Research Policy

How fast flows the brain drain?

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The loss of talented researchers abroad is one aspect of the crisis in research that attracts attention from the media and generates much anxiety. It is the feature of the crisis that the man in the street or the politician can best understand. The great man is interviewed just before he boards his plane to California and he bemoans the inability of the government to understand the importance of research, the shortage of funds, the lack of career prospects, and the scientific illiteracy of the mass of Britons. The media then point out that because the great man is leaving his work will be lost to Britain and children may die unnecessarily or Britain will come to lag even further behind in economically important technologies. Five years later the great man will be interviewed again in his log cabin in Colorado, and he will say that from where he sits research prospects in Britain look grimmer than ever.

The structure of this story will be familiar to everyone, and a previous article was devoted to the story of one young bright medical researcher who has emigrated to North America (19 March, p 844). But these stories cannot tell us about the scale and the seriousness of the "brain drain"; thus attempts have been made to measure it—and have proved difficult. Indeed, most have consisted of little more than lumping anecdotes together, and only the most recent study from the Royal Society has looked at both the immigration and emigration of scientists.⁸ Scientists have always moved around, and disgruntled researchers who are about to emigrate should be easy to find—and they stick in the memory. But scientists can also be found who are coming to Britain, particularly from Third World countries, and maybe the efflux is not much greater than the influx.

Tempted by the drain

Most of the researchers whom I spoke to had considered emigration at some time. The well known ones in particular usually have extensive international contacts, and many will have been actively "headhunted" by foreign, particularly American, institutions. Most do not consider it seriously because they are embedded in Britain and the British way of medicine and research.

Many of those I spoke to did, however, feel under considerable strain, especially the clinical academics. They have responsibilities for seeing patients, training undergraduates and postgraduates, running research departments, and doing research themselves. In addition, many of them sit on hospital, health authority, and university committees and have national responsibilities on the committees of government, bodies that fund research, and medical colleges. The financial problems in the NHS, the universities, and research make all of these commitments more demanding and more time consuming. The academics must also referee papers and grant proposals and "keep up" with their own research interests, in itself an ever expanding job.

When the responsibilities of clinical academics are listed like this

The press and the brain drain

Ironically my collection of press cuttings on "brain migration"—which have titles like "Research down the brain drain,"¹ "The sky in America is indeed the limit,"² "Despair drives physicist to US,"³ "Britain's brains go down the drain,"⁴ "Why the brains of Britain are fleeing,"⁵ and "Cuts force out top scientist"⁶—seem to be short on interviews with those leaving. One features Professor Colin Blakemore's much heralded departure (which never actually happened),² while another ends with a Canadian born Cambridge don saying: "My wife is English. We love Cambridge. I love my work."¹ Indeed, the only article from my collection that actually interviews in depth scientists who have migrated features two Austrians who have taken a salary cut to work at the Imperial Cancer Research Fund in London: "Money isn't everything. . . . This city is a real centre for the type of [molecular biological] work we're interested in, and it's also an interesting place to live. The working environment is as good as anywhere in the world. . . ."⁷

it seems extraordinary that anybody can do so much, and of course most can keep sane only by severely limiting some of their activities. All too often it will be research that suffers: a project in molecular biology can be put on one side in a way that a patient in renal failure, a room full of undergraduates awaiting a lecture, or a threat to close half of your unit's beds cannot.

Senior clinical academics in Britain are not, of course, alone in the world in having such myriad responsibilities. Most of the researchers I spoke to thought, however, that the Americans were much better at protecting important clinical researchers, giving them time and freedom to pursue their research interests. This seems to be partly a matter of resources and partly a matter of culture.

Younger clinical researchers do not have so many committee responsibilities as their seniors, but many still have service and teaching responsibilities. They are therefore just as likely to have their research time eroded, but they are also greatly worried by career and financial prospects. What is the point in a clinical researcher taking a post as a professor of medicine if he will have no time, money, equipment, or staff to do research? The proposal to downgrade the research in many of Britain's universities will make this problem even more acute.

More so perhaps than a scientifically trained medical researcher, the medically qualified researcher has an easy route out. Both might consider emigrating or entering industry, but the medically qualified researcher also has the option of entering the NHS. Those struggling up the NHS career structure may find it hard to believe that ascending the career structure in research is even more fraught, but many of those doctors who contemplate a career in research are "high flyers" who can climb the NHS hierarchy more easily than most. One of the medically qualified researcher's problems is that if

he leaves his transfer from research to the NHS too late his research background will be a hindrance rather than a help.

The uncertainty of a career in research is, I think, the main factor that leads medically qualified researchers to join the "internal brain drain" into the NHS, but finance also plays a part. The comparability of pay between medically qualified researchers and academics is always under threat, but at the best of times the researcher is less likely to get overtime and he will not have removal expenses paid, when his NHS colleague does. The other problem is private practice. The researcher may well be prevented from earning any money from private practice (although rules seem to vary from university to university and department to department), and as the private sector grows in medicine the academic doctor may well find himself at an enormous financial advantage. The question thus arises whether academics should be allowed to keep the proceeds from private practice. The argument against is obviously that such a move would probably cut still further into the little time that academics have to do research.

Sources of dissatisfaction

Although they may have had difficulty proving that the brain drain was a large problem the reports produced by the Advisory Board for the Research Councils⁹ and the Royal Society⁸ did illustrate the reasons why scientists are leaving Britain. Table I from the Royal Society report, gives the reasons why the heads of research groups and university departments thought that scientists left Britain. (This is unfortunately a second hand view; those leaving

TABLE I—Reasons why scientists left Britain (Royal Society⁸)

Reason	No	%
Rates of pay	95	14
Status of science	33	5
Scientific vigour	44	6
Standard of living	41	6
Political climate	2	<1
Level of equipment and research facilities	92	13
Personal reasons	30	4
Career opportunities abroad	125	18
Career limitations in UK	122	18
Working conditions	14	2
Desire to widen experience	86	12
Other	7	1
Totals	691	100

Totals are greater than the number of respondents answering this question since each could choose a maximum of three reasons.

may not be clear themselves why they are leaving, but their ex-colleagues may be even less clear.) The commonest reason was the poor career opportunities in Britain and the much better ones abroad. The better level of pay and the better research facilities abroad were also important reasons. Also important was the desire to widen experience, and these people at least may be likely to return.

The report from the Advisory Board for the Research Councils produced similar reasons why scientists left, but also added aggressive recruiting on the part of American universities and industry and "greater receptiveness of US industry to novel and untried ideas."⁹ This last reason chimes somewhat with the government view on why scientists join the brain drain: "Young scientists and engineers are refugees not from the Treasury but from the cumulative effects on British science of educational, fiscal, and cultural failings."¹⁰

Measuring the brain drain

Measuring the brain drain has proved difficult, and the results must have disappointed the various bodies that commissioned the

reports. They wanted hard data to support the many anecdotes of scientists leaving, and they have not found them.

Figure 1 shows the numbers of natural scientists from Britain given permanent immigration status in the United States from 1966 to 1985; the numbers settling in the US were much higher at the end of the 1960s than they are now.⁸ Data from the National Science Foundation (table II) show that more scientists and engineers entering the United States in 1984 emigrated from Britain than from any other European country—but many of these will not be researchers and immigration is probably easier from Britain because of the "special relationship."¹¹ Anxiety over the brain drain was more acute in the 1960s than it is now, and various studies were undertaken to try to measure the flow.¹² The methods and assumptions of these studies were criticised, and in the 1970s the Organisation for Economic Cooperation and Development concluded that many of those who left Britain in the 1950s and 1960s later returned and that much of the anxiety was unfounded.¹³

FIG 1—Graduate scientists from Britain given permanent immigration status in the United States 1966-85 (National Science Foundation).

TABLE II—Source of scientists and engineers emigrating to the United States (National Science Foundation)

Country of last permanent residence	1984	Per million inhabitants
Britain	1001	18.0
Ireland	34	10.2
Switzerland	48	8.1
Denmark	24	4.1
Holland	49	4.0
Belgium	42	3.7
West Germany	267	3.4
Italy	128	2.3
France	127	2.2

We do not know how many of those emigrating now will return, but the University Grants Committee did have a "new blood" scheme to attract back the very best academics. This was successful in a small way but has now ended. The Wellcome Trust is also interested in attracting back to Britain medical researchers who have left, and this was one of the aims of its senior basic medical science fellowships.¹⁴ Unfortunately of 59 applications received in October 1985 only six came from abroad.

Some recent attempts to measure the brain drain have been abandoned—for instance, by the British Academy and the Eco-

nomic and Social Science Research Council.¹⁵ A spokesman from the ESSRC was quoted as saying: "We got people writing to say that there was a serious problem but they couldn't recall any of their friends who had actually left."¹⁵

The report from the Advisory Board for the Research Councils was at least published but made no attempt to measure the immigration of scientists, and the published report contains only very sketchy data.¹⁶ Forty leading research groups were sent questionnaires and were asked for evidence of loss. Most replied but "in many cases numbers were too small to bear statistical analysis." Departments were "in general gravely concerned about increasing losses overseas not only of their most talented students and postdoctoral research workers but also of outstanding senior scientists" and it was "generally felt that" newly qualified PhDs were "increasingly unlikely to return." Chemistry was the subject thought to have suffered the most severe losses, but five senior biochemists had been lost and eight "first rate molecular biologists" were named as having taken permanent posts abroad.¹⁷

Although the data from the report are very thin, the Advisory Board for the Research Councils did acknowledge the "internal brain drain" in its report: "Across all fields there is concern about the increasing difficulty of recruiting good junior and middle level postdoctoral research workers because of the more attractive salaries and prospects in industry and the civil scientific service. . . . The supply of talented young blood is falling off because many of the best students . . . are opting for careers in accountancy, stockbroking, and insurance rather than pursuing a scientific career."¹⁸

Royal Society report on the brain drain

The Royal Society and Fellowship of Engineering report on the brain drain was much more ambitious than previous reports and did study immigration as well as emigration but did not look at the "internal brain drain."¹⁸ The study was concerned with five subjects—biochemistry, chemistry, earth sciences, electronic engineering, and physics. A total of 750 questionnaires were sent to all heads of university departments in the selected disciplines, to leaders of some university research groups, and to "appropriate industrial, government, and research council establishments"; 568 questionnaires were returned, a 77% response rate.

At least 617 experienced British scientists and engineers working in the five subjects were identified as having left Britain between 1975 and 1985. In the same time 314 graduates in those subjects, most of whom had recently achieved a doctorate, also left. But 685 scientists and engineers working in those subjects entered Britain during the same period: 183 were Britons returning. Both emigration and immigration increased slightly over the 10 years.

The flow of scientists and engineers in each year was not large

FIG 2—Proportion of fellows of the Royal Society living outside Britain (Royal Society¹⁸).

when related to the size of the groups that they were leaving and joining. The emigration rate for postdoctoral research assistants and more senior members of university research groups was about 2% a year; the rate was lower for those employed by university departments (who are generally more senior) and those from industry, government, and research council establishments—0.5% or less a year. The immigration rate to university research groups was 2.9% a year and to industry, government, and research council establishments less than 0.4% a year.

FIG 3—Proportion of fellows of the Royal Society living outside Britain at the time of their election (Royal Society¹⁸).

These figures were not, however, reassuring to the Royal Society because those emigrating tended to take up long term posts abroad (mostly in North America), whereas those coming to Britain stay for less than three years before returning. Attempts to measure the quality of those coming and leaving were not very rewarding, but "because foreigners working for only short periods in the UK could not fully replace those British scientists and engineers who had left for permanent posts abroad, the resulting net loss of talent was regarded as having an adverse effect on British research, particularly in universities."¹⁸

Other information on migration

The Royal Society has another source of data on the brain drain—the place of residence of its own fellows.⁸ For British scientists being elected a fellow of the Royal Society is only one down from a Nobel prize, and eligibility is restricted to citizens of Britain, the Commonwealth, and the Irish Republic or to those "ordinarily resident" in those countries. Figure 2 shows the proportion of fellows living outside Britain, and figure 3 shows the proportion living outside Britain at their election. The proportion of fellows resident in the US grew from 2.8% in 1960 to 8.0% in 1986, and the proportion of fellows living in the US at the time of their election trebled between 1960-2 to 1984-6. This is thus strong evidence of the exodus of outstanding scientists from Britain, and unfortunately there is no evidence of outstanding American scientists coming to

Britain: in September 1984 only two of 1484 members of the US National Academy of Sciences were working in Britain.

One other source of data on the brain drain is the Universities' Statistical Record, and the staff who collect this information provided the Royal Society with extra data for its report. These showed that the number of full time academics in engineering and technology, agriculture, biological, and physical sciences who left for overseas posts fell from 350 in 1974 to 290 in 1984. The numbers of "wholly university financed" staff in these subjects who emigrated also fell from 165 in 1974 to 47 in 1984. But those on short term contracts who emigrated increased from 185 in 1974 to 243 in 1984. (These figures may be underestimates because many of those leaving universities do not say where they are going, and the proportion who did not say increased from 20% in 1974 to 38% in 1984.)

Conclusions

The brain drain abroad is widely perceived among scientific researchers to be serious, but attempts to measure its scale have been disappointing. Possibly it is not as serious as it is perceived.

MATERIA NON MEDICA

Play the game

Cricket is a special sport—or is it? There has always been a certain aura about cricket, a gentle game played by gentlemen. The primeval instincts aroused by lesser sports like boxing and football were not meant to taint the serene calm of cricket. Perhaps the modern world with its altered values and different perspectives intends to change all that. Perhaps the twenty first century will have no special category of men called "gentlemen," and the concept of "fair play" will be cast aside in the rising tide of ruthless ambition.

The recent headline catching antics of a Pakistani umpire and an English captain have brought this simmering issue to focus. Success in cricket has become synonymous with national pride. On the one hand the former colonies see victory in cricket as an expression of a newly discovered self assertion, while the ex-colonials view it as a form of corroboration of the past. Given such an explosive and antagonistic mixture of national feelings, the recent controversy was perhaps inevitable.

The real question now is: Can this unhappy trend be reversed, or is cricket inexorably doomed to join the ranks of the gladiatorial sports? I hope the latter will not happen, for in a small way all of us will have lost. Cricket embodies the best in all decent men. It is one game which genuinely has the potential of encouraging the spirit of participation over the instinct of triumph. I think it would be sad if circumstances forced us to appoint neutral umpires. A cricket umpire should be a custodian of democratic principles, and a democracy is best judged by the manner in which it treats its minorities—in this instance the visiting team. No one is infallible; all of us make mistakes (even cricket umpires). If a point is in doubt one makes the plea for adjudication in favour of the visitors. One also appeals to all cricketers, especially captains, never, ever, to question the umpire's decision. After all, we are hoping that by the dawn of the next millennium all men will be equal; perhaps all men will even be gentlemen.—G DAS, lecturer in urology, London.

Are microwave ovens hazardous to health?

Microwaves occupy the electromagnetic spectrum from 30 MHz to 300 GHz. It is more convenient to think in terms of frequency because the wavelength may vary when the same "wave" is propagated in different media. Thus at 3 GHz the wavelength will be 10 cm in air, 1.49 cm in skin, 3.79 cm in fat, and 2.12 cm in muscle. The effects produced by microwaves are thermal and non-thermal. On the non-thermal effects Brennan comments, "Other arcane non-thermal effects of exposure to low level RF radiations have been reported, particularly by Eastern block countries. They range from sterility and congenital abnormalities to general ill health, vague malaise, and malignancy. None of these effects has been satisfactorily demonstrated in epidemiological studies."

More serious, particularly in medicine, may be the "brain filter" that stops bright graduates entering research and the "internal brain drain" that takes researchers into other careers. Somebody should surely attempt to measure these problems among medical researchers.

References

- 1 Franks A. Research down the brain drain. *The Times* 1987 April 1:10.
- 2 Davis I. The sky in America is indeed the limit. *The Times* 1987 April 1:10.
- 3 Anonymous. Despair drives physicist to US. *The Times* 1987 Aug 28:3.
- 4 Anonymous. Britain's brains go down the drain. *Economist* 1987 March 28:27-8.
- 5 Lukes S. Why the brains of Britain are fleeing. *Observer* 1987 April 26:10.
- 6 McKie R. Cuts force out top scientist. *Observer* 1987 July 26:24.
- 7 Schoon N. Why our science can still appeal. *Independent* 1987 Aug 3:13.
- 8 Science and Engineering Policy Studies Unit. *The migration of scientists and engineers to and from the UK*. London: Royal Society, 1987.
- 9 Advisory Board for the Research Councils. *The brain drain. A summary of findings from an enquiry by the Advisory Board for the Research Councils*. London: ABRC, 1985.
- 10 Walden G. How to halt the brain drain. *The Times* 1987 April 6:10.
- 11 National Science Foundation. *Science indicators*. Washington: NSF, 1986.
- 12 Royal Society. *Emigration of scientists from the UK*. London: Royal Society, 1963.
- 13 Young A. International movements of scientists and engineers in the 1960s as an aspect of the mobility of highly qualified manpower. In: Friberg G, ed. *Brain drain statistics. Empirical evidence and guidelines*. Stockholm: Committee on Research Economics, 1973.
- 14 Wellcome Trust. *Sixteenth report 1984-6*. London: Wellcome Trust, 1987.
- 15 Judd J. Quiet flow the dons to the USA. *Observer* 1987 June 14:10.

Microwaves dissipate energy, as heat, on passing through tissues, the amount depending on such factors as frequency, power, and nature of the tissue. Obviously microwave ovens are designed to obtain good penetration by the waves and efficient absorption of energy so that the meat is cooked. They generally operate at about 2.45 GHz. The tissue in the operator that is generally regarded as most at risk to thermal effects ("the critical organ") is the crystalline lens in the eye, which depends for cooling on the aqueous humour. So, given a safety factor of 10, the exposure standard for dose was set at 10 mW/cm².

Well designed microwave ovens do not allow the waves to penetrate outside the walls of the oven itself, and interlocks should stop the magnetron operating when the door is unlatched. The possibility remains, then, of leaks around the door seals. Many ovens have two catches to ensure that the door is held tightly shut against the frame, but it is important for the user to ensure that the door seals are kept clean and the door is not warped.

Manufacturers work to an emission standard of below 1 mW/cm² at 5 cm, allowing for a deterioration to about 5 mW/cm² to occur. This is a manufacturing emission standard and not an exposure standard. It is possible to check the leakage of the oven with an appropriate electromagnetic leakage monitor. Selection of the appropriate instrument and its method of use are really the province of a physicist or hygienist.—W R LEE, professor of occupational health, Manchester.

- 1 Brennan DH. Non-ionising radiation. In: Raffle PAB, Lee WR, McCallum RI, Murray R, eds. *Hunter's diseases of occupations*. London: Hodder and Stoughton, 1987:608.

What might be the cause of nocturnal polyuria in a man in his 50s and how should we treat it?

Nocturia frequently occurs after drinking too much before retiring. Most people realise this association and modify their fluid intake accordingly. Although the patient is only in his 50s, left ventricular failure and prostatic obstruction should be excluded. Usually this is possible from the history alone, but clinical examination of the heart, lungs, and prostate followed by chest x ray examination, electrocardiography, and ultrasonography to assess the volume of residual urine will clarify the position. The nocturia of advanced chronic renal failure secondary to an osmotic diuresis resulting from a raised plasma urea concentration can easily be assessed by measuring the serum creatinine concentration. Apart from diabetes mellitus, endocrine and metabolic causes of nocturia in middle aged men are uncommon.

Two drugs other than diuretics may cause nocturia: nifedipine and lithium. Nifedipine is a calcium channel antagonist, which relaxes arterial smooth muscle. There is a sustained increase in renal blood flow in some people who take this drug to control hypertension and nocturia results. I have found that substituting labetalol 200-400 mg for the evening dose of nifedipine controls the hypertension and abolishes nocturia. One adverse reaction to lithium is polyuria, a consequence of renal tubular damage, secondary to chronically high serum lithium concentrations. This nocturia may respond to the withdrawal of lithium.—ROGER GABRIEL, consultant renal physician, London.