MEDICAL PRACTICE

Contemporary Themes

Audit of a surgical firm by microcomputer: five years' experience

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Abstract

From 1982 to 1986 inclusive work of one surgical firm was audited with a microcomputer. Data were recorded on 4336 patients having 3355 operations, who were under the care of one consultant in a general surgical unit; fifty items of information were recorded on each patient, allowing a wide range of analyses to be performed—for example, the number of admissions and operations, grades of operation, diagnostic grouping, complications, and complication rates associated with individual surgeons. Data collected for the audit provided a valuable baseline for the unit, defining aspects of practice that could be reviewed and improved. During the audit the overall rate of complications as a percentage of admissions fell significantly from 13% to 9% and the rate of postoperative complications decreased significantly from 16% in 1982 to 11% in 1986. The incidence of chest and wound infections also decreased significantly. The system was improved by using the data to produce discharge summaries as well as audit; the microcomputer thus became an integral part of the office work of the unit.

Introduction

With the recent emphasis on unit budgeting and quality control in surgery consultants have become increasingly interested in having access to accurate data about their workload and the occurrence of complications in their patients. Several consultants have begun to develop microcomputer programs for this, but no reports of long term experience with such methods seem to have been published.

I carried out a comprehensive audit on all my inpatients over the past five years with a microcomputer. During the past three years I developed a program to allow the gathering of data and use of the microcomputer to be incorporated into the routine work of the surgical office.[1] All discharge summaries are now produced by the microcomputer from the audit data. I have often been asked whether there are any benefits from carrying out an audit. I present some of the results obtained and show how the information gathered has been used in this surgical unit.

Methods

AUDIT

In 1981 I started a comprehensive audit using a method based on a pocket diary.[2] Over the next three years I developed a method for use with a Superbrain QD microcomputer with a 7·5 megabyte external hard disk and using the Xcalibur database program (D P N Systems, Sheffield). This ran in parallel with the diary method from 1982 to 1984 inclusive in my department. This allowed us to define the problems of running an audit and the most useful data to collect. The extra work needed to produce the audit on its own could not be sustained in parallel with the routine workload, and in 1984 I began to develop a new program to allow the data to be gathered as an integral part of the routine of the unit. It was based on the Rescue database program[2,3] (Grade One Computing Services, Glossop) and was run on a Sirius 1 microcomputer with a 10 megabyte internal Winchester hard disk. The data were used for audit and also to produce discharge summaries and other documents automatically, and this became standard practice from 1 January 1985. The program (Dunnfile)[2,3] subsequently ran on multiuser software on an ICL DRS 300 computer with a 40 megabyte disk and three terminals. We used a Fujitsu DL2400 letter quality dot matrix printer.

Data on patients were collected on a proforma attached to the notes, verified by the consultant, and entered into the computer by a clerk or medical secretary, the whole of this process taking about eight minutes. Discharge summaries produced conventionally take an average of 15 minutes for composition, dictation, and transcription. To ensure that every patient admitted to our beds was included in the audit names were kept in a register and marked as the proforma was received.

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PRACTICE

At the start of the study I held most of my sessions at this hospital but also visited Huntingdon Hospital twice a week for a clinic and an operating list. The work at Huntingdon Hospital was not included in this study, though some of those patients were transferred to this hospital, increasing the workload. In 1985 this arrangement stopped and all work was done only at this hospital. In addition to normal National Health Service duties I had a heavy teaching commitment as director of surgical studies at Cambridge Clinical School and director of studies in medicine at St John's College, Cambridge.

The unit is part of a double consultant firm, which trains one senior registrar, one registrar, and two preregistration housemen. Patients admitted under the second consultant were not entered into the database until 1 January 1986 and are excluded from this report. This hospital is a teaching hospital with a strong district and regional commitment. I am on call for emergencies one day each week and have one and a half outpatient sessions each week, in which I see 2500 patients each year. I have four operating lists and the nominal use of 14 inpatient beds.

All patients are given a date for their operation in the outpatient department, and there is no waiting list as such. Patients with hernias are usually given dates within six weeks, and the longest waiting time for a non-urgent operation is one year. At any time about 50 patients are booked ahead for their planned operation. This figure rose to 120 during the NHS strike in 1982.

Disruptions to the workload were frequent during the five years studied owing to the strike of ancillary workers in 1982 and several periods when beds were closed, theatre lists cancelled, and other interruptions from various causes occurred.

Junior staff rotated through the unit, senior registrars usually staying for eight months and registrars for five months. Operations were classified according to the scale of the British United Provident Association as major, intermediate, or minor. In 1985 and 1986 operations previously classified as major were classified as major, complex major, or major plus.

Complications were defined as any problem occurring during admission whether resulting from the management or not. The impracticality of apportioning blame for any particular event meant that all problems were ascribed to the surgeon involved—for example, death due to inoperable cancer after a laparotomy was recorded as a complication for the surgeon. Major complications were defined as those that were life threatening or appreciably increased the time spent by the patient in hospital; all other complications were described as minor.

Statistical analysis was performed with the unpaired U test.

Results

ADMISSIONS

A total of 4336 patients were admitted under my care during 1982-6, 2579 (40%) of them as emergencies. Table I shows the admissions for individual years. An additional 15-20 patients a year were seen as referrals, or were reviewed in the admissions unit but sent home. Non-urgent admissions dropped slightly when the outpatient clinic at Huntingdon Hospital was stopped at the end of 1984. Of the patients admitted, 1040 were aged over 65 and 295 over 80. Table II shows the subspecialties to which the patients belonged. Data on discharges and deaths published by the Hospital Activity Analysis are still incomplete for 1986, but from 1982 to 1985 its figures showed that the total number of discharges and deaths was 2731 compared with our figure of 3521, which is a deficit of 790 (22%) over four years.

OPERATIONS

The 4336 patients had 3355 operations, 840 of which were emergencies. Operations were recorded as performed by the main surgeon; the occasions when the consultant or senior registrar acted as an assistant during training sessions were not recorded. Registrars carried out 1678 operations, senior registrars 906, and the consultant 638. The remaining 133 were done by housemen, radiologists, or anaesthetists. These figures represented only a proportion of the workload of each surgeon and were also affected by periods when the hospital was closed and holidays. Altogether 1536 of the operations were classified as major, major plus, or complex major on the British United Provident Association scale (table III). Four hundred and nine of the 638 operations (64%) carried out by the consultant were in these categories. The mean proportion for senior registrars was 63 out of 128 (49%) and for registrars 54 out of 145 (37%) (see table VII).

COMPLICATIONS

Three hundred and ninety nine patients, representing 9% of admissions, developed one or more complications. Included in this figure were deaths caused by carcinomatosis and other "inevitable" problems. In 366 patients complications occurred after operation (11% of all operations); table IV shows the annual figures. The overall rate of complications in patients over

TABLE I—*Number of patients admitted during 1982-6*

Admissions	1982	1983	1984	1985	1986	Total	Mean per year
Emergency	381	408	356	286	326	1757	351·4
Non-emergency	505	593	523	469	489	2579	515·8
Total	886	1001	879	755	815	4336	867·2
Total (from Hospital Activity Analysis)	683	769	677	602	*		682·8

*Not available at time of writing.

TABLE II—*Admissions during 1982-6 according to subspecialty*

	1982	1983	1984	1985	1986	Total	Mean per year
Neonatal	33	55	29	35	24	176	35·2
Paediatric (under 12)	118	124	150	118	109	619	123·8
Vascular	47	56	66	59	90	318	63·6
Stomach	97	50	66	43	33	289	57·8
Colorectal	81	130	115	78	104	508	101·6
Thyroid/endocrine	5	15	7	7	10	44	8·8
Breast	60	95	87	79	77	398	79·6
Appendix	67	66	56	65	51	305	61·0
Hepatobiliary	39	46	37	44	43	209	41·8
Gynaecological	11	8	14	7	9	49	9·8
Hernia (all types)	123	131	139	106	106	605	121·0
Venous	13	14	29	22	29	107	21·4
Urological	23	28	21	30	21	123	24·6

TABLE III—*Number and type of operations 1982-6*

Operations*	1982 (n=666)	1983 (n=781)	1984 (n=680)	1985 (n=593)	1986 (n=630)	Total (n=3350)	Mean per year (n=670)
Emergency	172	187	171	153	157	840	168
Non-emergency	494	594	509	440	473	2510	502
Complex major				18	21	39	19·5
Major plus				12	17	29	14·5
Major†	353	384	315	236	248	1536	307·2
Intermediate	158	160	142	216	238	914	182·8
Minor	155	237	223	141	144	900	180

*Graded according to scale of the British United Provident Association. For example, complex major=aortic surgery, oesophagectomy, anterior resection of rectum, and abdominoperineal resection; major plus=Nissen's fundoplication, partial hepatectomy, total colectomy, and femoropopliteal bypass; major=cholecystectomy, vagotomy, amputation, mastectomy, laparotomy, and partial colectomy; intermediate=hernia repair, removal of breast lumps, and stripping of varicose veins; and minor=removal of skin lumps, draining of abscesses, and circumcision.
†Total major or more.

TABLE IV—*Number and degree of complications 1982-6*

	1982 (n=112)	1983 (n=95)	1984 (n=68)	1985 (n=49)	1986 (n=75)†	Total (n=399)	Mean per year (79·8)
Non-operative	6	8	5	6	8	33	6·6
Postoperative	106	87	63	43	67*	366	73·2
Minor	57	49	27	24	33	190	38·0
Major	33	21	28	14	27	123	24·6
Death	22	25	13	11	15	86	17·0
Complications as % of admissions	13	10	8	7	9†	9	
Major complications or deaths as % of admissions	6	5	5	3	5	5	
Postoperative complications as % of operations	16	11	9	7	12	11	

*$p<0·02$ Per operation done, 1986 *v* 1982.
†$p<0·05$ Per admission, 1986 *v* 1982.

TABLE V—*Number (percentage) of certain types of complication*

	1982	1983	1984	1985	1986	Total
Haemorrhage	10 (1·5)	6 (0·8)	11 (1·6)	5 (0·9)	9 (1·4)	41 (1·2)
Wound	8 (1·2)	5 (0·6)	7 (1·0)	3 (0·5)	6 (1·0)	29 (0·9)
Deep	2 (0·3)	1 (0·1)	3 (0·4)	2 (0·3)		8 (0·2)
Other			1 (0·2)		3 (0·5)	4 (0·1)
Infection	72 (10·8)	44 (5·6)	19 (2·8)	20 (3·4)	18 (2·9)	173 (5·2)
Chest	39 (5·9)	22 (2·8)	9 (1·3)	12 (2·0)	6 (1·0)**	88 (2·6)
Wound	21 (3·2)	17 (2·2)	6 (0·9)	6 (1·0)	6 (1·0)*	56 (1·7)
Deep†	4 (0·6)	3 (0·4)	2 (0·3)		3 (0·5)	12 (0·4)
Fever of unknown origin	7 (1·1)	1 (0·1)		2 (0·3)	3 (0·5)	13 (0·4)
Other	1 (0·2)	1 (0·1)	2 (0·3)			4 (0·1)
Wound dehiscence	2 (0·3)	3 (0·4)				5 (0·2)
Thrombosis	8 (1·2)	14 (1·8)	2 (0·3)	3 (0·5)	4 (0·6)	31 (0·9)
Deep venous	2 (0·3)	4 (0·6)		2 (0·3)	1 (0·2)	9 (0·3)
Pulmonary embolism	6 (0·9)	10 (1·3)	2 (0·3)		2 (0·3)	20 (0·6)
Other				1 (0·2)	1 (0·2)	2 (0·1)
Anastomotic problems	2 (0·3)	2 (0·3)	6 (0·9)	4 (0·7)	4 (0·6)	18 (0·5)
Retention of urine	7 (1·1)	5 (0·6)	3 (0·4)	1 (0·2)	9 (1·4)	25 (0·7)

*p<0·01, **p<0·001 for 1986 *v* 1982.
†Infections such as pelvic and subphrenic abscesses.

65 was 18% (184/1040); the mean postoperative stay in this group was 14·3 days, about twice the overall mean postoperative stay. In patients over 80 the rate of complications per admission was 25% (74/295 patients). The overall rate of complications fell significantly from 1982 to 1986, as did the postoperative complication rate (table IV). Table V shows the types of complication that occurred; the incidence of chest infections decreased significantly from 5·9% to 1·0% over the five years, and that of wound infections from 3·2% to 1·0%. Thromboembolism was only a minor problem throughout, with an incidence of 0·3-1·8%.

Table VI shows the causes of death. Seven deaths were recorded in neonates. The most consistent causes of death in elderly patients were advanced arterial disease and carcinomatosis.

TABLE VI—*Number of deaths 1982-6*

	1982 (n=22)	1983 (n=25)	1984 (n=13)	1985 (n=11)	1986 (n=15)	Total (n=86)
Non-operative	5	7	5	2	4	23
Postoperative	17	18	8	9	11	63
Neonatal deaths		3	1	1	2	7
Deaths from:						
Trauma	1		2			3
Advanced malignancy	9	10	7	4	8	38
Advanced arterial disease	3	5	2	3	5	18
Pulmonary embolism	1	4				5
Other	8	3	1	3		
Average age of patients (years)*	75	74·5	74·5	76·1	69·4	73·9

*Excluding deaths of neonates and from trauma.

The highest rates of complications per surgeon were for the consultant (18%) and senior registrars (mean rate of complications 19%), representing the fact that they were allotted high risk cases; registrars generally had a lower mean rate of complications (6%) (see table VII). This was thought to be the correct way to manage the firm.

INDIVIDUAL PROCEDURES

The following examples show the type of data available for all procedures or diagnostic groups. Of 557 operations for hernias, 481 were inguinal, 35 femoral, and 41 midline. Inguinal operations included 43 bilateral hernias, making a total of 524 inguinal hernias. Two wound infections were the only complications recorded during admission. For the 146 adult patients having operations for inguinal hernias in 1985 and 1986 follow up data were recorded at the first outpatient visit, usually at six weeks, in 104. Only two patients had further problems, complaining of pain in the wound. Thirty four children having operations for hernias in 1985 and 1986 had no recorded complications during or after their admission. The mean waiting time for an operation for an inguinal hernia was 39 days and the mean postoperative stay 2·2 days. The mean time taken to operate was 34 minutes.

After colonic or rectal anastomoses the incidence of leakage was 7·6% (8/105 cases), after anterior resections it was 22% (5/23 cases), and after right hemicolectomies it was 11% (3/27 cases). Non-emergency procedures on the aorta (39) carried a mortality of 10%,[4] and emergency operations on ruptured aortas (11) carried a mortality of 27%.

Among the 176 neonates 51, most of whom were premature and had low birth weights, needed a major operation soon after birth. Mortality in this group was 14% (seven deaths) and the complication rate 28% (14 cases). Thirty one other babies needed Ramstedt's operation and were not included in these figures; none of these babies died, and the complication rate was 16% (five babies had problems associated with the abdominal wound). Only one such complication occurred in the past two years.

INDIVIDUAL SURGEONS

Table VII shows the number of operations performed by individual surgeons and the associated complication rates over the five year period. These results are presented anonymously in order of decreasing complication rate. Variations in the number of operations performed were due to different periods of study leave, a variable number of lists that were cancelled, and occasional changes in the rotation. The total number of operations shown in the table is less than the overall total, as work done by registrars whose posts overlapped the beginning and end of the study and by

TABLE VII—*Number of operations with associated complications, according to individual surgeons 1982-6*

Surgeon*	Total No of operations†‡	No (%) of major operations§	No (%) of complications
Registrar:			
1	113	37 (33)	15 (13)
2	93	38 (41)	9 (10)
3	181	78 (43)	17 (9)
4	86	38 (44)	6 (7)
5	230	79 (34)	16 (7)
6	119	55 (46)	7 (6)
7	159	61 (38)	9 (6)
8	136	57 (42)	7 (5)
9	119	40 (34)	4 (3)
10	150	50 (33)	5 (3)
11	207	62 (30)	6 (3)
Mean	144·8	54·1 (37)	9·2 (6)
Senior registrar:			
1	115	64 (56)	36 (31)
2	148	65 (44)	33 (22)
3	124	58 (47)	25 (20)
4	225	126 (56)	37 (16)
5	56	23 (41)	8 (14)
6	102	40 (39)	8 (8)
Mean	128·3	62·7 (49)	24·5 (19)
Consultant	638	409 (64)	114 (18)

*Figures relate to main surgeon, regardless of presence of more senior surgeon.
†Not including estimated 500 further operations supervised by consultant, and about 70 by each senior registrar during training of junior doctors.
‡Not including work of consultant at another NHS hospital and work of registrars and senior registrars for additional consultant.
§Major, major plus, and complex major.

locums is not included. During 1982-6, 170 operating sessions were lost because of strikes, bed closures, lack of anaesthetists and public holidays.

The data provide a useful background for comparisons between surgeons but should not be interpreted solely as showing technical skill, as complications may develop for many other reasons—for example, the age and fitness of the patient. Registrar 1 had the highest complication rate (table VII), but eight of the complications were unavoidable. In general the registrars with the lowest complication rates had done fewest major operations; good results were achieved by registrar 6, who did a high proportion of major operations and whose associated complication rate was 6%.

Discussion

The purpose of this audit was to provide data that could be used to improve the management of a surgical firm. It was not a study of a series of individual operations; data on the incidence of specific complications, such as wound and chest infections, are given merely to show the type of information readily available from an audit performed with a microcomputer. Although such data are not sufficient for scientific studies, they are valuable in showing aspects of a surgical practice that deserve more careful and precise study.

As far as we are aware this is the only report of using a microcomputer to study the total workload of the firm of one consultant over a period as long as five years; we therefore have little to compare our figures with. In general, authors have published the results of audits carried out for one year, but no individual year can be considered to be "typical" as is illustrated by our annual numbers of admissions. As a result of the NHS strike in 1982, 1983 was exceptionally busy, with the operations that had been cancelled during the industrial action being added to the usual workload. In 1985 the effect of one fewer outpatient clinic a week was evident. The value of averaging out the differences in annual totals therefore becomes apparent; 1984 seems to have been the most typical year in this period.

A problem was trying to ensure comparability of the figures produced from year to year as what one person counted as a complication might not be counted by others. We tried to ensure comparability by having all the data verified by the same consultant. Although the system could be improved, the results are more comparable each year than those that might be produced from a retrospective study of patients' notes. Differences as large as those that occurred between 1982 and 1986 are most unlikely to be due simply to observer variation.

We reported our method of combining audit and the production of discharge summaries in 1986[1] and have since reported further details of both our past and present methods of audit.[2,3] Gough *et al* presented a comprehensive manual audit of the work of a surgical firm over one year and expressed the hope that an audit could be done more easily with computers.[4] We have achieved this, though over 4000 hours of development work was necessary. Comparisons between units are difficult because of variations in the type of work, the working environment, the characteristics of patients, and differing opinion on the definition of complications. Our results seem to compare favourably with those of Gough *et al*, though the comparison is affected by the larger number of surgeons within their unit and the inclusion of data on 300 endoscopies, which we do not perform.[4] The complication rate for all admissions was 16·9% with a rate of postoperative complications of 12·7%. Their rate of minor complications was greater than ours (13% against 4%), their death rate similar (1·3% against 1·9%), and their rate of major complications slightly higher (3·9% against 2·8%).

Several other workers have reported their experience of audit.[4-9] Stern and Rubin described the use of a computer to produce discharge summaries in a rehabilitation unit in 1979.[10]

ALTERATIONS IN SURGICAL PRACTICE

We did not expect the audit to lead to an appreciable change in surgical policy but rather to refine our existing procedures, and it is in this respect that a continuing audit is of greatest value in surgical management. A wide range of precautionary measures are taken as part of surgical practice; whether all of them are being carried out correctly is impossible to monitor, but data from the audit provide the stimulus to concentrate on certain aspects. From our initial analyses there seemed to be little advantage in altering our practice in cases of thromboembolism, deep infection, or haemorrhage, but the high incidence of chest and wound infections led us to put increased emphasis on measures that might reduce these problems. In the case of chest infection we increased the pressure on patients to stop smoking before their operation and were able to be more persuasive because of the figures available to us. We also presented the figures to our anaesthetists, who increased their use of postoperative nerve blocks, especially for upper abdominal surgery and repair of hernias.

The rate of wound infection was probably affected by the knowledge that all complications would be recorded; as a result, increased care was taken with wound haemostasis and closure and with remembering prophylactic antibiotics when these were part of the routine. We used prophylaxis in cases with potential infection but not for clean operations. We also encouraged patients to lose weight before their operation when necessary, which many were able to achieve. The incidence of five burst abdomens in the first two years of the study led us to review the technique of wound closure among our junior staff. We used a continuous one layer nylon loop suture throughout, and it seemed that excessive tension was being used in many cases, causing the suture to cut through muscle. We therefore supervised the technique of new registrars in closing laparotomy wounds more carefully. No wound dehiscences occurred in the past three years. Finally, our initial analyses showed that complications were more likely to occur when many major operations were performed in a short space of time, and we tried harder to spread the workload more evenly.

ALTERATIONS IN AUDIT PROCEDURE

We changed the process of gathering data for audit as a result of continuing experience. Firstly, we restricted the amount of data collected to that which could be justified as clearly useful. By using the data to produce discharge summaries and operating lists[4] we reduced the administrative work of junior staff and secretaries and the audit became part of our office routine. Secondly, in the past two years we started to collect data on complications that occurred between discharge of the patients and their first follow up visit, often at six weeks. The data are still incomplete, but the initial results show few complications occurring after early discharge. Thirdly, we began to define the analyses that were regularly needed and incorporated these into the computer program. Overall figures and incidences were found to be of little value, and the program was adapted easily to produce full details of the patients, as discussed elsewhere.[3] Finally, having realised the value of performing the audit on several firms, we expanded the study in 1986 to include four consultants and plan to include another three soon. As a result we saved one full time secretarial post from the pool dealing with discharge summaries and are able to produce more complete data for trainee doctors.

VALUE OF DATA

We now give our trainees full details of their patients, the operations that they performed, and any complications that occurred. Complications can be assessed with the trainee and technical problems identified.

The data on patients over the age of 65 proved valuable when the area health authority decided to reduce the budget for acute surgical cases in favour of geriatric medicine and other specialties. We were able to point out that a cut in our budget would adversely affect many elderly patients amenable to treatment, who represented 24% of our workload and 46% of our complications. Data on the number of our patients who had complex operations and were unable to get into the intensive care unit similarly forced the district authority

to examine the provision of intensive care facilities in our hospital.

The fact that our figures, which may be verified with names and addresses, showed 22% more work being carried out than the figures available to the health authority showed, has obvious implications for the costing of our service.

Finally, surgeons often make judgments on the basis of available statistics for mortality for a procedure; the availability of up to date statistics from the unit concerned is an advantage in advising patients.

CONCLUSION

This audit helped to establish norms for our unit; it allowed us to recognise variations in results and to act when necessary to improve our results. The more the microcomputer was used for routine tasks in the department the easier it became to complete the audit. I suggest that a system such as ours should become part of the normal running of all surgical units.

My senior registrar Mr R Dale gave invaluable help in developing the current computer program. I thank the numerous house staff, registrars, and senior registrars who helped to collect the data; Mrs A Osborne, Miss E Tabor, and Miss Judith Bliss for entering the data into the microcomputer in the early stages of the project; and Mrs Ros Britton for her help with this manuscript.

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Research Policy

Glimpses of the National Institutes of Health II: review systems and evaluation

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The National Institutes of Health operate what must be the largest peer review system in the world to decide which grant applications they will support. The main difference with the system of the Medical Research Council is that the NIH system is more open: applicants are given detailed feedback on their proposals together with the chance to rebut the comments before a final decision is made and to appeal when they are turned down. The feedback is, however, anonymous, except in that the names of members of the committees are public knowledge.

The system "opened up" about 10 years ago to the accompaniment of dire predictions that the system would collapse or become enmeshed in argument. Neither prediction came true, but Dr Jerome Green, the director of the division of research grants, told me that comments on grants are now more detailed and careful and the whole process much more educational. It also must, he agreed, be more time consuming. Another important difference between the American and British systems is that a quarter of the members of one of the two committees that are part of the American process are lay people.

The review process

More than three quarters of the budget of NIH is spent on work done in outside institutions (mostly universities and medical schools), and about 30 000 grant applications are currently received each year.[1,2] About 3000 of these are directed to other federal institutions—for instance, the Food and Drug Administration—and the rest are considered within NIH. About 22 000 are considered centrally by the division of research grants, and the other 5000 are considered by the institutes themselves (this applies particularly to multidisciplinary and solicited applications and to applications for research training).

All applicants must be sponsored by a host institution, which is one method of ensuring that very poor applications are not submitted. The applications are long and detailed, and one researcher told me that it would take him about 10 weeks' work to complete an application. He did not think of this time as wasted because it was a time of hard creative thought that would be useful even if the application was turned down. The submitted applications are first looked at by health scientist administrators, who refer them to one or sometimes two of just under 100 initial review groups (more commonly called study sections) that cover all possible subjects. The administrators will send the applications back only if they are grossly incomplete, are not in English, or (an increasingly common reason) exceed the permitted 20 pages. The administrators have specific guidelines on which initial review group should see a particular application, but inevitably some applications would qualify for more than one group. Applicants can request that their proposals should be seen by particular review groups.

A review group has about 15-20 members, all of whom are researchers, and is chaired by a researcher. Figure 1 shows who these people are. A key person is the executive secretary of the group, who is not a practising researcher but an employee of NIH. Always the secretaries will have been researchers, and often they will have

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