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Research Training Grants in Anesthesia:

Seventeen Years of N.I.H. Support

Robert A. Hirsh, M.D.,* and Harry Wollman, M.D.†

Thirteen centers were granted a total of $10,709,000 from the National Institutes of Health for research training in anesthesia in fiscal years 1959 to 1975, inclusive. Eighty-nine per cent ($9,543,000) of the funds were spent. Of 442 trainees supported, 376 have made career decisions. Two hundred seventeen (58 per cent) of these pursued academic careers (academicians). Seventy-four of the former trainees (20 per cent of those who have chosen a career) received subsequent NIH awards for research projects between fiscal years 1962 and 1974, inclusive, supporting 446 grant-years of research. These research investigators are considered "total successes." One hundred forty-three (38 per cent) of the former trainees, pursuing academic anesthesia careers, but who have not yet received NIH support for research, are considered to be "qualified successes" of this training program. After an estimated lag time of five and one-half to six years following completion of training, it is expected that one-third of those trained in these programs will receive NIH research support (145 to 150 individuals).

The expenditure per postdoctoral trainee per year was $17,400, and the average number of months of support per trainee was 15.1, for an average cost per trainee of $21,600. The cost per academician was $37,400; the cost per research investigator was $96,400. The cost per research investigator is estimated to be $57,000 if one-third of the former trainees subsequently obtain NIH research support, as we project. Compared with estimated expenditures of $12,600 per year of medical school education, these costs are not unreasonable. Further follow-up study of the careers of the graduates of research training grant programs is needed to complete the data collection and to verify the accuracy of our projections.

The research training grant program in anesthesia has been beneficial in alleviating the manpower shortge of academic anesthesiologists and research investigators and has also provided 14 chairpersons in academic anesthesia departments. The current and future needs for academicians and research investigators in anesthesia must be determined in order to ascertain whether additional research training support is required in anesthesia. (Key words: Education, research training; Anesthesiologists; Grants; Manpower; National Institutes of Health.)

IF RESEARCH TRAINING GRANT support in anesthesia is to be justified, a need for academicians and research investigators in anesthesia and the effective use of prior training grant support should be demonstrated. The first requirement will have to be addressed elsewhere. This report is directed to the second.

Data on research training grant expenditures are available from NIH, but accurate information on current professional activities of former trainees can be obtained only from current surveys. The last accurate updating of the current activities of research training grant recipients was done in 1969 by R. M. Epstein and H. Wollman.‡ Those data are summarized in table 1. The authors have attempted to update that information with the help of the chairpersons of the anesthesia departments receiving NIH research training grant support since fiscal year (FY) 1969.

In the late 1950's there was general agreement that anesthesiology was among the most undermanned of medical specialties. There was a shortage of medical school faculty in anesthesia. Many medical school departments of anesthesia had no chairperson, and many other departments were of low quality. These shortages were exacerbated by the broadening scope of anesthetic practice in obstetrical anesthesia, in respiratory and intensive care units, and in support of highly specialized surgical techniques such as cardiopulmonary bypass, elective hypothermia or hypotension, and organ transplantation, each of which necessitated the attendance of one and often two highly trained anesthesiologists.[1]

There was agreement that research in anesthesia was needed, and that the number of anesthesiologists qualified to do research and teach had to increase to attract adequate numbers of qualified medical and scientific graduates into the specialty and train them to meet the obvious manpower needs.[1]

The research training grant programs in anesthesia started in fiscal years (FY) 1959 to encourage the production of these research investigators and teachers.

* Assistant Professor.

† Robert Dunning Dripps Professor and Chairman.

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Address reprint requests to Dr. Hirsh.

‡ Epstein RM, Wollman H: Research Training in Anesthesiology: Report of the Training Grants Committee, National Institutes of General Medical Sciences, January 1971. (R. M. Epstein, M.D., Professor and Chairman, Department of Anesthesia, University of Virginia, School of Medicine, Charlottesville, Virginia 22901.)

TABLE 1. Summary of the Results of the FY 1969 Research Training Grant Survey

Graduates	173
Total months of support	3,222
Months of support per trainee	18.6
Academicians	99
Adjusted per cent academic	61.1*
Number of chairmen of academic anesthesia departments	6
Cumulative expenditures	$4,323,000
Expenditures per graduate	$ 25,000
Expenditures per graduate per year	$ 16,000
Adjusted expenditures per academic graduate	$ 40,900†

* The adjusted per cent academic is the number of academic anesthesiologists who received support at the postdoctoral level divided by total number of trainees minus (those in military service plus those still in training) × 100 per cent.

† The adjusted expenditures per academician are computed by deducting the training expenditures of those still in training or in obligated military service (11 × $25,000) from the cumulative expenditures and dividing the result by 99 academicians.

The expenditures reported by R. M. Epstein and H. Wollman are the actual dollars spent and are not adjusted to the 1967 dollar; by coincidence, the expenditures in 1967 dollars are $4,396,000, which is 1.7 per cent higher than the actual expenditures.

Three programs were funded in FY 1959. The number of programs increased, with 20 institutions being funded at one time or another. Thirteen anesthesia training grants were active in 1969, and ten were active in FY 1975.

It is the purpose of this paper to present data on the amounts of support and the post-training careers of the 442 postdoctoral trainees who have been supported.

Materials and Methods

A list of postdoctoral and predoctoral trainees receiving stipends from an anesthesia research training grant was assembled from NIH printouts and the 1969 survey of R. M. Epstein and H. Wollman.‡ Each list was sent for corrections and updating to the respective department chairperson at the 13 institutions with active research training grant programs as of FY 1969. We did not survey the other seven institutions because together they accounted for only 8 per cent of the trainees (14/173) and 7 per cent to the expenditures ($300,000/$4,323,000) in the 1969 survey and because they were not involved in the anesthesia research training grant program after FY 1967. We sought the following information about each trainee:

1) Number of months of support from the research training grant
2) Year of completion of training (the fiscal year in which the last month of anesthesia research training grant support occurred)
3) Professional activity as of August 31, 1975 (see Appendix 1 for classification)
4) Academic rank

In addition, each respondent was asked to correct and update information pertaining to awards, expenditures, total months of support and number of trainees for each fiscal year. Award and expenditure data represent total costs: that is, direct costs plus indirect costs, which are 8 per cent of direct costs.

In every case the individuals contacted provided all the information we requested. The calculations done for each institution and for all the institutions considered as one are in Appendix 2.

Award and expenditure data were calculated both in unadjusted dollars and in adjusted dollars (calendar 1967 = $1.00). The conversion factor for a given fiscal year was obtained by taking half the sum of the consumer price index[2] (CPI) for each calendar year in which that fiscal year fell. For example, the conversion factor for FY 1959 = ½ (86.6, the CPI for 1958, plus 87.3, the CPI for 1959). For FY 1975, the conversion factor was simply the average of the monthly CPI[3] from July 1974 to June 1975, inclusive.

We determined the number and fraction of predoctoral trainees entering anesthesia, as well as the number pursuing academic careers; however, we did not adjust the expenditures per postdoctoral trainee

TABLE 2. Current Positions of Postdoctoral Trainees

	Number	Per Cent
In academic anesthesia	215	48.6
In another academic post	2	0.5
Still in training	36	8.1
Military service	25	5.7
Non-academic position	152	34.4
Unknown	7	1.6
Deceased	2	0.5
Ill	1	0.2
Not active professionally	2	0.5
TOTAL	442	

$$\text{Adjusted per cent academic} = \frac{\text{Academicians}}{\text{Total trainees—(those still in training, in obligated military service, dead, and not active professionally)}}$$

$$= \frac{215 + 2}{442 - (36 + 25 + 2 + 1 + 2)} \times 100\% = 58\%$$

The adjusted per cent academicians excludes from the denominator those who have not yet made a career decision because they are still in training or in obligated military service, those who could not choose a career because of death or illness, and those inactive professionally.

Of the two individuals in non-anesthesia academic posts, one is Assistant Professor of Oral Biology and the other Assistant Professor of Statistics.

for support given to predoctoral trainees, since the latter support was negligible.

The number of former trainees awarded NIH grants between 1962 and 1974, inclusive, was determined using the NIH Research Grants Index for those years. Number of grants and years of support were also determined.

Results

Positions

There were 442 postdoctoral trainees in the research training grant program through fiscal 1975 (July 31, 1975). Their current positions are summarized in table 2. If those who have not yet chosen a career (because they are still in training or in obligated military service) and those who could not choose a career (because of death or illness) are excluded from the denominator, the adjusted percentage of former trainees in academic posts is 58 per cent. Fourteen former trainees are chairpersons of academic anesthesia departments. Of the two individuals in non-anesthesia academic posts, one is an assistant professor in a department of oral biology (11 months of support) and the other is an assistant professor of statistics (10 months of support).

Three predoctoral trainees pursued anesthesia careers (12 per cent of all predoctoral trainees), and one of the three holds an academic post (4 per cent). Two others are in non-anesthesia academic posts. One is now an assistant professor of orthopedic surgery (four months of support); another, supported for 50 months, is now an assistant professor of physiology. Thus, three of 25 predoctoral trainees (12 per cent) now hold academic positions.

Grants

Seventy-four graudates (20 per cent of all trainees and 36 per cent of academic graduates through FY 1974) were awarded at least one year of subsequent NIH support for a research project between FY 1962 and FY 1974, inclusive. The percentages are adjusted for those in military service and those unable to practice or still in training. We estimate that the average lag time between completion of training and first grant award is five and one-half years, on the basis of the data shown in figure 1, where the lag time to the first award is plotted by the year of completion of training. The curve is flat for the years 1963–1967 and then decreases, reflecting only the former trainees since 1968 who have been awarded a first grant after less than the average lag time.

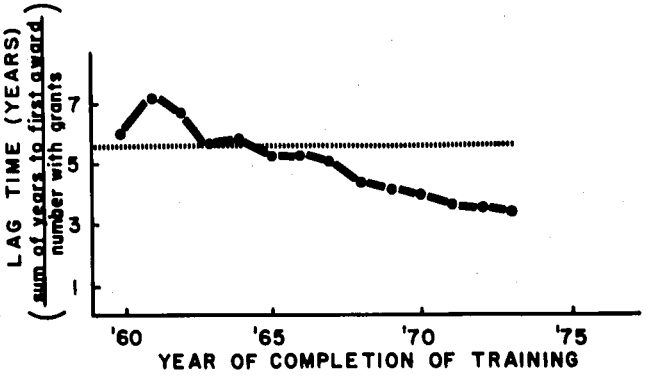

FIG. 1. Lag time to first NIH grant. The lag time to the first subsequent NIH grant award following completion of training is plotted on the ordinate. The lag time for each year is calculated by dividing the sum of the number of years from completion of training to the first subsequent NIH grant award by the number of former trainees from that year receiving subsequent support. After an initial period of adjustment the curve is essentially flat between the years 1963 and 1967, the average lag time for that period being 5½ years (indicated by the dotted line).

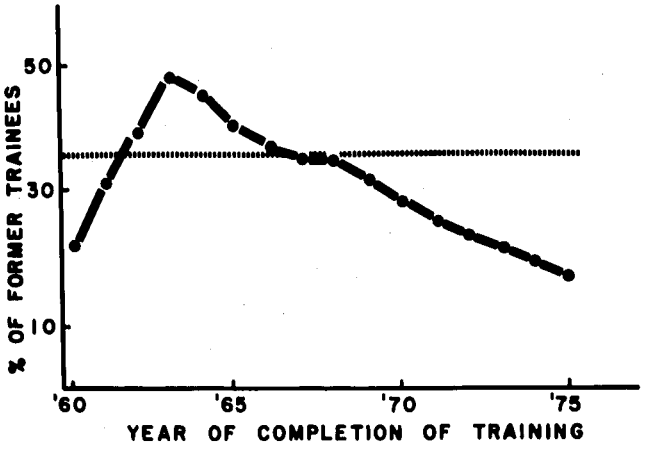

FIG. 2. Percentage of former trainees with a subsequent NIH award. The percentage of research training grant recipients who have or have had NIH grant support subsequent to completion of training is plotted (*ordinate*) by year of completion of training (*abscissa*). The curve levels off at 34 per cent (*dotted line*) for the years 1966 to 1968 before falling in the years following 1968. Inasmuch as additional former trainees from the years 1968 to 1975 will receive their own NIH grants, the curve can be expected to rise to 34 per cent for those years as well.

Similarly, figure 2 shows the percentage of trainees who have or have had NIH grant awards subsequent to completion of training. This curve levels off at 34 per cent for the years 1966–68, and that value is the estimated average of the fraction of former trainees who will obtain NIH support for their research. These data are incomplete, not only because of the lag time, but also because more than half of the trainees (235/442) completed their training after 1970 (fig. 3).

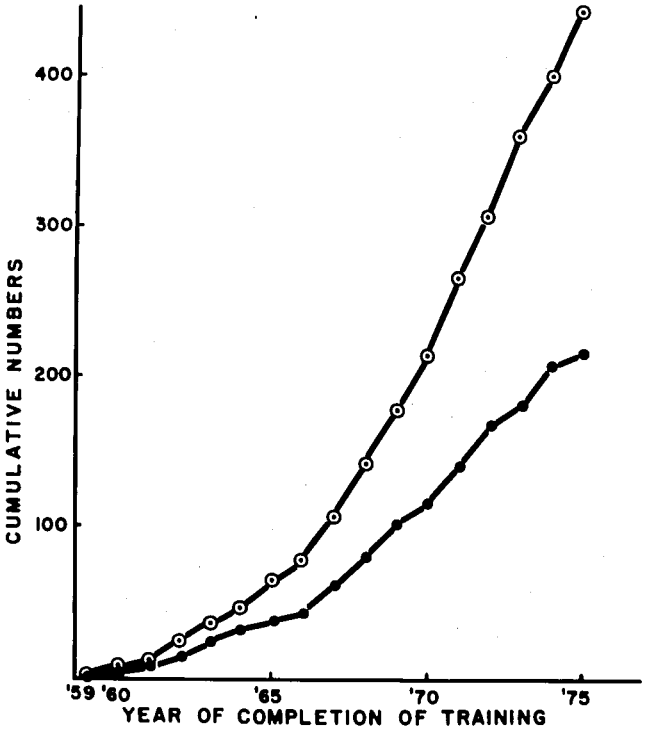

FIG. 3. Cumulative number of trainees (⊙) and cumulative number of academicians (○). The cumulative number of academicians does not rise at a rate commensurate with the cumulative number of trainees because 66 research training grant recipients have not yet made or cannot make a career decision due to the fact that they are still in training, in obligated military service, deceased, disabled, or not active professionally. The majority of the former trainees completed their training in the years 1970 and thereafter. When their career decisions are made, the curve for cumulative number of academicians will more closely approximate that for the cumulative number of trainees.

Table 3 summarizes the distribution of grant support by anesthesia center grants, other center grants (cardiovascular, pulmonary and neonatal physiology, metabolism of pharmacologic agents, etc.), and individual awards. Forty-eight former trainees received subsequent NIH support from an anesthesia center grant, 27 from some other center grant, and 19 from individual awards where the former trainee was the principal investigator. (This total is more than 74 since some investigators had grant support in more than one category).

Two hundred twenty-four projects were supported and 446 grant-years (the sum of the product of each grant and the respective number of years of support) were funded.

AWARDS AND EXPENDITURES

Of $10,709,000 awarded, 89.1 per cent, or $9,543,000, were spent. Expenditure data are presented in table 4 for the 13 institutions that participated in this survey and in table 5 for the entire research training grant program.

In comparing expenditures from tables 4 and 5, it is useful to use a standard (1967) dollar, since the awards were made over a span of 17 years. Review of the data in tables 4 and 5 demonstrates the validity of emphasizing only the data from the 13 institutions that participated in this survey. Their cumulative expenditures (table 4) were $9,543,000, or 96.8 per cent of the $9,854,000 spent in the entire research training grant program (table 5). In 1967 dollars, these 13 universities accounted for 96.1 per cent of the cumulative expenditures for the entire program. Furthermore, these 13 institutions trained 96.7 per cent of the trainees and provided 97.0 per cent of the total months of support.

The cost of postdoctoral support is not adjusted for the expense of predoctoral support because there were 6,666 months of postdoctoral support, an average of 15.1 months per trainee, and only 217 months (3.2 per cent of 6,666) of predoctoral support. Furthermore, the cost of predoctoral support was even less than 3.2 per cent of the total support.§

Figure 4 shows the annual expenditures, both unadjusted and adjusted to the 1967 dollar. This graph also demonstrates how the purchasing power of the dollar has plummeted from 1969 to 1975, although the size of the awards has remained about the same, at $1,000,000 per year, since 1967.

Expenditures per trainee, per trainee per year, and per academician are presented in figure 5. The ex-

§ One institution supported a predoctoral trainee for 60 months. That trainee is counted as a postdoctoral trainee since his support was at the level of a postdoctoral trainee. He accounted for 40 per cent of the months supported by that institution. All other predoctoral trainees were supported for an average of six months.

TABLE 3. NIH Grant Recipient Data

Individuals with grant support	74	
Anesthesia center grant		48
Other center grant		27
Individual grant		19
Number of projects supported	224	
Anesthesia center grant		157
Other center grant		46
Individual grant		21
Grant-years of support	446	
Anesthesia center grant		302
Other center grant		84
Individual grant		60

Seventy-four former research training grant trainees received subsequent NIH grant support. The total for grant support from various grant sources (anesthesia center grant, other center grants and individual grants) is more than 74, since some former trainees received support from more than one type of grant.

penditures per academician are adjusted (dashed line) for 1975 for the cost of training those who have not made a career decision because they are either still in training, in obligated military service, dead, ill, or not active professionally.

Discussion

Success Criteria and Achievement

Thirteen universities supported by research training grants in anesthesia had expenditures of $9,543,000 ($8,390,000 in 1967 dollars), or 96 per cent to 97 per cent of all the expenditures in the anesthesia research training grant program since its inception in 1959. These 13 universities accounted for 96.7 per cent of the trainees and 96.0 per cent of the total months of support. It is, therefore, reasonable to view their data as representative of the entire program.

Two questions must be answered in evaluating any program. First, what are the goals of the program? Second, what are the indices of good performance in terms of output, costs and efficiency? We can assume that the goals of the research training grant program in anesthesia were to produce academic anesthesiologists to be both teachers and research investigators in a specialty that was seriously undermanned as recently as a decade ago.[1]

We have arbitrarily defined "total success" as a trainee who has received NIH-grant support subsequent to completion of training, *i.e.*, a research investigator who has passed stringent peer review. We have further defined an academician who is a teacher but does not have a subsequent NIH research award as a "qualified success," even though some have recommended "redefinition of training programs to encompass obligations to train teachers as well as research investigators."[4]

Seventy-four research training grant program graduates (20 per cent of those who have made career decisions) are already "total successes," receiving subsequent NIH grant support for a total of 446 grant-years. This s a very strict criterion and does not take

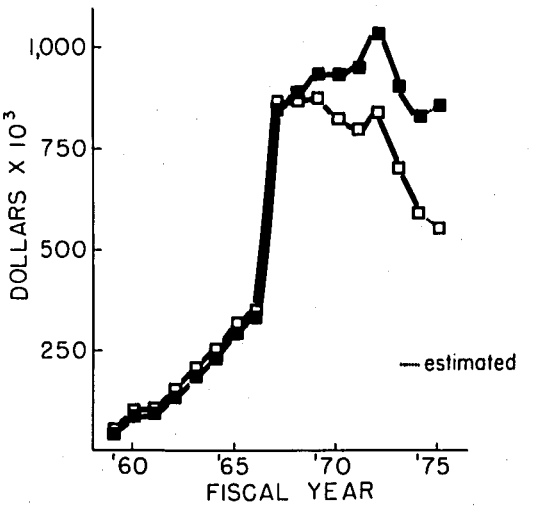

Fig. 4. Annual expenditures unadjusted and adjusted to the 1967 dollar. Annual expenditures in both actual dollars (*solid squares*) and 1967 dollars (*open squares*). Of note is that fact that while the amounts of the expenditures have not changed much since 1968, the purchasing power of those dollars has diminished. The expenditures for 1975 are estimated.

Table 4. Summary of Data for Thirteen Universities, 1959–1975

Trainees	442
Total months of support	6,666
Months per trainee	15.1
Academicians	217
Adjusted per cent academicians	58 per cent
Chairpersons of academic anesthesia departments	14

	Unadjusted Dollars	1967 Dollars
Cumulative expenditures	$9,543,000	$8,390,000
Expenditures per trainee	21,600	19,000
Expenditures per trainee per year	17,400	15,200
Expenditures per academician	44,000	38,700
Adjusted expenditures per academician*	37,400*	32,900*

* The adjusted expenditures per academician are computed by deducting the training expenditures of those still in training, in obligated military service, dead, unable to practice because of illness, and not active professionally (66 × $21,600 or 66 × $19,000 for unadjusted and 1967 dollars, respectively) from the cumulative expenditures and dividing the result by 217 academicians.

These data were obtained from the universities that had active research training grant programs in anesthesia after fiscal year 1969. The cumulative expenditures ($9,543,000) are 96.8 per cent of the expenditures for the entire research training grant program since its inception in 1959.

Table 5. Summary of Data for the Entire Anesthesia Research Training Grant Program

Trainees	457
Total months of support	6,871
Months per trainee	15.0
Academicians	224
Adjusted per cent academicians	57.1 per cent
Chairpersons of academic anesthesia departments	14

	Unadjusted Dollars	1967 Dollars
Cumulative expenditures	$9,854,000	$8,728,000
Expenditures per trainee	21,600	19,100
Expenditures per trainee per year	17,200	15,200
Expenditures per academician	44,000	39,000
Adjusted expenditure per academician*	38,800*	34,400*

* The adjusted expenditures per academician were calculated as explained in table 4.

These are the data for the entire research training grant program in anesthesia. The expenditure data do not differ markedly from those presented in table 4.

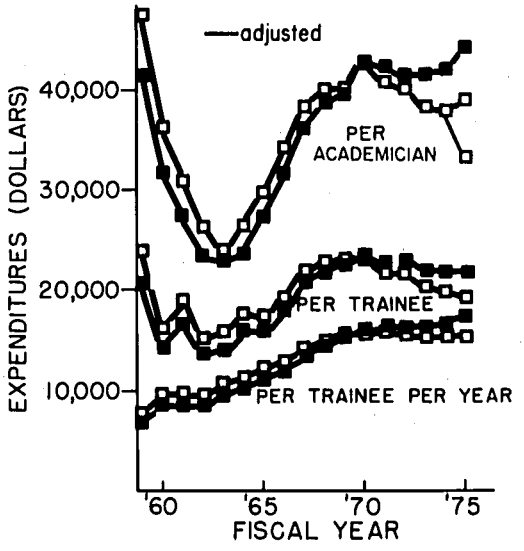

FIG. 5. Training expenditures in actual and 1967 dollars by fiscal year. In standardized (1967) dollars (*open squares*), costs per trainee per year have remained stable since 1968. Costs per trainee have declined in that period due to a shortening of the training period. Costs per academician have also decreased since 1970, and when the data are further adjusted, substracting the expenditures of those who have not yet made a career decision (*dashed line*), the cost per academician falls to $33,000.

into account awards from other granting institutions or unsponsored research. In addition, 143 graduates (38 per cent) are "qualified successes" as defined above. The 20 per cent figure for the fraction of graduates with subsequent NIH awards is a low figure because it is not adjusted for the lag time. The data plotted in figure 2 suggest that a third of the graduates will be "total successes," *i.e.*, they will ultimately get NIH support for research when the appropriate lag time has elapsed. The lag time of five and one-half to six years is longer than one might wish, but is probably due to the fact that most trainees have spent two years in obligated military service following the completion of training.

The data on subsequent careers are complete, with the current positions of only seven of the 442 trainees (1.6 per cent) being classified as unknown. We assume that the unknowns hold non-academic posts.

The value of supporting predoctoral research trainees is questionable, since only one currently holds an academic anesthesia post. This aspect of the anesthesia research training program has been discontinued.

EXPENDITURES

All costs per trainee and per academician increased between 1963 and 1968, a period during which there was a marked increase in the funding of the research training program. Expenditures per trainee per year (in 1967 dollars) increased about 50 per cent from about $10,000 in the early 1960's to $15,000 for the past seven years. This increase in expenditures was not due to longer training periods. The average training period actually decreased from 18.6 months as of FY 1969 to 15.1 months in this survey (tables 1 and 4). Higher stipends justified by more extensive backgrounds (doctoral degrees in the physical and biological sciences) and an overall increase in postgraduate medical training stipends to a living wage during the middle and late 1960's account for most of the increase in expenditures per trainee.

The erosive effect of inflation, particularly since 1968, is a serious problem. An estimated $850,000 were spent in FY 1975 and also in FY 1967. Yet, when the dollars are standardized to the calendar 1967 dollar, the 1975 money bought only $550,000 worth of training (fig. 4). Nonetheless, expenditures per trainee per year have remained stable and expenditures per trainee and expenditures per academic graduate have decreased from 1970 to 1975 (fig. 5).

Expenditures per academician have been decreasing since 1970. This decrease is probably the result of a more efficient use of funds, since the fraction of research training grant graduates pursuing academic careers has remained constant. An alternative explanation, that decreasing expenditures per academician represent a less effective program, is less tenable, since 100 former trainees have accepted academic posts during this period (1970–75). To be sure, we will not know until 1980 how many research investigators, perhaps the most pertinent criterion of the effectiveness of the anesthesia research training grant program, will have emerged from the classes of 1970–75. The 1975 value for expenditures per academician is adjusted for the cost of training those who have not yet chosen a career because they are still in training, in obligated military service, dead, or unable to practice. The adjusted expenditure of $32,900 per academician compares favorably with an estimated annual cost of $12,600 ($9,800 in 1967 dollars) for medical student training.¶ Expenditures per research investigator (in 1967 dollars), adjusted for the cost of training those who have not yet made a career decision, are $96,400. Adjusted expenditures per grant year of NIH-funded research following the completion of training are $16,000. If a third of the 442 trainees should ultimately receive NIH awards,

¶ Halley HJ (Associate Dean, Resource Management Medicine, 234 Med. Labs/G3 University of Pennsylvania, School of Medicine, Philadelphia, Pa. 19171): Personal communication, based on The Cost of Medical Education presented to the Medical Council of the School of Medicine of the University of Pennsylvania, April 2, 1974.

the expenditure per research investigator will be $57,000. These expenditures do not include educational and training costs prior to research training.

Institutional Performance

Evaluation of institutional performance must be approached with caution, particularly the data on percentage of research investigators and expenditures per research investigator. The numbers are small when broken down by institution; hence, the variance is large. Second, the subsequent research project support categories are biased in favor of those institutions that have participated in the research training grant program the longest because of the lag time between graduation and subsequent grant awards. Nonetheless, the data are presented because they indicate that most of the institutions perform well in one or more aspects, in terms of either production of teachers or research investigators or efficient management of funds. Six universities, A, D, J, K, L, and N, show more than 60 per cent of their graduates in academic posts (table 6). Thirty per cent or more of the graduates from universities A, H, and N are research investigators. Expenditures per academician are less than $30,000 in universities D, E, J, L, and N.

Universities G and N have spent the least, $67,200 and $68,700, respectively, per NIH grant recipient. Five universities, A, B, G, H., and K, have spent less than $15,000 per grant-year of subsequent research. This lower level of expenditure may simply represent efficient operation of a research training program. Alternatively, the lower level of funding may reflect inadequate support and poor research performance. We cannot support the former or refute the latter explanation until we know how many of the trainees from these programs receive NIH funding for research projects following the completion of training. That funding is the stamp of good performance, since it follows critical peer review.

Evaluation

The yield of 20 per cent research investigators and an additional 38 per cent academicians constitutes only a qualified success for the research training grant program. To be sure, in the late 1950's and early 1960's, when there was a desparate need for academicians in anesthesia, a 60 per cent yield was interpreted as success. Today, however, when graduating trainees are spilling over to other institutions whose faculty slots are not filled, a total success for research training is not simply an academician, but a research investigator, and the yield of research investigators has been disappointing. Defined as those who have been awarded NIH grants subsequent to the completion of research training, the yield of research investigators has been 20 per cent in anesthesia versus 13 per cent in other clinical specialties (Epstein RM, personal communication). These figures require correction, not only for the people who have not yet decided what course they will follow, but also for those who show the average lag time of five to six years between completion of training and awarding of their

Table 6. Performance Indices

University	Per Cent Academic (Adjusted)	Per Cent with Subsequent NIH Grant Award (Researchers)	Expenditures in 1967 Dollars, Adjusted				
			Per Trainee	Per Trainee per Year	Per Academician	Per Subsequent NIH Grant Recipient	Per Grant Year of Subsequent NIH Funded Research
All 13 institutions	58	20	$19,000	$15,200	$32,900	$ 96,400	$ 16,000
A	67	33	36,000	11,700	54,000	108,000	2,500
B	56	17	19,400	15,500	34,800	116,000	13,300
D	71	21	19,800	13,000	27,100	90,300	25,800
E	56	12	15,900	11,500	28,600	143,000	71,500
G	50	27	17,900	17,800	35,700	67,200	11,900
H	39	30	24,600	18,900	62,500	81,100	12,500
J	70	12	11,000	11,300	15,100	88,500	19,200
K	63	18	19,200	17,200	30,100	106,000	14,100
L	86	14	16,600	14,000	17,600	106,000	35,300
M	28	7	22,300	22,000	62,400	312,000	312,000
N	88	38	25,700	20,600	29,400	68,700	22,900
O	36	7	20,300	15,000	56,800	284,000	142,000
P	42	10	23,800	16,200	56,500	226,000	25,100

The percentages of academicians and research investigators are adjusted for those who have not yet made a career decision. Expenditures per grant-year are for subsequent NIH awards and are obtained by dividing each institution's cumulative expenditures as of 1975 by the sum of the number of years of subsequent NIH grant support that former trainees of that institution received.

first grants. Perhaps the present average lag time of five and one-half years will be shortened in the future to three and one-half years because the required two years of military service are no longer a factor. The recently announced NIH grant program for new investigators[5] should further shorten the lag time between graduation and subsequent NIH grant award.

The argument that NIH grants are not the only kind of research support available has been raised. If a third have NIH research grants, presumably others will have other kinds of research support. In these calculations NIH research grants were used as a criterion because they may receive the most critical peer review of the various grants, and they may, thus, represent a kind of ultimate criterion of scientific quality.

On the one hand, we can be proud of producing an eventual yield of one third researchers, but on the other, not very proud of the two thirds of trainees who did not fulfill what was perhaps the most important mission of these grants.

How, then, can this mission be accomplished? What avenues will exist for research training in anesthesia, and how can those mechanisms be made more efficient than the old research training grant system that we have reviewed?

Two mechanisms will exist—individual fellowships and new institutional research training grants.

The utility of individual fellowships is limited because many anesthesia residents do not decide to seek research training until they are in the second, also the last, year of clinical anesthesia training—too late to apply for such a fellowship. In addition, many anesthesia residents switch institutions for research training and the circumstances of moving from one institution to another make timely application for individual fellowships impossible. A second problem limiting the effectiveness of individual fellowships as a potentially widespread mechanism for research training support in anesthesia is the lag time of nine months from application to notification of award. The prospective research fellow would have to decide upon a research career and apply for a fellowship by June 1 of the first clinical anesthesia year. Notification of award would occur in March of the second clinical year.** If the fellowship application were not funded, it would be too late for the applicant to make other plans. Thus, for this mechanism to work, there must be an institutional guarantee to support the applicant, if he is not awarded a fellowship.

New institutional research training grants, available under the National Research Service Act,[6] will serve a larger group of prospective research trainees than will the individual fellowships. The yield of research investigators and teachers will also improve because there is a payback provision now. Either time is paid back in academic work, or money is paid back. This provision will discourage those who are unsure of an academic career from accepting a traineeship. We will have more highly motivated and more definitely decided individuals going into research training under the National Research Service Act. Unfortunately, the payback provision will also discourage potential research investigators who were not quite so definitely decided.

Further follow-up study of the careers of research training grant recipients is needed to complete the data collection, to verify the accuracy of our projections, and to determine the effect of the National Research Service Act and New Investigator awards upon the yield and cost of research investigators.

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** NIGMS, Office Of Grants Administration, Washington, D. C., Tel. (301) 496-7897.

APPENDIX 1

Classification of Professional Activities

a) Still in training
b) Military service
c) Academic position—full-time academic position at a university in a department of anesthesia OR AT LEAST FIVE YEARS in such a post before leaving it.
d) Non-academic position
e) Other academic position—as in "c" above, but not in a department of anesthesia
f) Deceased—any deceased person who could not otherwise be classified in "c", "d" or "e"
g) Disabled—unable to practice because of illness and not classifiable in "c", "d" or "e"
h) Changed specialty
i) Unknown
j) Not active professionally

APPENDIX 2

Calculations Performed for Each Fiscal Year, for Each Institution and for the Entire Program

1) Cumulative awards (A_{cum})
2) Cumulative expenditures (E_{cum})
3) Per cent expenditures/awards (% E/A)
4) Per cent cumulative expenditures/cumulative awards (% E_{cum}/A_{cum})
5) Cumulative months support (M_{cum})
6) Cumulative number of postdoctoral trainees (G_{cum})
7 Expenditures per trainee (E_{cum}/G_{cum})
8) Expenditures per academician:

$$\frac{E_{cum}}{ACAD + OA}$$

where E_{cum} is cumulative expenditures, ACAD is the number of former postdoctoral trainees with an academic position in a department of anesthesia, OA is the number of former postdoctoral trainees with an academic position not in a department of anesthesia.

9) Adjusted per cent academicians:

$$\frac{ACAD + OA}{G_{cum} - (SIT + MIL + DD + DZ + NAP)}$$

where ACAD and OA have been defined above and G_{cum} cumulative number of former postdoctoral trainees; SIT is the number of postdoctoral trainees still in training, MIL is the number of former postdoctoral trainees in obligated military service, DD is the number of former postdoctoral trainees who are dead, DZ is the number of former postdoctoral trainees unable to practice, NAP is the number of former postdoctoral trainees not active professionally.

10) Number of months per trainee (M_{cum}/G_{cum}), where M_{cum} is the cumulative number of months of support and G_{cum} has been defined above.
11) Adjusted expenditures per research investigator equal (total expenditures in 1967 dollars minus expenditures for trainees who have not yet made a career decision) divided by the number of research investigators. For the entire program, this calculation is

$$\frac{\$8{,}390{,}000 - 66(\$19{,}000)}{74} = \$96{,}400.$$

12) Adjusted expenditures per grant year of subsequent NIH-funded research equals (total expenditures in 1967 dollars minus expenditures for trainees who have not yet made a career decision) divided by grant years. For the entire program, this calculation is

$$\frac{\$8{,}390{,}000 - 66(\$19{,}000)}{446} = \$16{,}000.$$