if defensible, is unlikely to bring about clearly needed change.

Sharpe recently identified one of Britain's failings in scientific research as an inadequate supply of technical and managerial skills to capitalise on the innovative skills of the research community.³⁰ Certainly Richard Nixon's war on cancer in the United States in the 1970s proved that money alone will not solve research questions if the infrastructure to manage its use is inadequate. If British medical science is being held back by its management in the same way that British manufacturing industry was a generation ago, then the white paper is timely. In its reaction to this challenge to look into the future the MRC has shown again that its culture does not embrace change easily. Our research also shows that Dr Rees's colleagues within the MRC's own research units do not uniformly share his belief in the excellence of his particular remedy.

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II—Is medical research well served by peer review?

The research community uses peer view widely for assessing work both when making funding decisions and for publishing the results. The appropriateness of peer review in both arenas is being questioned increasingly on theoretical and practical grounds. Some believe its use retrospectively, as in publication review, is less objectionable than when used prospectively in steering funding decisions for original research, though many of the weaknesses apply in both applications. Its use in both contexts, however, continues undiminished and largely unaltered.

In the previous article we examined aspects of the management structure of Britain's largest single funder of medical research, the Medical Research Council and highlighted the unsuitability of its centralised bureaucracy to the research environment.¹ Much of this central structure exists to service the council's peer review mechanisms, and any attempt to restructure the way the MRC works must address the central part that this form of review plays. We examine here the concept of peer review, appraise its operation in the light of recent research within the MRC, and consider an alternative operational pattern which could overcome the MRC's dependence on a system which is theoretically and practically flawed.

The problem

Within the MRC, peer review is carried out by ad hoc panels of the "great and the good" from the scientific community who are asked to review researchers' achievements or their future plans—or both. The flaws in this system lead to the suboptimal application of available funds, incur considerable hidden costs, and result in many lost opportunities through the long periods of uncertainty generated, particularly in MRC's own flagship units.

THEORETICALLY FLAWED

The work of Kuhn² and others^{3,4} shows that peer review must favour incremental research which defends the existing body of understanding of a subject—the current paradigm. Kuhn goes on to demonstrate that fundamental scientific progress stems from completely new approaches which break the mould of current thinking. In Braben's words: "The central problem with the peer review approach is that it is only any good for next step research of limited vision. It is totally inappropriate for the exciting big leaps which carry understanding forward."⁵

Kuhn² and others also argue that those chosen to perform peer review, having long careers and prestigious reputations founded in the current paradigm, are likely to be hostile to its overthrow and thus least receptive to innovative science.^{6,7} When the paradigm changes accumulated experience of the old paradigm counts for nothing—what Barker terms the "back to zero effect."⁸ In looking at the practicalities of the peer review process within the MRC this paper draws on recent research⁹ as outlined in our previous paper.¹

SUBJECTIVE

No final mechanism exists within peer review to resolve conflicting views among reviewers or between reviewer and the scientist under review. This makes the process essentially subjective.^{2,10} In turn this further undermines its appropriateness both theoretically and practically.

One leading academic researcher, widely experienced on both sides of the review process acknowledged that, "We seem to suspend scientific method when involved in peer review and objectivity and self doubt are replaced by preconception and subjective conviction. I have seen it on all sorts of granting

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committees . . . and indeed have been guilty of it myself."⁹

COSTLY

For peer review to operate in the MRC hidden costs are incurred in side tracking the productive efforts of the most able, experienced, and highly paid researchers, who are called on to give their (and their employers') time to allow the system to operate.

In 1961 Nobel laureate Leo Szilard ruefully suggested that, within his research lifetime, 100% of the scientific workforce would spend 100% of their time engaged in the peer review system of one side of the fence or the other.¹¹ At that point, he noted, the nature of scientific enquiry would change from the performance of science to the planning of science. Though this suggestion was tongue in cheek, recent work by Turney suggests that individual researchers in some disciplines spend more time writing for and participating in peer review activities than in doing their research.¹² Also involvement as a reviewer is skewed towards the most able and most experienced members of the scientific community.

Taken together these considerations indicate the degree to which operation of a peer review system interferes with scientific productivity, efficiency, and effectiveness. In this way the costs of the system reach far beyond MRC's own £250m annual budget, yet this vast hidden, and unquantified, cost is kept concealed through the collusion of the research community. One unit director observed: "I suspect that if they costed the process on a realistic basis they would have to discontinue it tomorrow. It cannot possibly be cost effective in that sense."¹⁰ One of the directors quoted in the previous paper¹ was not alone in pointing out that the review of his own unit had taken up two years of his time.

LACKING PACE

The existing system is problematical to manage with any degree of pace.¹⁰ As peer reviewers are asked to participate without payment and since doing the job conscientiously requires considerable time, long delays have to be built in to allow referees to fit the task in. These hold ups are further compounded by the tiered committees which then consider the judgments given. Nine of the 11 MRC unit directors sampled felt the time taken for peer review was unnecessarily protracted, and five complained of the effect this had on planning within their units. No director thought it fully met the needs of the organisation.

PLANNING BLIGHT

MRC funding varies from three and five years' duration, yet protracted timetables mean decisions on continuing funding routinely take two years to emerge, resulting in researchers spending up to half of their funded period suffering from this form of planning blight. Such uncertainty drastically damages a research unit's capacity to attract industrial and corporate finance and to enter into medium term partnerships with the private sector. For example, one unit was

instructed not to negotiate an extension to a highly successful six figure research contract with an industrial partner while its review took place, seriously damaging its chances of further collaboration. In the rhetoric of the MRC, however, alliances with industrial partners are increasingly vaunted as the potential salvation of basic research.

INTERNAL EXPERTISE

Addition to peer review encourages a culture within the MRC in which its central managers fail to develop an understanding of the current issues in science.^{9 13} This occurs because they are never called on for expert opinion, which is always imported from outside experts. This devalues this cadre of scientific manager from the highly knowledgeable individual, fully abreast of scientific thinking, found in his or her equivalent in an industrial research and development culture, to little more than an administrator checking the deliberations of external advisors. In turn it robs the organisation of in house expertise and leads to a bureaucratic structure with many more layers than are found necessary in the private sector.¹⁴ Glaxo, for example, has four management tiers between the chairman and an active benchworker; in parts of the MRC 11 layers are identifiable. These layers further contribute to an overall lack of pace in decision making and isolate MRC central managers from mainstream scientific thought, the organisation's *raison d'être*.

SHIFTING GOALPOSTS

As the same external reviewers do not remain involved for the full duration of a funding cycle, research directions approved when funds are granted are often criticised by that peer review committee's successors when funding is reviewed later. This points up the subjectiveness of the process and, as the primary reason for rotating reviewers is to protect them from an unreasonable long term commitment, it tacitly acknowledges the hidden costs. This constant moving of the goalposts, however, damages morale and the achievement of long term objectives within MRC research groups.

UNFAIR?

One could argue that all these delays and uncertainties might be worth tolerating if the system could be shown to be fair, effective, and honest in operation. The few studies done to evaluate these factors for peer review in general, however, indicate that these cannot be guaranteed. Cole has shown considerable variation in outcome, depending on the referees chosen.¹⁵ Peters and Ceci have shown bias based on the fame of the authors and their place of work or where they obtained their PhD.¹⁶ These authors went on to describe their difficulties in getting these data published via a publication system run on peer review. Yet more reprehensible was the way in which the scientific establishment closed ranks against them after publication of their findings.¹⁷ We could find no published studies attempting to refute this work, however, suggesting that those hostile to its conclusions have been unable to rebut these findings by usual scientific debate.

In 1986 Irving analysed the backgrounds of those advising the MRC through their key committees of external experts.¹³ He found a pronounced bias towards southern medical schools (Oxford, Cambridge, and London in particular) and to non surgical disciplines (see table). He also found MRC funding to be similarly skewed, with disproportionate amounts going again to London, Oxford, and Cambridge. He and others ascribed a causal relation to these disparities, with Dudley accusing the MRC of operating a "self perpetuating oligarchy."¹⁸ An examination of the

Composition of MRC funding committees and the distribution of MRC funds. Values are numbers and percentages

	London	Oxford and Cambridge	Other universities	Total
Three principal MRC boards	31 (47)	8 (12)	27 (41)	66
Grant awarding committees	27 (43)	11 (18)	24 (39)	62
Representation on MRC council, training awards and grant awarding committees	67 (46)	22 (15)	55 (39)	144
Placement of MRC units	21 (38)	13 (24)	21 (38)	55
MRC unit staff numbers	1552 (51)	685 (23)	791 (26)	3028
Holders of programme grants	68 (53)	31 (24)	29 (23)	128
Relative size of university (% medical students trained)	30	7.8	62.2	100

After Irving.¹³ Figures for 1985 from *MRC Handbook*.

current MRC handbook suggests little has changed in terms of source of experts and location of research units (though detailed evaluation as Irving did is no longer possible from published data).

EFFECTIVE?

Six MRC unit directors felt unable to judge the effectiveness of the peer review process, some commenting that they were unsure how that could be assessed. Only one thought unreservedly that the process was effective, while another, though critical of the system, commented, "It seems to come up with the right answers." On the other hand, three thought the peer review process was not effective at all. One of the directors suggested, "With funding cuts in their brief now and very much on the agenda there are other motives at work. It can no longer be viewed as pure peer review."

OPEN TO MANIPULATION?

Finally and most sensitively, peer review makes the assumption that intellect and integrity go hand in hand. Again recent work calls this premise into question.^{6 15 19 20} With the competition for research funds more frantic than ever and scientific specialisation ever more focused, a scientist's peer is his or her closest rival. Anecdotes abound about publications being held up while a referee's coworkers repeat the work and rush into publication elsewhere, and with funding decisions there is the pervasive view that "less for him means more for me."

Views current within the MRC would seem to uphold these general concerns. Six of the unit directors interviewed regarded the system as unfair. One said of the process, "It's just not honest. My unit was scheduled for closure because they criticised the science, the only real grounds for closure. When I funded the work from industry, it was confided to me that they [MRC] weren't at all critical of the science really, but claimed they knew I would get alternative funding if the MRC withdrew." Another was more acerbic: "It's a stitch up. They know the outcome they want and the referees and committee members are chosen in the expectation of the view they will deliver." Indirect support for this view might be gleaned from another director, who was assured in advance of his unit's review that he had nothing to worry about from its outcome.

Even one director who believed it to be a fair system (in which he had participated many times as a reviewer) said that peer reviewers did "sometimes get bees in their bonnets and . . . got caught up on details . . . which then got out of perspective."

ACCEPTANCE

Notwithstanding the widespread reservations expressed about the operation of peer review within the MRC, surprisingly, only one unit director had serious reservations about the process in principle. One enlisted Churchillian sentiments in suggesting that it was an awful system but the best there was. It might be borne in mind that those interviewed had prospered under current arrangements so they may have no vested interest in change, though this consideration makes their candour about the system's shortcomings (shared with a stranger in most cases) the more telling.

Are there alternatives?

Other organisations engaged successfully in biomedical research and development, such as the pharmaceutical industry, do not use a peer review system, and nor does the defence research sector when evaluating research ideas. It is to these models that we might look for an alternative approach. Though there

are clearly a range of alternatives to the present structure we have singled one out for special consideration. The one chosen would complement and facilitate our earlier suggestions for changes in the operational structure of the MRC.¹

LEADERSHIP

Rather than leaving its strategic decisions in the hands of outsiders and operating a system designed to deliver consensus, "lowest common denominator" research we believe the MRC should show leadership. It should change its culture by recruiting in house expert opinion, review research areas (which it already claims to do) in partnership with the myriad of interested learned societies, and, so armed, commission research in areas it believes to be important. Programmes should be bid for by interested scientists and these bids developed in partnership with a new breed of in house MRC expert. Most of each programme, perhaps 80%, should be carefully costed and scheduled and have specific, measurable, achievable, realistic, and timetabled goals agreed from the start.

CREATIVE FREEDOM

The remaining portion should be funding to allow for the free development of ideas whence the unpredictable, paradigm redefining advances will stem. Such concepts are common in many highly innovative companies, 3M's "stolen time" concept perhaps being the most well known. Here research and development scientists are not expected to account for up to 20% of their expenditure, freeing it to be used for speculative experimentation. Several of 3M's most innovative and profitable new products have stemmed from such activity. Renewed funding should depend both on this "free" activity and on the achievement of specific goals. If the MRC wanted to fund the infrastructure of some of these groups then that too should be possible separately from the winning of specific research funding, at least initially. Clearly continuation of such base funding arrangements could be simply assessed on the basis of a group's success at winning commissioned research, without the need for any element of peer review.

RISK ANALYSIS

In many other areas of high risk investment realistic funding and goal setting are helped by the use of risk/cost analysis techniques when proposals are being developed. These techniques are an attempt to assess the risks involved rationally. This approach is widely used in the defence and commercial research and development sectors but is as yet unheard of in medical research circles. Skill in risk/cost analysis is available through specialist consultancies, some of whom are positive about the wider application of their methods and interested to see them applied in different disciplines (P D Cook, personal communication).

PARTNERSHIP

The availability of experts on the MRC payroll would allow rapid and constructive interaction while the research progressed—something that is almost totally absent in the current system.¹ Thus a real partnership would develop between the purchasers and providers of medical research, replacing the adversarial basis of their current relationship. Such contact would also serve to keep the expert research managers at the cutting edge in terms of their knowledge and awareness, maintaining their capacity for informed decision making. As the system would not be the slave of external expertise, though such expertise might be its servant through input from learned societies, it would be much less labour intensive and could operate flexibly and fast. A new research com-

missioning agency of this type fits much more comfortably with the latest proposals from the Advisory Council on Science and Technology for future science funding¹ than it does within any plans the current MRC has for its future development.

Conclusions

The theoretical arguments against the use of peer review for assessing innovative scientific proposals now date back more than 30 years. In that time little has been published to attempt to refute Kuhn's work and much has been published to support it. Remarkably, however, these arguments have largely failed to influence the practicalities of peer review. Nevertheless, this does not undermine their validity. Peer review for funding decisions on new science remains open to question philosophically.

Others have examined the way in which the MRC operates its peer review procedures before.^{10 13 18 21-25} In general these articles, many by individuals with more experience of the organisation than we have, were critical of what they found in 1986 and 1988. The conclusions reached seven years ago would still seem to be tenable today.

In our earlier paper we showed that the MRC is slow to embrace change,¹ and there is little in the current research findings to lead one to conclude that the MRC's peer review system is any more trusted or effective than it was five to seven years ago. A vital ingredient in any effective system is that it must command the trust and respect of those involved in it. Yet in her recent valediction to the MRC's toxicology unit at Carshalton Craddock commented, "Now we must not only be cost effective, which I am certain we always were in the long term, but to be seen to be cost effective in the eyes of those who have only a superficial understanding of what is involved."²⁶

Peer review is simply a decision making process, and is only as good as the decisions it delivers. Clearly there is room to question the quality of these judgments and the principles that give rise to them, yet the scientific community is reluctant to question the process from which they emanate. Those who would seek to defend the process on cost benefit grounds must assess the hidden costs of the system before they can be set against what this research suggests are its questionable benefits. Managerially no practical defence of the process can be attempted without thoroughly evaluating all the opportunity costs incurred by reviewers and those reviewed. To our knowledge this has never been attempted. Even if it were done it would be impossible to audit the benefits derived from research selected by peer review against those that would have

come from work not funded by the process. Whether such an undertaking is worthwhile for a system so theoretically flawed must be open to question. As Pegg commented recently, the whole science of molecular biology, now consuming so much of the medical research budget, would never have become established if the early work on which it is based had relied on peer reviewed funding.²⁷

To abandon an established paradigm such as peer review is always in part an act of faith. A convincing case can be made that heavy reliance on peer review is failing the scientific community, and the consideration of alternatives may help nurture an appetite for change. Little in the alternatives suggested here or in our accompanying article will strike anyone whose background lies within a successful commercial research and development culture as revolutionary. The problem lies in the fact that our research suggests that most research managers within the publicly funded research organisations will see these proposals as apostasy.

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AN EXPERIENCE THAT DETERMINED MY CHOICE OF SPECIALTY

High morale, low illness rates

I qualified towards the end of the war and was soon called into the army and sent to the Far East. As a medical officer in a battalion in Burma I had to submit figures of the general sickness rate and of the rates of various illnesses such as malaria, dysentery, and venereal diseases. When these figures rose I was anxious. What would the battalion commander think of the way I was looking after his troops? To my surprise and great relief no one took any notice of me. The person who was on the mat was the battalion commander who was asked to explain to his superiors what was wrong with his leadership that caused such low morale.

Bill Slim, commander in chief in Burma, was one of the few army commanders who recognised that these figures were indices of morale. If morale was high fewer soldiers were ill. They took their antimalarial pills and kept their

mosquito nets in good repair and there was less malaria. If hygiene was good there was less dysentery and probably soldiers were more discriminating and there was less venereal disease. For a doctor who had just qualified, who was brought up solely on the medical model, and who believed that the only way to consider malaria was that it was due to parasites, dysentery to bacilli, and syphilis to spirochaetes, this approach was an eye opener. It made a profound impression on me and was an important factor in determining my choice of psychiatry as a career.—ALEXIS BROOK is a retired consultant psychotherapist in London

We welcome contributions up to 600 words on *A patient/paper who changed my practice; A memorable patient; The message I would most like to leave behind*, or similar topics.