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Factors Contributing to Current Distress in the Academic Community

The growth of the NIH extramural program from 1960 to 1970 is analyzed.

Thomas J. Kennedy, Jr., John F. Sherman, R. W. Lamont-Havers

An analysis of the fiscal history of the National Institutes of Health (NIH) through the 1960's was undertaken in an attempt to explain the disproportion between the recent variations in NIH funds for biomedical research and the stress and perturbation currently experienced throughout the academic community.

The institutes and research divisions of NIH (later abbreviated I/RD) obligated more funds for the support of research each year of the decade until fiscal year 1970, when obligations declined by 5 percent, and an increase in appropriations for the next fiscal year has permitted obligations in excess of those for 1970 by about 15 percent. The distress of the academic community, however, is due to quite tangible constraints and dislocations imposed by three principal factors: sudden deceleration of program growth; inflation, sometimes exceptional in the biomedical sphere; and marked variations in the funding of NIH components, each receiving separate appropriations from the Congress.

During the decade, there have been a number of organizational changes, such as the creation of new institutes and divisions—National Institute of General Medical Sciences (NIGMS), Division of Research Resources (DRR), National Institute of Child Health and Human Development (NICHD), National Institute of Environmental Health Sciences (NIEHS), National Eye Institute (NEI), and Division of Regional Medical Programs (DRMP)—both newly established and as a result of internal reorganization; the separation of components from NIH—DRMP and National Institute of Mental Health (NIMH); and the addition of new components—Bureau of Health Manpower Education (BHME) and National Library of Medicine (NLM). All fiscal data included in this report have been adjusted for these changes to ensure consistency and compatibility.

Budgetary History

The NIH budget from fiscal year 1960 through 1970 is presented in the aggregate, with several subsets that are of interest (Table 1).

1) Many of the tabulated data are derived directly from budget activity schedules and are self-explanatory: regular research grants, special program grants, general research support grants, research contracts, training grants, fellowships, and research facilities construction grants.

2) The total of these obligations—extramural program (I/RD)—is a comprehensive measure of current operating support to grantee institutions and of long-range capital investment in their people (through training awards) and their space (through construction grants).

3) Obligations for academic science include research, training, and facilities awards to academic institutions.

4) A subset of these—awards to medical schools by the institutes and research divisions of the NIH—is available only from fiscal year 1967 to date. Prior to that time, the series included awards to medical schools from NIH as well as the current components of the NIH. The formidable clerical task of stripping out the former data from the time series has not been completed. The combined NIH-NIMH data from fiscal 1960 to 1970 is still of consider-

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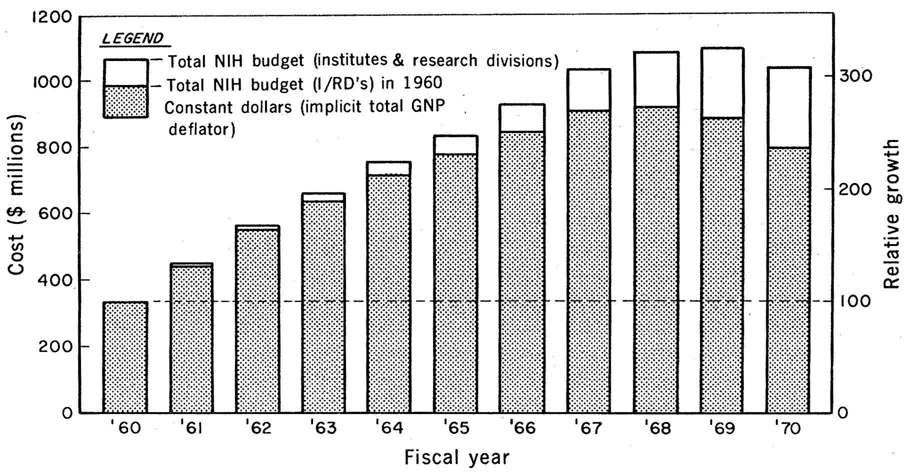


Fig. 1. Total NIH obligations: institutes and research divisions, 1960–70.

able interest and hence is included in Table 1.

In Table 2, major elements from Table 1 have been selected and normalized to reflect fiscal year 1960 as representing 100. The general patterns of growth are discernible, although the fairly large composites presented here tend to obscure the more precipitate changes in some of their elements visible in Table 1. For example, the category of special program grants began only in the decade covered and grew rapidly and steadily until recently, whereas health research facilities grants had a meteoric decline.

Figure 1, derived from Tables 1 and 2, illustrates the patterns of growth. The aggregate growth in actual dollar level of most of the tabulated activities was steady and positive until about fiscal 1967. Since then, changes have been small. Most elements decreased in fiscal 1970.

Toll of Inflation

Fiscal obligations are the most readily available index of the principal mission of the NIH—the support of the nation's biomedical research program. The basic program elements, such as people, institutions, and projects, are complex mixes, and it is difficult to find simple and meaningful characteristics that can be accurately measured. Obligations, however, reflect at least roughly the level of program activity supported and can be refined further to approximate the real state of affairs by taking into account several factors that modulate the extent to which total obligations are indicative.

One refinement is to correct dollar growth for simple price inflation. The implicit price deflator for the total gross national product (GNP) is used throughout this article to convert "current" to "constant" dollars (see Table 2 and Figs. 1–3). By this index, price inflation was modest until 1967, averaging about 3 percent per year. Annual increases thereafter have been between 5 and 6 percent.

The activities supported by the NIH, such as research and research training, include salaries of research and other personnel as their major (60 to 75 percent) cost element. There is evidence that salary scales have risen at rates considerably in excess of general price inflation.

Each year, the Association of American Medical Colleges solicits and publishes data on the median salaries of "strict full-time" faculty (*1*). Between 1964 and 1970 the annual compound rate of increase in salaries for all faculty positions in eight clinical science

Table 1. NIH obligations for various budget categories, fiscal years 1960–70 (in millions of dollars).

Budget category	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Total budget (I/RD)*	337	451	566	662	756	837	929	1034	1085	1095	1038
Total extramural program (I/RD)	283	383	499	574	656	729	806	909	947	946	881
Total extramural research	192	265	364	414	474	519	579	684	719	728	702
Regular research grants	163	202	266	305	351	370	402	444	456	455	437
Special program grants †	10	27	49	41	52	56	79	104	111	116	110
General research support grants		13	18	26	30	39	39	45	54	53	50
Research contracts	20	23	31	36	41	54	58	90	97	105	105
Training grants	49	70	77	86	98	106	124	134	135	142	131
Fellowships (and career awards)	13	18	23	30	35	40	45	49	52	55	48
Research facilities construction	29	30	36	50	50	65	59	42	41	22	0
Total academic science (I/RD)	211	292	372	434	492	554	610	690	710	724	647
Research	137	189	255	292	338	372	413	483	510	529	486
Training and fellowships	54	77	88	103	115	127	148	163	166	176	161
Facilities construction	20	27	29	39	39	55	49	35	35	19	0
Total medical school academic ‡ science (NIH and NIMH) §	145	209	280	302	357	397	439	482	478	508	483
Research	92	131	195	207	241	262	287	325	314	348	338
Training and fellowships	40	58	65	79	94	103	121	138	142	154	145
Facilities construction	14	21	21	16	22	32	31	18	22	6	0
Total medical school academic science (I/RD)	NA‖	NA	NA	NA	NA	NA	NA	436	429	452	425
Research	NA	NA	NA	NA	NA	NA	NA	308	295	327	315
Training and fellowships	NA	NA	NA	NA	NA	NA	NA	110	112	119	110
Facilities construction	NA	NA	NA	NA	NA	NA	NA	18	22	6	0

* Total budget excludes foreign currency program (P.L. 480). † Special program grants includes P.L. 480 funding. ‡ Includes schools of osteopathy for 1969–70. § Includes I/RD's, BHME, and NLM. ‖ Figures not available.

Table 2. NIH obligations for various budget categories, fiscal years 1960–70, in current and 1960 constant dollars, normalized to 1960 = 100. The implicit price deflator for total gross national product (GNP) (1960 = 100) is utilized to convert current to constant dollars. Normalized constant dollars are shown in parentheses.

Budget category	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Total budget (I/RD)	100	134	168	196	224	248	276	307	322	325	308
	(100)	(132)	(164)	(189)	(213)	(231)	(250)	(270)	(272)	(262)	(236)
Total extramural progam (I/RD)	100	135	176	203	232	258	285	321	335	334	311
	(100)	(134)	(172)	(195)	(220)	(240)	(258)	(282)	(283)	(270)	(238)
Total extramural research	100	138	190	216	247	270	302	356	374	379	366
	(100)	(136)	(185)	(208)	(234)	(252)	(273)	(313)	(316)	(306)	(280)
Training grants	100	143	157	176	200	216	253	273	276	290	267
	(100)	(141)	(153)	(169)	(190)	(202)	(229)	(241)	(233)	(235)	(204)
Fellowships (with career awards)	100	138	177	231	269	308	346	377	400	423	369
	(100)	(138)	(169)	(223)	(254)	(285)	(315)	(331)	(338)	(338)	(285)
Total academic science (I/RD)	100	138	176	206	233	263	289	327	336	343	307
	(100)	(136)	(172)	(198)	(221)	(245)	(262)	(287)	(284)	(277)	(235)
Total medical school academic science (NIH and NIMH)	100	144	193	208	246	274	303	332	330	350	333
	(100)	(142)	(188)	(201)	(234)	(255)	(274)	(292)	(279)	(283)	(255)

departments and in basic medical science departments was 6.0 percent. The annual rate of growth ranged from 4.4 percent for chairmen of departments of psychiatry to 8.1 percent for associate professors of radiology. The overall increase in faculty salary rates clearly exceeded that of simple price inflation, as demonstrated in Fig. 2.

In September 1970 the staff of the National Cancer Institute (NCI) surveyed a sample of five important grantee institutions (and 12 major NCI contractors) to obtain data on changes in the cost of performing research during the period 1968–70. Grantee institutions reported annual increases of 6.8 percent for salaries, 7.3 percent for supplies, and 7.7 percent for equipment. Salaries accounted for 60 percent of their research costs.

The rapid increase in faculty and research salaries could reflect inflationary pressure occasioned by the rapid infusion of federal research funds. Evidence that salary increases in cognate areas approximate what could be expected from simple price inflation (base salary × GNP deflator) would tend to support this hypothesis.

Data collected by the Internal Revenue Service (IRS) (*2*), however, indicate that the professional income of physicians (either in solo or partnership practice) has escalated much more rapidly than price inflation and a little more rapidly than the salaries of medical school faculty (Fig. 2). These data suggest that the primary force pushing up academic faculty salaries has been competition for medical personnel in short supply rather than the increase in funds for research, reflecting the reality that medical school salaries must be competitive with income from the practice of medicine if the schools are to recruit and retain clinical faculties.

Although no comprehensive data are available on biomedical research salaries in industry, the NCI data mentioned above indicate comparability with the IRS data on physicians. The NCI contractors reported annual increases of 8 percent for salaries and 4 percent for supplies and equipment. Salaries accounted for 70 percent of their research costs. Again it would appear that salaries in areas comparable to, but little affected by, NIH programs have mounted faster than costs in general, contributing to the stresses on the academic community.

Several other items that constitute substantially large cost elements in research budgets should be identified as taking a toll probably in excess of that reflected in simple price inflation.

A measure of hospital cost increases may be gained from NIH experience in supporting clinical investigation. Special research grants for the support of general and categorical clinical research programs account for a significant portion of NIH research expenditures. An additional large amount of clinical investigation is performed under regular project grants, where patients hospitalized in "scatter beds" are studied. Over the last 5 years, the General Research Center program alone has supported an

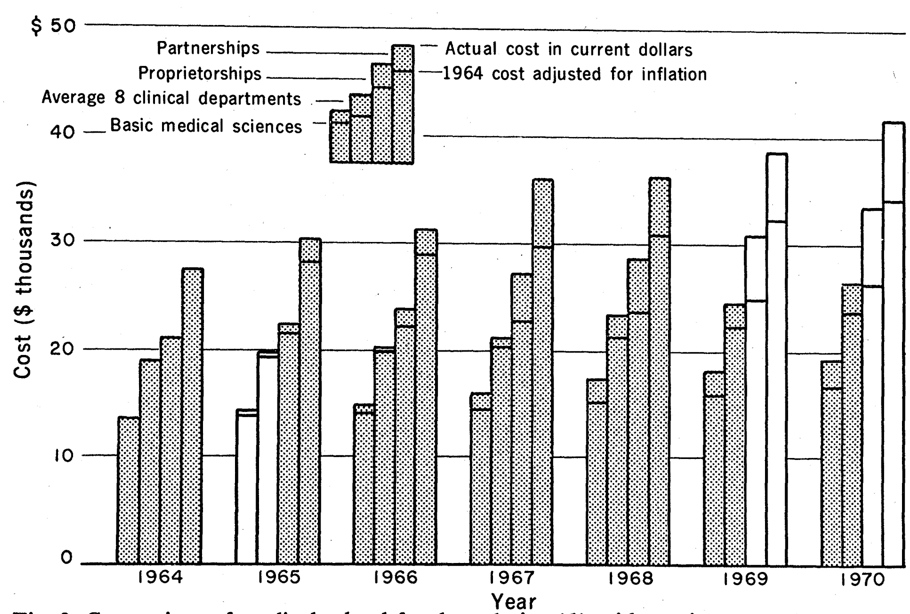


Fig. 2. Comparison of medical school faculty salaries (*1*) with net incomes of practicing physicians (*2*). Actual average figures are shown, with the exception of medical school faculty salaries for 1965 and net incomes of practicing physicians for 1969 and 1970 (blank bars). For these years, approximate figures are based on the average annual growth rate of 6.0 for faculty salaries between 1964 and 1970, and of 8.0 and 7.2 for net income of physicians in proprietorships and partnerships, respectively, between 1964 and 1968. Values for 1964 costs adjusted for inflation were obtained by applying the total GNP deflator to the 1964 base for each category.

Table 3. Growth in direct costs of general clinical research centers, fiscal years 1965–70.

Budget category	Cost in dollars					
	1965	1966	1967	1968	1969	1970
Personnel*	45	48	55	63	71	
Hospitalization*	41	46	50	56	63	69†
Other operating expenses	4	4	4	4	4	
Total direct costs*	90	98	110	122	138	

* Cost per patient day. † Calculated on 80 centers in 1970 after 13 centers were closed. Comparable data on personnel costs not available.

average of about 1000 beds (or a capacity of about 365,000 patient-days of hospital experience). Table 3 illustrates the increase in the direct costs of operating General Clinical Research Centers, which include the costs of faculty, nurses, other patient-care personnel, and hospitalization. Together these account for about 95 percent of the direct costs incurred by the centers. Figure 3 illustrates the national average growth in daily service charges of all hospitals between 1960 and 1970 (*3*). Clearly, the toll here far exceeds that of general inflation.

The growing complexity of science has not only stimulated the development of increasingly complex instrumentation, but has also been a consequence of such development. Indeed, the fact that new instruments make possible the measurement of new properties of systems leads to the formulation of hypotheses that would not have been seriously advanced or even conceived in the absence of appropriate measuring devices for testing them. Progressive improvement in instrumentation has occurred, for example, in the field of microscopy, and has entailed considerable increases in cost. The digital computer, to mention another example, has come to play a large role in biomedical research in the last decade. While costs for performing routine calculations have been reduced, greatly increased costs usually attend research in which the computer becomes an integral part of the instrumental ensemble, permitting execution of experimental procedures otherwise impossible.

The period since World War II has been one of rapid expansion of the national as well as federal investment in research. This growth has brought large numbers of young investigators into the biomedical sciences. As these scientists mature and assume increasing responsibility, salary increases occasioned by promotions and advancement in faculty rank are superimposed on basic salary adjustments for cost of living or price inflation or both. This phenomenon has consumed a substantial part of the increments in NIH obligations.

Toll of Indirect Costs

In the domain of research, the indirect is as real and necessary a cost as the direct. Indirect costs have posed a difficult problem for many years. In the early days, when the level of NIH support was low, project research could usually be accommodated within a grantee institution's existing program activities, and the incremental overhead costs were small. As research assumed larger proportions, however, arbitrary federal limitations on reimbursement for indirect costs resulted in more significant burdens on performing institutions.

In lieu of reviewing the long and involved history of this issue, the following summary may be made. With respect to research project grants, the NIH from 1955 to 1963 limited overhead to 15 percent of total direct costs. In 1963 the limit was fixed at 20 percent of allowable direct costs, which in practice worked out to about 16 percent of total direct costs. In 1966, in a major policy shift, the NIH began to pay full indirect costs and to require grantee institutions to share with the government in the total cost of each project. The basis for the rise in indirect costs is complex and not well understood. Several factors have been implicated, but not clearly defined, nor has their relative importance been assessed. They include better identification of costs through more effective systems for grantee management, as well as inflation.

Table 4 shows the direct, indirect, and total amounts awarded in research grants from 1965 to 1970. Total costs under grants have grown faster than direct costs, reflecting the rapid rise in indirect costs during the past 5 years. The rate of increase in total costs—a less accurate index of program activity than direct costs—overstates the rate of increase in program level. While the NIH favors payment of full indirect costs to grantee institutions, implementation of this policy reduces the amount of research that can be purchased at any given level of funding. If this reduction alone is added to the toll taken by inflation, the level of program activity for 1970 as reflected by direct costs is well below that for 1965. Thus, the decade of the 1960's saw an impressive rise followed by a sharp decline in the actual quantity of biomedical research supported by the NIH.

Table 4. Growth in indirect costs of research grants of the ten NIH institutes, fiscal years 1965–70, excluding NIH grants for general research support, general clinical centers, animal centers, and other special research resources administered by the Division of Research Resources. Total direct and indirect costs and total awards are shown in millions of dollars.

Budget category	1965	1966	1967	1968	1969	1970*
Total direct costs	332	370	410	411	399	379
Normalized to 1965 = 100	100	111	123	124	120	114
Total indirect costs	54	63	80	92	101	104
Normalized to 1965 = 100	100	117	148	170	187	193
Total awards	386	434	490	503	500	483
Normalized to 1965 = 100	100	112	127	130	130	125
Indirect costs (percent of direct)	16	17	20	22	25	28

* 1970 estimates = funds available for obligation; excludes OMB reserves.

Pressure of Expanded Research Potential and Need

Curtailment of available funds has coincided with an expanded potential for research, generated by the growth of grantee institutions, programs, and the pool of candidate investigators. The full measure of the pressure resulting from this potential is not necessarily reflected in the volume of applications for research grants, because express demand tends to track availability of funds and to shrink in the face of tight budgets.

The number of trained scientists qualified for and expecting careers in biomedical research has grown remarkably in the last decade. Data from the U.S. Office of Education (*4*) show that total graduate enrollment in the biosciences increased from 14,774 to 34,861 between 1960–61 and 1970–71. The number of Ph.D. degrees conferred in these same disciplines increased from 1193 to 3418 (*5*). Cumulatively, a substantial number of doctoral-level scientists have been added to the research manpower pool over and above what could have been foreseen from 1960-level activity. Many of these have joined the nationwide competition for research support.

A parallel growth has occurred in the number of physicians who have received research training experience during the course of their postdoctoral education and have since sought support for independent research. Enumeration of this group is difficult because it is not subject to a labeling procedure, as is the award of a doctorate. Between 1963 and 1970 the NIH supported, through the mechanism of training grants and fellowships, an annual average of approximately 4500 physicians. Almost four-fifths of those were fellows and full-time trainees. Past experience indicates that about half terminate training each year and, if opportunities arise, enter research rather than medical practice.

The number of institutions awarding advanced degrees has expanded. Since research is *the* method of graduate education in the sciences, these institutions have, by their very existence, expanded the competition for available research funds. In the 1960's, about 20 new medical schools were created in this country. Each has recognized that a modern science-based medical curriculum demands a vigorous, high-quality research program of at least modest proportions.

During the 1960's a large number of problem areas potentially amenable to scientific approaches emerged, and many of them come within the purview of the NIH. Notable are population, mental retardation, human development, environmental hazards, child health, alcoholism, drug abuse, occupational health and safety, and the organization and delivery of health services. Each of these fields is in competition for health research funds.

Role of Organizational and Managerial Factors

Changes in the overall NIH budget and the impact of such changes on the aggregate level of supported research provide only a partial description of factors which NIH introduced and which bear directly on the academic biomedical research community. Superimposed on the aggregate and average effects on research are specific events resulting from: interplay among the overall policies and procedures of the NIH, the individuality of each of its component institutes and the consequent inter-institute variability, and externally imposed rigidities and transients. The impact of these factors may be experienced with disproportionate severity by certain constituencies, and individuals or institutions may perceive incomprehensible inequities.

Yet the occurrence of unusual events from time to time can only be expected in view of the magnitude, diversity, and complexity of the effort conducted by the NIH. The research component of the agency operates with 12 separate appropriations; processes about 8000 competing research grant proposals each year, not to speak of applications for about 7500 noncompeting research grants, about 3000 graduate training grants, and about 6000 fellowships and career awards; and utilizes 50-odd study sections plus a roughly equivalent number of other initial review groups to evaluate proposals. The challenge of coordinating this vast process of fund allocation resides in the fact that the purposes for which support is sought are discrete yet highly interrelated.

In the overall governance of the NIH, a style of operations which developed over the last quarter-century forms a backdrop that should be kept in mind in examining specific causes of distress in the academic community.

Research grant applications submitted to the NIH are processed through three screens: one for NIH-mission relevance by the NIH staff; one for scientific priority by study sections; and one for program priority—pertinence to the individual missions of the supporting institutes—by the national advisory councils. The study section review accords a numerical score to each application deemed worthy of an investment of federal funds; the advisory council action modifies that assessment in a variety of ways by introducing what amounts to a weighting coefficient. Recommendations emerge from the review process on the appropriate funding and duration of each project. The order of payment of approved applications is determined by the modified priority score.

There are three cycles of review in each fiscal year. Institute directors with the advice of their national advisory councils must develop a strategy for obligating equitably the funds appropriated, with a view to supporting the most meritorious of the approved applications whenever received during the fiscal year.

More than two decades ago the NIH established a policy of funding out of current-year appropriations only the first year of a multiple-year award, and of according to continuation applications under these awards the first claim on funds appropriated in subsequent years. These continuations were re-

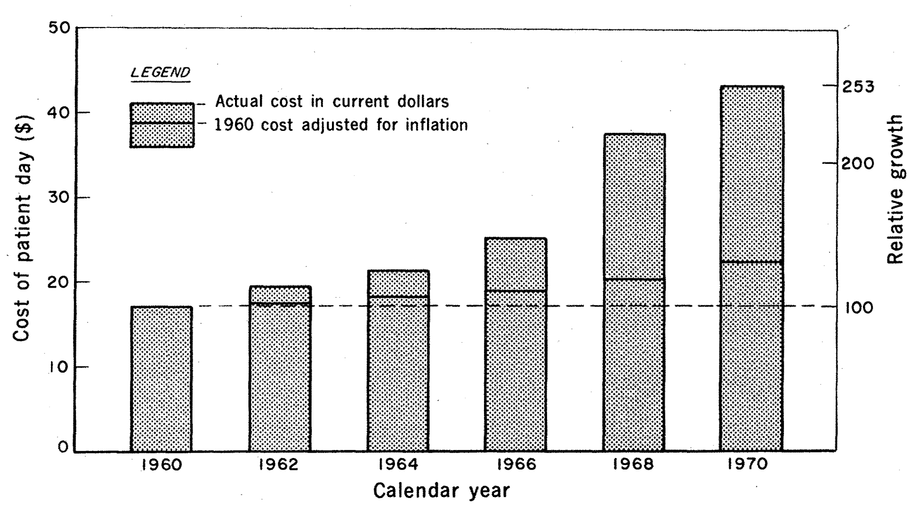
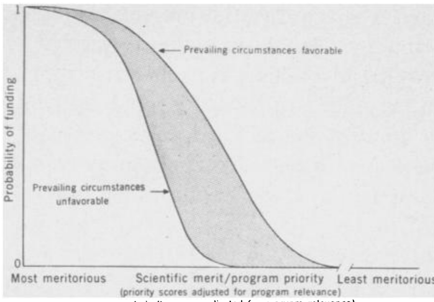


Fig. 3. Growth of hospitalization costs, 1960–70; national average of daily service charges per patient (adult patient, two-bed room, short-term stay) (*3*).



(priority scores adjusted for program relevance)

Fig. 4. Probability that an approved competing proposal will be funded.

garded as moral commitments. The discretionary funds available to an institute in any given year are those remaining after the moral commitments have been honored.

As a matter of sound management, the NIH staff, through periods of committed support, has negotiated awards upward or downward as warranted by progress in the conduct of a project and within limits established by the national advisory councils. Such negotiations are in no way incompatible with the policy of honoring moral commitments.

The NIH has sought continuously, within limits imposed by the review process, to expand the number of institutions engaged in biomedical research. As a consequence, an examination of the distribution of NIH research support among institutions reveals a heavy concentration of funds in a relatively small number of institutions characterized by general excellence in science, together with a very broad dispersion of relatively small amounts of funds to a large number of institutions. During periods of fiscal retrenchment, institutions with modest support are vulnerable in many ways, and over the last few years a number of them have lost all NIH funding.

Since 1937 a series of legislative and administrative actions have expanded the single National Institute of Health to include ten categorical institutes and several research divisions under the umbrella of a central administrative organization known as the National *Institutes* of Health. The cumulative effect has been to transform a small federal laboratory into an agency that accounts for more than half of all federal, and about a third of all national, support for biomedical research. Funds are appropriated by the Congress each year to the individual institutes, not to the umbrella organization; and transfer of appropriated funds from one institute to another is for all practical purposes impossible. Each of the institutes has a unique history and growth pattern of its own.

A more detailed examination of the factors that account for the variability between institutes, and a more specific illustration of the consequences of these variations on individual investigators, grantee institutions, and fields of science, will help to illuminate the phenomena that are causing distress.

Growth patterns in obligations by the individual institutes have varied significantly. In the past, almost three-fourths of the total funds available to an institute for research grants has been used to honor committed continuation projects; only the remainder has been available for competing applications. The funds awarded for noncompeting applications have tended to increase annually for almost every institute. Hence, for the several institutes whose total funds available for obligation declined, there was a disproportionately severe decrease in the support for competing projects (Table 5).

The noncompeting funding requirements are analagous to the obligations categorized as "uncontrollable." They are made up not only of moral commitments in the usual sense of the term, but also of grants in support of complexes called "centers" and "resources." The programs, emphasized in recent years, that these instruments support are broad, the objectives long-range, and the fiscal requirements large. Thus, resources and centers once initiated are more likely than regular projects to be sustained in subsequent competition for renewal.

Table 6. Percentage of research grant funds from the ten NIH institutes, by type of grant, fiscal years 1967–70.

Year	New	Renewal	Noncompeting	All
1967	23	9	23	21
1968	23	17	24	23
1969	19	22	26	25
1970	16	25	28	26

The cost of sustaining these large projects has risen each year. Since the total research grant funds available to the ten institutes and the Division of Research Resources have been relatively constant for the past several years, an increasing proportion of those funds would be expected to go for support of the large projects, not because of recent new starts but merely to sustain existing programs. Table 6 shows the percentage of each type of research grant funds.

The net effect of these commitments to grants for resources and centers is to increase the uncontrollable expenditures and to decrease the discretionary funds for new and renewal awards. The level of available discretionary funds varies from institute to institute and from year to year; it reflects, in part, conventional moral commitments and, in part, the unique history of each institute's utilization of centers and resources to achieve its specific mission.

Recently a smaller proportion of new grant funds has been awarded for program projects and centers, indicating a shift to the support of regular (and less costly) research projects. The rate at which this general trend is occurring varies from institute to institute. It is largely dependent on the extent to which the organization is involved in long-range commitments and the options open to it to modify its approaches in the light of the probable consequences of a policy change.

As the program scope of the several institutes has evolved, some have tended to become increasingly the major source of support for specific fields and disciplines. Thus the fortunes of those domains of science and the "patron" institutes tend to rise or fall together.

Other disciplines and fields derive support from several categorical institutes. Thus, with differential growth in institutes, investigators of equivalent

Table 5. Research grant awards from four institutes by type of grant, fiscal years 1967 and 1970.

Institute	Millions of dollars: Noncompeting funds 1967	Noncompeting funds 1970	Competing funds 1967	Competing funds 1970	Percent of total for competing 1967	Percent of total for competing 1970
NICHD	24.0	26.9	12.8	13.2	35	33
NIAID	29.0	32.0	17.5	17.1	38	35
NCI	48.5	53.9	22.1	17.5	31	25
NHLI	68.7	66.4	27.7	20.0	29	23

caliber may experience different success in obtaining support, reflective of the fortunes of the institute within whose program scope their work falls. Oncogenic virology, for example, will probably fare better than virology in general for the next few years as a result of the rapid growth in funds for cancer research.

Certain grantee institutions, especially free-standing research organizations with a heavy categorical focus, come to derive the major fraction of their total support from a single institute. Grantee institutions with small total support, based on isolated islands of scientific excellence, also tend to be funded by a single institute. Here again the fortunes of a grantee institution and an institute become coupled, and the special vulnerability of the grantee institution in times of fiscal constraint is obvious. In the years 1967 to 1970, the total number of institutions of higher education receiving NIH research grants declined successively from 330 to 316, 299, and 277.

The fate of a particular competitive application is dependent not only on funds available to support it but also on the amount of competition it must face within the institute to which it is assigned. At any time, the total flow and distribution of new, competing renewals and noncompeting continuation grants differ for each institute and may depart significantly from the aggregate pattern for the NIH as a whole.

Each of the approximately 50 study sections has a discrete pattern of response to the new and renewal applications it reviews. Since the study sections tend to be organized along disciplinary lines, and the institutes along lines of categories of disease, each study section reviews applications assigned to many institutes (though most are related to a few institutes). The result is that the approval rates which the initial review groups (IRG's) accord a group of applications vary by institute and over time.

Approval rates of renewal applications have been consistently greater than have those of new applications. This is to be expected, since each renewal application represents a project that once competed successfully as a new application. The winnowing process has already selected the applicant as a more promising investigator than his unsuccessful former competitors. In the context of this discussion, the fate of an application, viewed statistically, is related to whether it is a new or renewal proposal.

Table 7. Number of competing and noncompeting grants of the ten NIH institutes, fiscal years 1962–70.

Year	Competing	Noncompeting	All projects
1962	4,573	7,509	12,082
1963	4,387	8,144	12,531
1964	3,966	8,475	12,441
1965	3,766	8,457	12,223
1966	3,494	8,476	11,970
1967	3,879	7,992	11,871
1968	3,023	8,092	11,115
1969	3,324	7,596	10,920
1970	2,605	7,226	9,831

The variable pattern of IRG behavior is reflected not only in approval rates but in the distribution of priority scores for approved applications. Moreover, within a single IRG, dynamic trends are occasionally discernible as the membership changes, as the field matures or goes into eclipse, or as other forces supervene. The net result is further inter-institute variation in the scientific-merit priority scores.

Each institute has a distinct mission or missions, usually categorical, as in cancer, heart, or arthritis. Therefore, its program director, with the assistance of the members of its national advisory council, must develop a plan for attaining the central goals of the organization. This strategy results in emphasis on certain fields or disciplines or areas of science. Thus, proposals of roughly equivalent scientific merit (understood in the light of the previous discussion of variation in IRG behavior) are adjudged as more likely to advance the missions of an institute if they are in certain fields. Conversely, applications of equivalent merit from a specific field are likely to be assigned different program priorities by different institutes. Thus, in each cycle of review, the number of competing applications received by a given institute varies absolutely and in relation to that of other institutes. Moreover, the prospects of award are modulated by complex influences exerted by study sections, national advisory councils, and institute program objectives.

Table 8. Funding rates for new and renewal research grant proposals, National Institute of General Medical Science (NIGMS) and all NIH institutes, fiscal years 1967–70 (percentage of IRG-approved proposals funded).

Fiscal year	New proposals (%)		Renewal proposals (%)	
	NIGMS	NIH	NIGMS	NIH
1967	53	74	67	80
1968	29	57	46	73
1969	49	63	68	70
1970	13	42	32	60

External Limitations

From time to time unexpected interruptions, limitations, and contingencies arise to create managerial problems.

Occasionally an item in a budget is earmarked for a narrow, highly specific objective. This dedication of funds may occur within the Executive Branch during the development of the President's budget or may be imposed by the Congress. The effect is an expansion of uncontrollable expenditures and a reduction of funds for flexible and discretionary use. By its very nature, limitation of this sort can have an impact that may well seem capricious.

The NIH grew at a rather steady rate for many years, and its procedures and processes were based on and geared to such a growth pattern. Patterns of experience, expressed in operating statistics, for projecting future management of the agency's responsibilities necessarily reflected this history. The relatively sudden cessation of growth which began in the late 1960's required adjustments to a new set of expectations, reexamination of the total set of policies that had developed since about 1950, and decisions on long- and short-range modifications of policies, procedures, and practices. Action pursuant to such decisions tended to be applied in situations already scheduled for action according to existing timetables—for instance, competing grants—rather than across the board, in order to avoid destabilizing the entire biomedical research community. Thus, as noted above, a shift away from emphasis on long-term grants was first manifest from action on new and renewal grant applications, but the full extent and impact of this trend will not be apparent until all grants of this type reach the end of their project period and reenter national competition. Since each institute has different requirements and thus different proportions of such grants, and somewhat different expectations, the pace and extent of change have varied.

From fiscal year 1962 through 1968, the research grant funds awarded by the

Table 9. Factors determining whether a scientifically meritorious competing proposal will or will not be funded by the NIH.

Extrinsic to the NIH

Proposal relates to program with a large/small public constituency.

Related to program having/not having presidential, congressional, or departmental priority.

Line item/no line item in budget for program.

Submitted during period of rapid growth/stability or decline in funding institute.

Intrinsic to the NIH

Processed by a study section disposed to give high/low priorities.

Area of high/low institute program priority.

Competing renewal application/new application.

Submitted to a funding institute with a small/large number of long-term commitments (centers, program projects) and relatively great/little flexibility.

Funding decision coincident with time when many/few options are open within annual funding strategy of patron institute.

Related to a field or discipline widely regarded as undersupported/oversupported in scientific or program terms.

Proposal relatively original/unoriginal; comparable ones are not/are in competition; little/much related work in progress.

ten research institutes (or their predecessor units) increased steadily from \$332 million to \$503 million. In 1969 and 1970 the total amount decreased somewhat, reaching \$483 million. Table 5 indicates the trends in the number of competing (new and renewal) and noncompeting projects supported by the ten institutes.

Competing awards declined sharply between 1967 and 1970. The year 1969, however, was exceptional, probably because the NIH, faced with what was first thought to be a transient curtailment of funds, decided to modify its policy of moral commitments and to negotiate all noncompeting awards downward to an average extent of 10 percent beyond normal negotiations required by sound management. This action was intended to maintain as many investigators as possible through a period of crisis. Moreover, the NIH could not have reasonably complied with the ceiling on expenditures imposed by the Congress through the Revenue and Expenditure Control Act of 1968 (P.L. 90-364) without limiting the obligations for noncompeting grants.

In the following year, the attenuation of growth seemed likely to continue. Hence, the NIH decided to curtail arbitrary across-the-board negotiations and to resume insofar as possible its long-standing policy of supporting projects with the highest program priority minimally but adequately, relegating to a secondary role the objective of maintaining stability throughout the biomedical research community.

The fiscal stringency experienced since 1969 has exposed previously masked consequences of the early NIH policy decision to support research through the funding of individual project proposals. In essence, a project system embodies the principle of cost reimbursement: the amount awarded reflects the best peer judgment of the reasonable costs required to complete work of the scope proposed. Thus it makes little sense to provide less than full support, notwithstanding the impulse to spread available funds among all approved proposals during times of fiscal stringency. Recognizing this, the NIH proposes to all but eliminate arbitrary negotiations of moral commitments by fiscal year 1972.

The experience of 1969 illuminates the fact that two NIH policies, both widely regarded as highly desirable—to honor moral commitments and to fund approved applications by rank order of program priority—while quite compatible when budgets are rising, come into sharp conflict under contracting fiscal circumstances. It also reveals that honoring moral commitments increases the uncontrollables and thus restricts during periods of fiscal stringency the funding of new or renewal projects of equivalent scientific but higher program priority.

Between 1962 and 1968 other factors that contributed to the reduction in the number of projects were the trend toward larger projects in which several small ones were consolidated, and the more rapid growth in the unit cost of research than in funds available. This situation was brought about because of inflation, technological complexity, investigator salaries, and indirect costs.

The net result of the operation of all the factors discussed is reflected in the number of approved projects that a given institute funds. Recent trends for one of the institutes, compared here with the total experience of the NIH, reveal the pattern illustrated in Table 8. Comparable data for all the institutes show wide variation, not only in comparison with other institutes but from year to year. Even the cumulative effect for the entire NIH shows striking changes over a period of only 3 years.

In the light of this analysis, it is possible to outline the circumstances under which an application of high intrinsic scientific merit would have the greatest or least probability of funding (Table 9).

The abstract graphic representation

Table 10. Summary of NIH research obligations by program, fiscal years 1970–72 (estimated). Budget authority in millions. Excludes P.L. 480 programs and NIMH portion of general research support grants.

Institutes and research divisions	1970 (comparable)	1971 (estimated)	1972 President's budget (final)
Total budget (I/RD)	\$1,012.5*	\$1,166.3*	\$1,291.8
Allergy	94.1	98.1	99.3
Arthritis	128.4	134.4	135.4
Biologics standards	7.9	8.7	9.0
Cancer	179.0	230.5	234.3
Child health	75.4	93.7	103.2
Dental	28.3	34.7	38.8
Eye	24.2	30.4	32.6
Environmental health	17.2	20.0	25.3
Fogarty International Center	3.2	3.7	3.3
General medical sciences	142.9	154.5	150.4
Heart	156.7	191.6	195.5
Neurology	92.7	99.5	96.5
Research resources	62.7	66.4	68.1
Cancer conquest program			100.0

* Reflects comparative transfer of \$23 million from the institutes to BHME for research training grants.

in Fig. 4 indicates that at any given state of NIH affluence, an application of given priority will encounter a range of probabilities of funding depending on a number of prevailing circumstances. Most applications processed through the system encounter a mixture of factors, some enhancing, some reducing the probability of success. Rarely are the circumstances all unfavorable. Individuals, grantee institutions, or the research community in general may infer from the improbable case that the system is basically given to capricious or idiosyncratic behavior, an impression reinforced by the tendency for memories of such events to accumulate and persist.

Neither the available data nor the more subjective analysis of Fig. 4 conveys adequately the impression, strengthened by recent events, that inherent conflicts between competing and equally meritorious goals in a federal support program can become crucial when funds are curtailed. Support of innovative ideas, which tend to be risky, competes with support of lines of proven productivity; and mission relevance, with scientific merit.

Discussion and Conclusions

The data presented in this analysis identify the major bases for the concerns that have been aroused in the biomedical research community. While the total budget for research, measured in current dollars, remained about level from fiscal year 1967 to 1970, the amount of research supportable with these dollars undoubtedly declined considerably. Particularly was this true of the salaries of the professional personnel who carried out the investigations. For example, the rate of increase of salaries of medical school faculty has exceeded the toll attributable to inflation, and the NCI study indicates that this may also be true of the salaries of investigators in industry. As a consequence, the actual quantitative level of research declined even more rapidly than the direct costs measured in constant dollars (Table 4).

The leveling off of biomedical research funding coincided with an expansion of potential for research performance, attributable to an increase in the number of scientists and of institutions granting the doctoral degree, as well as to an expansion of the scope of problems viewed as appropriate for support from public funds.

The sheer magnitude and complexity of the NIH budget and the logistics of managing it have occasioned unexpected year-to-year and institute-to-institute vagaries, the impact of which becomes most apparent when operating in conjunction with budget restrictions.

The research community has experienced considerable difficulty and major disruptions in coping with these problems. Moreover, the decreases, both substantial in magnitude and relatively sudden, have occurred as other costs of operating institutions that are performing research have risen. The institutions are additionally subject to the stresses of a greatly increased demand for their special capabilities and resources.

Epilogue

In January 1971 the appropriation act for fiscal year 1971 was signed into law, and in February the President's budget for fiscal 1972 was published. The latter document indicated that the Executive Branch plans to obligate virtually all the funds appropriated for fiscal 1971.

In Table 10 fiscal 1970 obligations are compared with estimates for 1971 and requests for 1972. The data are internally compatible, but for reasons of accounting use a different format, embrace a somewhat different universe, and yield a different aggregate 1970 obligation figure than appears elsewhere in this text.

The budget of each of the institutes has increased. In the aggregate, the total estimated obligations for fiscal year 1971, measured in 1960 constant dollars, will exceed slightly the fiscal 1969 level, but not the levels of 1967 and 1968. If the Congress appropriates and the President authorizes obligation of the total budget requested for fiscal 1972, obligations for that year will match or slightly exceed the peak achieved in the 1967–68 period.

The projected aggregate increase is not uniformly distributed among the institutes. The NCI, NICHD, NEI, NIEHS, National Heart and Lung Institute, and National Institute of Dental Research would gain substantially, in both relative and absolute terms. This reflects increasing federal commitment to targeted research programs in cancer, atherosclerosis, population and family planning, dental caries, eye diseases, environmental health, and sickle cell anemia. Substantial fractions of the increases will be used, under contracts, to conduct centrally planned and managed research and development endeavors.

By contrast, the projected increases for the other institutes—the NIGMS, National Institute of Allergy and Infectious Diseases, National Institute of Arthritis and Metabolic Diseases, and National Institute of Neurological Diseases and Stroke—are uneven and modest. In constant dollars, the increase over the 2-year period will probably not compensate for inflationary reductions in program level.

The fiscal 1971 and 1972 budgets indicate that a reversal of the trends which characterized the latter part of the past decade has begun. Changes appear to be specific, not general. All of the variables of recent years must be considered in meeting the detailed impact of the budget increases anticipated for fiscal 1972.

References and Notes

1. Average salaries of medical school faculty were calculated from data reported in "Datagrams," *Assoc. of Amer. Med. Coll.* **10**, No. 10 (Apr. 1969); *ibid.* **11**, No. 6 (Dec. 1969).
2. Net incomes of practicing physicians were calculated from data reported in the following publications: *Internal Revenue Service: Statistics of Income—1964, Business Income Tax Returns* (Government Printing Office, Washington, D.C., 1967); *ibid.* for 1965 (Government Printing Office, 1968); *ibid.* for 1966 (Government Printing Office, 1969); *ibid.* for 1967 (Government Printing Office, 1970); *Preliminary Statistics of Income—1968, Business Income Tax Returns* (Government Printing Office, Washington, D.C., 1970). These data were based on preaudited, stratified samples of individual income tax returns, Form 1040 (proprietorships), and partnership returns of income, Form 1065 (partnerships).
3. Data were abstracted from *Daily Service Charges in Hospitals, 1960 through 1970* (American Hospital Association, 1961 through 1970).
4. *Students Enrolled for Advanced Degrees: Institutional Data, Fall 1969*; Office of Education 54019-69 Part B (Government Printing Office, Washington, D.C., 1970).
5. *Doctorate Recipients from United States Universities, 1958–1966* (National Academy of Sciences–National Research Council, Washington, D.C., 1967); *Doctorate Recipients from United States Universities: Summary Report 1970* (National Academy of Sciences–National Research Council, Washington, D.C., 1971).