past three years, however, other sponsors, including the American Heart Association and the Doris Duke Charitable Foundation, have developed similar initiatives aimed at easing the transition from postdoctoral study to employment as an assistant professor. In addition, the K22 awards now offered by several institutes within the NIH support both postdoctoral study, often at the NIH intramural laboratories, and the first two years as a faculty member.

Because all of these programs are relatively new, little is known about the success of this "bridging" model. Currently, an evaluation of the Lucille P. Markey Charitable Trust, including its Scholar Award, is being conducted by the National Academy of Sciences. However, the results of this evaluation will not be available until 2005. In this report, we provide a profile of the 1995-1999 CABS recipients and summarize the initial outcomes of those grantees who have now completed the award. We recognize that a fuller understanding of the program's success awaits the passage of time as more cohorts complete the award. Examination of similar outcome data on appropriate comparison groups also is important—an effort that has been initiated by the BWF but is still in the early stages of data collection. Nevertheless, given the paucity of data about "bridging" programs and their outcomes, we believe that the tracking efforts performed to date for CABS recipients are instructive in providing preliminary data on the program's early experiences and the award's potential for enhancing the academic research careers of young scientists.

The CABS program is grounded in several premises about how "bridging" support can strengthen the development of research careers. More specifically, the combination of salary and research support for both postdoctoral training and the early years of faculty service should:

Provide grantees the freedom and resources to develop an independent

research program while they are still engaged in postdoctoral study. Having their own support provides awardees with more freedom to develop independent research programs and gain early career experience as principal investigators, in contrast to their unfunded counterparts whose salary and research costs are paid by the research grants of their faculty advisors.

Increase the attractiveness of awardees to academic departments. Among the pool of applicants for faculty positions, CABS recipients may possess a "competitive edge" in several regards. Their potential has already been recognized by their nominating institutions and by their receipt of the CABS, which comes with a commitment of three years of salary and research support during the early faculty years. Further, the funding structure and administration of the award itself are exceptionally flexible and impose less of an administrative burden on awardees (and perhaps their employers) than is the case with many other traditional forms of support. As such, this may assist departments, particularly those with budget restrictions, in providing new assistant professor positions and additional resources to the new faculty member. Postdoctoral experience as independent investigators and resulting publications also increase the desirability of CABS recipients to institutions seeking entry-level faculty.

Enhance the conditions that promote developing and solidifying a strong program of research during the early faculty years. Salary support should help ensure sufficient time for research that is "protected" from the usual competing demands of teaching, patient care, and other faculty responsibilities. Although job offers may include reduced teaching or patient-care loads during the first year as faculty members, BWF awardees must have 80% of their time protected for three years. Independent research funding provides the resources to innovate and pursue risky leads, conduct pilot studies, refine study

designs, and collect preliminary data—activities that contribute to the preparation of a successful follow-on grant application.

Since its inception in 1994, the CABS program has represented BWF's largest financial commitment. Between \$9 million and \$13 million are committed to the program annually, with the investment through 2002 totaling more than \$75 million. The financial significance of this investment, coupled with the importance of determining whether the program would accomplish its objectives, prompted the BWF to regularly assess program implementation and outcomes. The goal was to use this information to guide programmatic decisions about enforcing CABS policies (e.g., protecting research time), the need for modifications that would strengthen the program, and the progress of CABS recipients toward building research careers. Over time, these tracking data would contribute to assessing the overall success of the program and the basis for continued investment. A current study comparing CABS recipients with individuals who applied for but did not receive the award will address the extent to which outcomes can be attributed to the CABS program.

Previous studies of research careers provide only modest guidance about how best to foster academic careers, especially in our current tight labor markets. Relatively limited attention has been paid to examining postdoctoral training and career development programs in the biomedical sciences. For example, recipients of awards from the Pew Scholars Program in the Biomedical Sciences, a program designed to support outstanding young assistant professors in the first or second years of their appointments, appear to obtain their first federal research grants at younger ages. In addition, more graduate students and postdoctoral fellows of the Pew Scholars Program went on to obtain academic appointments than did their peers

nationwide (as measured by the limited national statistics available).⁸ In another program targeted at young faculty, data collected on 192 recipients of the Heart and Stroke Foundation of Canada research scholarship indicated that they outperformed an unfunded comparison group in the numbers of published articles and in citations to those articles.⁹ Both these studies suggest that research support in the early faculty years is positively related to long-term career outcomes. However, because these programs targeted individuals who already had obtained faculty positions, they are less informative about the value of "bridging support" in obtaining and succeeding in a faculty position.

METHOD

Since 1997, we have conducted an annual survey of CABS recipients to collect data on a small set of variables that are partial, yet critical, measures of academic research careers. All active CABS grantees are asked to participate (e.g., the total was 101 for the 1999 survey). Outcome variables based on the CABS's premises were specifically chosen to determine the success of the program. These variables were the length of time needed to obtain a faculty position; applications for and receipt of external research support; time spent on research and other activities; the amount of institutional financial commitment to the grantee's career (e.g., the amount of new assistant professor laboratory start-up funding); the numbers of graduate students, postdoctoral fellows, and research personnel the recipient directly supervised; and the amount of the recipient's research space. Our survey also solicited awardees' views on the extent to which they believed the CABS had fostered their advancement (e.g., providing postdoctoral training for building research expertise, obtaining a faculty position, and increasing the time devoted to research) as compared with others at

the same career stage with similar training and experience. Each year, individuals with active awards are requested to submit a copy of an updated curriculum vitae and to complete a mailed questionnaire. From their vitae, we obtained data on their publications, and we gathered citations to these publications from the Institute for Scientific Information's Science Citation Index database. We began tracking each grant recipient one year after he or she received the award. In this paper, we focus on recipients who began their grants between September 1, 1995 and September 1, 1999.

RESULTS

Characteristics of Awardees

As of the writing of this paper, our response rates had exceeded 95% of each year's awardees. Table 1 presents some of the demographics and the educational backgrounds of all 101 CABS recipients who received awards between 1995 and 1999. Overall, approximately 56% had PhDs, 29% had MD-PhDs, and 15% had MDs. Nearly one third (31%) of the awards were made to women. Women were better represented among PhDs (39%) than among MD-PhDs (21%) and MDs (20%). The percentage of women CABS recipients who have PhDs corresponds closely to the percentage of women who have earned all new doctorates in the basic biomedical sciences, which has hovered around 40% over the last decade.¹⁰ However, when compared with women's graduation rate from U.S. medical schools (40%) and with the percentage of women assistant professors appointed in U.S. medical schools from 1991 to 2001 (35%),^{12,13} women's representation among MD recipients of the CABS is noticeably lower.

Underrepresented minorities have comprised approximately 3% of all CABS applicants, as compared with comprising 2% of all CABS grantees.

Table 1

Characteristics of the 1995–1999 Recipients of the Burroughs Wellcome Fund Career Awards in the Biomedical Sciences (CABS) by Highest Degree				
Characteristic	Degree			Total (n = 101)
	PhD (n = 57)	MD-PhD (n = 29)	MD (n = 15)	
Sex				
Male	35 (61.4%)	23 (79.3%)	35 (80.0%)	70 (69.3%)
Female	22 (38.6%)	6 (20.7%)	3 (20.0%)	31 (30.7%)
Race/ethnicity				
Asian-American	10 (17.5%)	8 (27.6%)	4 (26.7%)	22 (21.8%)
White	45 (79.0%)	21 (72.4%)	11 (64.7%)	77 (76.2%)
Black, Hispanic, and other	2 (3.5%)	0 (0.0%)	0 (0.0%)	2 (2.0%)
NIH funding rank of degree-granting institution*				
Top 25	31 (54.4%)	16 (55.2%)	9 (60.0%)	56 (55.4%)
26–50	13 (22.8%)	6 (20.7%)	3 (20.0%)	22 (21.8%)
51 or higher	6 (10.5%)	2 (6.9%)	1 (6.7%)	9 (8.9%)
Not applicable	7 (12.3%)	5 (17.2%)	2 (13.3%)	14 (13.9%)
Age at start of award†, mean (SD)	32.6 years (2.5)	35.3 years (2.2)	34.3 years (1.9)	33.7 years (2.6)
Postdoctoral training completed by start of award†, mean (SD)	41.8 months (10.0)	39.1 months (10.8)	46.7 months (10.2)	41.8 months (10.4)

*Rankings were based on the total National Institutes of Health (NIH) research funding awarded to U.S. institutions of higher education in FY 2000. "Not applicable" refers to awardees who received their degrees from non-U.S. universities.

†Applications are due on October 1 and awards begin on September 1, a lag of 11 months between applying for and beginning the award.

These participation rates for underrepresented minorities are distinctly lower than their rates for new MD recipients (11%), PhDs awarded in the biological sciences in 2000 (7%), and medical school faculty in tenure-track positions in 2001 (6%).^{12–14}

The majority of all CABS awardees received their training at institutions that are highly research-intensive in the biomedical sciences. Across all degrees, 55% received their PhDs or MDs from institutions that ranked in the top 25 of colleges and universities in terms of NIH research funding; this percentage increases to 77% if the list of institutions is expanded to the top 50. Among those with PhDs from U.S. institutions of higher education, 82% graduated from institutions judged to have distinguished doctoral programs in the biomedical sciences. (Institutions with distinguished biomedical sciences doctoral programs are those that ranked in the top 25 of 197 U.S. institutions, based on a summary index that was

constructed by averaging the standardized scores for the reputational survey ratings of the scholarly quality of faculty collected in a study by Goldberger, Maher, and Flattau.¹¹) This percentage is markedly higher than that for doctoral production in the biomedical sciences as a whole (e.g., 29% of 1991–1992 PhDs).¹⁵

As previously mentioned, the CABS is targeted at advanced postdoctorates, defined in the guidelines as biomedical scientists with more than 12 but less than 48 months of postdoctoral training at the time of application. To date, awardees overall have completed about 3.5 years (or 41.8 months) of postdoctoral research training at the time they have started their grants. (Applications are due on October 1 and awards begin on September 1 of the following year, a lag of 11 months between applying for and beginning the award.) Those with only the MD degree have been engaged in postdoctoral study significantly longer, however,

than their PhD counterparts. At the initiation of the grant, the average age of CABS recipients was 33.7 years. Given residency, postdoctoral, and perhaps some fellowship training, those with MDs and MD-PhDs were significantly older than their PhD counterparts.¹⁶

Applications to the CABS program are encouraged from researchers in all basic biomedical science disciplines, and this diversity was reflected in the fields of awardees. Across all 1995–1999 CABS grantees, the most frequent fields were cell and developmental biology and neuroscience; each accounted for 19% of CABS recipients. Approximately 12% of awardees worked in genetics, 11% in molecular biology, and 9% in microbiology or immunology. The remainder were in structural biology (6%), physiology and biophysics (5%), biochemistry (7%), parasitology and virology (6%), and several other fields such as pathology and reproductive sciences (4%).

The Ability to Focus on Research

The CABS program provides young investigators the opportunity to concentrate on research by stipulating that at least 80% of recipients' time must be spent in research. To see whether this requirement was being met, we asked the recipients in our annual survey to report the amounts of time spent in research and other activities (e.g., administration, teaching, and patient care) during the preceding year. For each individual, the percentages reported in each annual survey were averaged. Across all years of the award, CABS recipients committed an average of 89.8% of their time to research (SD = 9.0%). For the postdoctoral training portion of the award, this figure was 95.9% (SD = 5.9%).

Awardees were still able to allocate substantial amounts of time to research (mean = 87.2%, SD = 9%) even after moving into faculty positions that re-

quired some teaching or patient care. An additional indicator that awardees' time was being protected from other faculty demands was their perception of the CABS's influence on their research time. Nearly half (48%) of awardees in faculty positions reported that the award had increased the time that they devoted to research "a great deal," and another 33% responded that it had increased it "somewhat." Only a small fraction believed that its effect was "minimal" (13%) or "nonexistent" (5%).

Progress toward a Career as an Independent Investigator

Obtaining a faculty position. As of September 2000, 77% of the CABS recipients in our study were employed in tenure-track faculty positions. Among this group, 68% were assistant professors in basic sciences departments, 21% were in clinical departments, and 9% held

appointments in both types of departments. The remaining 23%, mostly more recent award recipients, were incumbents in postdoctoral positions.

The average age at becoming an assistant professor was 34.7 years (see Table 2). This is approximately one year older than the average age reported for the 1990–1995 cohort of Pew Scholars (33.4 years) but is consistent with national trends showing increases in the age of newly hired junior faculty.^{8,16} Once again, PhD awardees were noticeably younger than their MD and MD–PhD counterparts (33.6 and 36.3 years, respectively). The CABS recipients in our study typically obtained their faculty positions about 5.7 years after receiving their doctorates. For PhDs, the average was 4.8 years; for those with MD–PhDs or MDs, it was about two years longer. However, there were sharp differences between MD–PhDs and MDs; for those with dual degrees, the time to obtaining

Table 2

Faculty Career Progress Indicators for 1995–1999 Recipients of the Burroughs Wellcome Fund Career Awards in the Biomedical Sciences (CABS) by Highest Degree*			
Indicator	Degree		Total (n = 64)
	PhD (n = 38)	MD–PhD and MD (n = 26)	
Age at first faculty position, mean (SD)	33.6 years (3.1)	36.3 years (2.1)	34.7 years (3.0)
Time from last degree to first faculty position, mean (SD)†	4.8 years (1.3)	6.9 years (2.7)	5.7 years (2.2)
Awardees who perceived influence of award on obtaining a faculty position‡			
A great deal	12 (54.5%)	11 (64.7%)	23 (58.9%)
Somewhat	8 (36.4%)	6 (35.3%)	14 (35.9%)
Only a little	2 (9.1%)	0 (0.0%)	2 (5.1%)
Not at all	0 (0.0%)	0 (0.0%)	0 (0.0%)
Awardees who perceived influence of award on shortening the time to obtain a faculty position‡			
A great deal	6 (28.6%)	8 (53.3%)	14 (38.9%)
Somewhat	7 (33.3%)	4 (26.7%)	11 (30.6%)
Only a little	5 (23.8%)	2 (13.3%)	7 (19.4%)
Not at all	3 (14.3%)	1 (5.6%)	4 (11.1%)

*In this table are data for only those 1995–1999 CABS grantees who had moved to faculty positions by 2000. On the CABS's influence on obtaining a faculty position and on shortening the time to obtain this faculty appointment, recipients were asked to rate the award's influence compared with the situation of researchers who were at the same career stage and who had similar training and experience.

†CABS recipients who applied for and accepted a faculty position between the time they applied to the Burroughs Wellcome Fund and the time they were notified that they had received an award were excluded from this analysis.

‡All award recipients who spent six or more months in postdoctoral training as part of the CABS are included.

a faculty appointment was nearly one year longer than that for PhDs, but it was five years longer for awardees with the MD only. Although sound comparative data are not available, these figures, while not surprising, are nevertheless sobering; that is, even for individuals selected for their talent, skills, and promise in research, a large portion will be 40 years old or older when being considered for tenure by their institutions.

A key question is whether the CABS's bridging support facilitated obtaining an academic position. Unfortunately, at this time, there is no clear answer because similar information was not obtained from an appropriate comparison group (those who applied unsuccessfully for a CABS), nor are there clear comparison data in the literature. In addition, while the average time spent in BWF-supported postdoctoral training was 14 months for awardees in faculty positions, a significant proportion (17%) were offered and accepted faculty positions between the time of applying to the CABS program and actually beginning the award period. In these instances, the BWF allowed them to keep the award, but only the portion allotted to faculty service (i.e., three years of support). Overall, awardees spent, on average, a total of 54.9 months in postdoctoral study (SD = 13.4 months) before obtaining faculty positions; the figures were 54.9, 51.1, and 63.8 months for PhDs, MD-PhDs, and MDs, respectively. For those with PhD degrees, this length of postdoctoral term is similar to that reported for 1989-1991 PhDs in the biological sciences.¹⁷

Of those awardees with at least six months of postdoctoral training supported by the BWF and who held faculty positions, 95% rated the award as having a great deal or some influence on their ability to obtain faculty jobs, and 70% voiced similar perceptions with regard to the award's shortening the time required to obtain faculty positions. As a whole, MD-PhDs and MDs were more likely to see the award as instrumental in this regard. However, there was a noticeable

tendency for MDs, in particular, to believe the award had had a major influence on their success in obtaining faculty jobs. All MDs (100%) viewed the award as having had a great deal of influence on their ability to secure faculty appointments, as compared with 45% of MD-PhDs; 57% of MDs gave the same endorsement to the award's role in shortening the time needed to successfully locate faculty jobs, as compared with 36% of their MD-PhD counterparts.

Establishing an independent research program. One of the first career steps as a faculty member in the biomedical sciences is establishing a functioning laboratory, often a costly endeavor. The award requires the hiring institution to make a significant commitment to the recipient's career either by appointing the recipient to a tenure-track position or by providing funds to set up a laboratory, preferably both. The median dollar values of start-up packages for awardees across disciplines were \$250,000, \$350,000, and \$550,000 for those hired in 1998, 1999, and 2000, respectively. These packages were in addition to research funding provided by the award and were frequently accompanied by other benefits such as release time from teaching or clinical work during the initial years of service, mortgage and down-payment benefits, and salary guarantees in the event of lapses in funding.

Securing a tenure-track position is the typical prerequisite for seeking the external research funds necessary to build an independent research program.¹⁸ After entering the faculty ranks, the CABS recipients in our study were actively and successfully pursuing research support. Nearly all (91%) had applied for at least one grant, submitting an average of 2.7 proposals within the preceding 12 months. At the time of our survey, 78% had one or more active grants for which they were the principal investigator (see Table 3). Their primary sponsors were the National Institutes of Health (65% had one or more grants, most often R01s), and 71% had

been awarded funds by such private foundations and nonprofit organizations as the American Heart Association, the Andrew W. Mellon Foundation, and the Searle Foundation. Recipients with MD-PhDs or MDs were noticeably successful in obtaining NIH research support. Furthermore, approximately 82% of CABS recipients cited the award as having had either a great deal or some influence on their ability to attract external research support.

Successfully seeking research funding is one indicator that CABS recipients have made progress toward setting up their own independent research programs. Eighty-four percent of CABS recipients in faculty positions perceived the award as helping them "a great deal" in developing independent research programs, and another 11% believed it provided some assistance. Moreover, 69% of CABS recipients gave the award "a great deal" of credit for allowing them to pursue ideas that they considered "risky" or would have been unable to pursue with the more traditional forms of research support available to new faculty members.

Even those in postdoctoral training—a time when acquiring skills rather than cultivating one's own research and exploring risky ideas is the common focus—viewed the award as strongly beneficial in this regard. Slightly more than half of grantees who were pursuing additional postdoctoral training rated the award as facilitating the development of an independent research program "a great deal," with the remainder viewing it as "somewhat helpful." Nearly two thirds (64%) viewed it as having a great deal of influence in permitting them to explore riskier research ideas, with another 27% viewing it as having some influence.

Career Outcomes for CABS Graduates

As of the writing of this paper, support provided by the CABS program had ended for 33 grantees: 15 MD-PhDs

Table 3

Indicators for Establishing Independent Research for the 1995–1999 Recipients of the Burroughs Wellcome Fund Career Awards in the Biomedical Sciences (CABS) by Highest Degree*			
Indicator	Degree		Total (n = 64)
	PhD (n = 38)	MD–PhD and MD (n = 26)	
Awardees who had one or more active research grants as a principal investigator	24 (64.9%)	25 (96.2%)	49 (77.8%)
Awardees with research support from			
NIH	12 (50.0%)	21 (78.0%)	32 (65.3%)
Other federal agency	1 (4.2%)	2 (8.0%)	3 (6.1%)
Business/industry	0 (0.0%)	2 (8.0%)	2 (4.1%)
Foundations	16 (66.7%)	19 (76.0%)	35 (71.4%)
Other	6 (25.0%)	5 (20.0%)	11 (22.5%)
Awardees who were principal investigators on National Institutes of Health R01 grants	12 (32.4%)	14 (53.9%)	26 (41.3%)
Awardees who perceived influence of award on attracting external research support			
A great deal	13 (41.9%)	12 (48.0%)	25 (44.6%)
Somewhat	13 (41.9%)	8 (32.0%)	21 (37.5%)
Only a little	3 (9.7%)	2 (8.0%)	5 (8.9%)
Not at all	2 (6.5%)	3 (12.0%)	5 (8.9%)
Awardees who perceived influence of award on establishing an independent research program			
A great deal	31 (83.8%)	22 (84.6%)	53 (84.1%)
Somewhat	3 (8.1%)	4 (15.4%)	7 (11.1%)
Only a little	3 (8.1%)	0 (0.0%)	3 (4.8%)
Not at all	0 (0.0%)	0 (0.0%)	0 (0.0%)
Awardees who perceived influence of award on ability to pursue "risky" research ideas			
A great deal	24 (64.9%)	19 (76.0%)	43 (69.4%)
Somewhat	11 (29.7%)	5 (20.0%)	16 (25.8%)
Only a little	2 (5.4%)	1 (4.0%)	3 (4.8%)
Not at all	0 (0.0%)	0 (0.0%)	0 (0.0%)

*In this table are data for only those 1995–1999 CABS grantees who had moved to faculty positions by 2000. On the CABS's influence on establishing an independent research program and being able to pursue "risky" research ideas, recipients were asked to rate the award's influence as compared with the situation of other researchers who were at the same career stage and who had similar training and experience.

or MDs and 18 PhDs. Table 4 summarizes indicators that partly capture progress toward establishing a career as an independent and productive investigator.

These first two CABS cohorts had all obtained tenure-track faculty positions and were principal investigators on one or more research grants. Despite the

lack of comparative data, this figure is impressive when viewed in the context that only an estimated 15% of all recipients of PhDs granted in 1990–1996 in the life sciences held tenure-track positions in 1997.¹⁹

The average time from receipt of last degree to being hired as an assistant

professor was 6.0 years. For PhDs, the corresponding figure was 5.1 years, slightly longer than the number of years reported for 1985–1995 PhDs who were Pew Scholars (4.4 years).⁸ This somewhat extended length of time is consistent with the fact that CABS recipients also spent slightly more time in post-doctoral training (mean = 4.6 years) compared with Pew Scholars (3.8 years). This difference may partly reflect three factors. First, the time spent in post-doctoral training steadily inched upward for biomedical scientists during the 1990s. Second, there is an 11-month delay between the time individuals apply for the CABS and their start date, and this time period is usually spent in postdoctoral study. Finally, recipients are expected to continue their post-doctoral training for at least 12 months after receiving the award.

With regard to CABS recipients with MD–PhDs or MDs, the average number of years since receipt of their last degree was 7.2 years. Although few comparison data exist, the number of years may not be long, given that these individuals have completed residencies, postdoctoral research training, and, in some cases, training in a clinical specialty.

All awardees had active research programs as indicated by several measures of research involvement. Each was a principal investigator on one or more active research grants, and nearly three fourths had successfully obtained an R01 from the NIH (67% of those with PhDs and 80% of the MD–PhDs and MDs). Success in terms of being awarded NIH research support is markedly higher for CABS recipients than it is for researchers applying to the NIH in general; for example, since FY1997, the success rate for competing R01 applications has hovered around 31%.²⁰ Unfortunately, no data on successful NIH application rates for all young investigators are available. Even without this information, CABS recipients clearly have been quite successful in obtaining support that is often viewed as the "coin of the realm" in the biomedical research community.

Table 4

Career Outcome	Degree		
	PhD (n = 18)	MD-PhD and MD (n = 15)	Total (n = 33)
Awardees with tenure-track faculty position	18 (100%)	15 (100%)	33 (100%)
Time from last degree to first faculty position, mean (SD)	5.1 years (1.2)	7.2 years (2.4)	6.0 years (2.1)
Awardees with active research support	18 (100%)	15 (100%)	33 (100%)
Awardees with National Institutes of Health R01 grants	12 (66.7%)	12 (80.0%)	24 (72.7%)
Time from start of faculty position to receipt of R01 mean (SD)	1.5 years (0.9)	2.2 years (1.4)	1.8 years (1.2)
Article publication			
During award, mean (SD)	10.1 (7.6)	12.3 (6.7)	11.1 (7.2)
Citation rate (median) for articles published in			
1996	72.6	40.7	48.7
1997	40.7	38.0	39.3
1998	29.0	17.2	23.0
1999	12.3	17.0	13.3
2000	5.1	4.6	4.7
Articles published in top-ranked journals (median)*	48.7%	42.9%	43.5%

*The top-ranked journals are the 23 most prestigious journals in which to publish basic biomedical and clinical research papers, based on a survey of NIH intramural scientists.

During the time of the award, the CABS recipients in our study were also active publishers, each producing an average of 11.1 articles. Citation rates to articles published by awardees have averaged 48.7 for articles published in 1996; the corresponding figures for articles published in 1997–2000 were 39.3, 23.0, 13.3, and 4.7, respectively. Because no clear standard exists for judging young faculty's performances on this measure, interpreting these rates is difficult. However, based on another indicator of research quality, awardees, on average, had 44% of their publications published by top-ranked journals, i.e., those identified by intramural NIH scientists as the 23 most prestigious journals in which to publish basic biomedical and clinical research papers.²¹ For example, 55% of CABS graduates had published at least one article in the

Proceedings of the National Academy of Sciences during their award periods. The figures for the *Journal of Biological Chemistry*, *Molecular and Cellular Biology*, and *Science* were 30%, 21%, and 18%, respectively.

DISCUSSION

The CABS program was initiated to facilitate the critical transition from postdoctoral training to tenure-track faculty positions for talented young scientists. To accomplish this, the award provides salary and research support for both advanced postdoctoral study and the first three years as an assistant professor. The expectation is that by the completion of the grant period, recipients will have established productive research programs—ones that can com-

pete successfully for government and other external support.

The results reported here for both the 1995–1999 awardees and for those who have completed their grant periods suggest that this expectation has been fulfilled. All graduates, along with a significant fraction of the 1995–1999 awardees, hold tenure-track positions in research-intensive institutions. The majority have active research programs, and the survey data on both time spent in research and recipients' perceptions about the influence of the CABS on their careers indicate that research is their primary activity. Although there are no benchmarks for the value of laboratory start-up packages offered by the hiring universities, the amounts received by CABS recipients were certainly impressive, especially given that they were in addition to the research expenses provided by the award. This combination of funding ensures that CABS recipients have adequate resources to establish laboratories. To date, program graduates have been dramatically successful in obtaining R01s grants from the NIH—a clear sign that their research has passed peer review. In addition, a noteworthy proportion of their research results has appeared in journals held in high regard by the biomedical research community.

It is difficult to ascertain whether the CABS has shortened the time spent in postdoctoral study because sound comparative data on the length of postdoctoral training among recent doctorates are unavailable. In addition, a notable fraction of awardees obtained faculty positions between notification of receiving CABS awards and the start of the grant periods. However, the lengths of postdoctoral terms for awardees are quite similar to those for PhDs in the biological sciences. Among those whose career paths most closely matched the program's structure (support for both postdoctoral training and faculty service), the majority viewed their CABS awards as instrumental both in reducing the time in postdoctoral training and in

obtaining faculty positions. This question will be better addressed once the comparative study has been completed.

The results of our study suggest that CABS recipients are well on their way to being independent, productive biomedical researchers. From this perspective, the program is a sound investment for Burroughs Wellcome Fund. Of course, the persistent question for CABS and all other programs where talent and merit constitute the key selection criteria is whether these individuals would have excelled to the same degree without this award. The answer to this question must await the conclusion of the comparative study. At the same time, the CABS program may be most effective (and perhaps even unique) in fostering talent, independence, and innovative biomedical research. With few exceptions, recipients judged the award to be particularly beneficial in facilitating the development of an independent research program and permitting the exploration of risky research ideas or pursuit of ones that typically do not attract traditional sponsors at this early career stage. This is true both for those in faculty positions and for those in postdoctoral training. The handling of new and innovative ideas in the NIH peer review process has been a perennial source of dissatisfaction among biomedical scientists who are seeking research funds.²² We hope that our future evaluations will develop measures that better capture research innovation to determine the extent of the CABS program's unique role in facilitating this outcome. The CABS program's possible success in identifying and fostering innovative re-

search ideas in addition to facilitating the transition into academic research would be a distinct accomplishment.

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APPENDIX

Key Elements of the Burroughs Wellcome Fund Career Awards in the Biomedical Sciences (CABS)

The CABS program is targeted at basic biomedical science postdoctoral researchers with a minimum of one year and a maximum of four years of postdoctoral research training. Candidates must be citizens or permanent residents of the United States or Canada and nominated by a degree-granting institution in these countries or the United Kingdom. Each institution may nominate up to eight candidates and is encouraged to divide the candidates equally among individuals with PhDs and those with MDs or MD-PhDs. Individuals who already hold or have accepted tenure-track faculty appointments are ineligible.

Applications are reviewed by an independent advisory committee of 16–18 distinguished scientists with expertise across the range of the basic biomedical sciences. Finalists are recommended to the Burroughs Wellcome Fund (BWF) Board of Directors for approval. The BWF receives approximately 190 applications per year, representing about 70 different academic institutions, and typically selects between 14 and 26 individuals per year, for an average award rate of 11%.

The award currently provides \$500,000 in support over five years. During the postdoctoral and faculty periods, annual amounts of \$53,360

and \$117,600 are granted, respectively, and provide for salary and research expenses, with a designated cap on the salary allocation. When the institution pays the recipient's salary, the salary portion of the award can be used to supplement research expenses. Research funds may be used at the recipient's discretion, equipment purchases are transportable if the recipient changes institutions, and unexpended funds may be extended well beyond the term of the award. The award provides a 10% administrative fee to recipients' institutions to help defer indirect costs. Awardees are expected to spend at least 80% of their time in research during the grant.

Because the CABS is a bridging awards, a recipient is expected to complete at least one additional year of postdoctoral work upon receipt of the award. However, the recipient may accept a faculty position at any time during the postdoctoral year, and a recent change to the award allows funds not used to support postdoctoral work to be carried forward to the faculty portion of the award. For an awardee to accept an offer of a faculty position, the hiring institution must make a significant commitment to the awardee's career development. Tenure-track appointments

are strongly preferred, accompanied by salary support, funds for equipping a laboratory, or both. If the institutional commitment is deemed inadequate, the BWF negotiates with the institution on behalf of the award recipient. If these negotiations are unsuccessful, the BWF does not approve use of the award at that institution. To date, however, the BWF has not disapproved any award because of insufficient institutional commitment.

In addition to the financial benefits of the award, the BWF provides award recipients with other opportunities for career development. There are regular meetings of award recipients that are designed to facilitate scientific networking with peers and with senior scientists who serve on the BWF's Board of Directors and advisory committees. These meetings also include panels and presentations on such career-related topics as obtaining a faculty position, laboratory management, technology transfer, and academia–industry collaboration. The networking associated with the program and a related supplemental program that supports scientific presentations by CABS recipients at meetings help bring awardees and their research to the attention of the scientific community.