severity of health problems and the variety of options for care and care settings.

Secondly, concern about the use of QALYs still focuses on doubts about their adequacy as measures of health gain⁴ and on the technical validity of comparisons of costs per QALY.⁵ Though these problems may be overcome, we believe that the authors' conclusions are mistaken, even when considered within the logic of their own "economic" arguments.

The authors fail to acknowledge that the marginal cost per QALY changes with the extent of unmet need for a service. If services are provided first to those with greatest need the marginal cost per QALY will increase as provision is increased. As the point at which need is completely met is approached the marginal cost per QALY is likely to increase sharply because the marginal benefit derived from increasing provision declines. For example, the number of people in a population who need hip replacement is finite.⁶ Once services have reached the level at which all such people receive a replacement quickly the QALYs gained by increasing provision further will be zero and the marginal cost per QALY infinite. The only way around this problem is to estimate cost per QALY at each level of unmet need (not service provision as the authors suggest), based on an understanding of the distribution of severity of a health problem within the population.

It might be argued that for most services unmet need is so great that gain in QALYs can be assumed to remain constant over the range of any marginal increase in service provision. We believe that this view cannot be accepted uncritically and that the estimation of unmet need must form the basis of a strategy for planning and purchasing health services, even where maximising QALYs is the agreed objective. This can be achieved only by considering a wide variety of formal and informal information on the occurrence of health problems and the effectiveness, balance, and costs of services.² This is the business of needs assessment.

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Cost effectiveness of magnetic resonance imaging

SIR,—A K Szczepura and colleagues present a valuable analysis of the costs of a magnetic resonance imaging service¹ but conclude that there is no evidence of a beneficial effect on their patients' quality of life. This conclusion is based on a cohort study without a control group. Mean quality of life scores are presented, based on responses to questionnaires completed at the time of the scan and six months later; the mean score for the whole group fell by 0.059, but there is no statistical analysis of these data to indicate significance, confidence intervals, or the statistical power of this study. Only 52% of the patients in the study completed questionnaires, and the possibility of sample bias is not discussed. Moreover, their data relate to a group of patients who had a wide variety of brain and spinal diseases.

It seems inappropriate for conclusions about the impact of radiological investigations on patients' quality of life to be drawn from an audit of this nature.

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- 1 Szczepura AK, Fletcher J, Fitz-Patrick JD. Cost effectiveness of magnetic resonance imaging in the neurosciences. *BMJ* 1991;303:1435-9. (7 December.)

AUTHORS' REPLY.—L J Abernethy is wrong to suggest that our study concludes that magnetic resonance imaging has no beneficial effect on patients' quality of life. The main focus of our evaluation was the impact of imaging on diagnosis, diagnostic certainty, and patients' management and the economic implications for the health service. In the service setting with which we were faced we were unable to set up a randomised controlled trial. To achieve our main objectives we chose a controlled observational methodology as the optimum means of ensuring adequate prospective control.¹ The lack of an external control group naturally meant that we were not able to identify with any certainty whether patients' quality of life changed because of magnetic resonance imaging. In the paper we state that "there was no indication that patients' quality of life improved after magnetic resonance imaging."

Furthermore, our study was restricted to neuro-science referrals, and large scale improvements in quality of life were not expected. The pattern we observed is similar to that reported by Dixon *et al.*² Both studies show a relatively high average quality of life for patients at the time of their scan and a slight deterioration six months later. In our study we also recorded the prognosis made by consultants at the time of referral. This predicted a slight deterioration overall, which was confirmed by the quality of life measurements.

Because our chosen methodology could not measure the impact of imaging on patients' quality of life we considered recruiting a contemporary control group of matched patients from other centres to obtain this information. Owing to financial constraints we had to reject this idea. Similar quasiexperimental studies, however, failed to recruit genuine control populations in earlier evaluations of new medical imaging technologies such as computed tomography.⁴ All this is fully explained in our report on the project¹ but could not be included in the condensed version published in the *BMJ*. Interestingly, the most recent document summarising the Australian trial of magnetic

resonance imaging (produced since our paper was submitted) concludes that further work is needed to measure the effects of magnetic resonance imaging on patients' quality of life "but that such data may be difficult to obtain."³ Our experience supports this.

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SIR,—A K Szczepura and colleagues¹ discuss the cost effectiveness of magnetic resonance imaging in the neurosciences. I wish to highlight the sensitivity of the cost per patient to changes in the throughput of patients; reinterpretation of the authors' data with some modifications leads to a far more favourable outcome for the use of magnetic resonance imaging.

The authors compared the annual costs in their unit in Coventry with those at other sites in the United Kingdom and in Australia and the United States. I have used the authors' data, with some modifications to take account of the current prices of equipment in the United Kingdom, to analyse the sensitivity of the cost of an examination to the number of patients scanned. The theoretical maximum throughput for magnetic resonance imaging is difficult to assess; in the private sector low throughput may result from an inability to attract referrals, while in the public sector it may result from underutilisation of equipment. I estimate that an achievable throughput approximates to one patient every 30 minutes with a 1.5 T system, falling to one patient every 45 minutes with a 0.5 T system. These figures are quite achievable, given that a typical lumbar spine examination, with imaging in two planes and up to date sequences, takes under 10 minutes at 1.5 T.

I have not included the cost of upgrading the system in this analysis as it is not necessary to

Estimated annual cost (£) of magnetic resonance imaging service in United Kingdom, based on 1991 prices

	Field strength*			
	Mid-field	Mid-field	Mid-field	High field
Patients per year	2 250	2 880	3 840	5 760
Patients per day	9	12	16	24
Operating hours	8	8	12	12
Annual capital costs:				
Equipment†	107 000	107 000	107 000	179 000
Accommodation‡	20 000	20 000	20 000	20 000
Total annual equivalent	127 000	127 000	127 000	199 000
Annual revenue costs:				
Staffing‡	105 000	105 000	155 000	155 000
Operating	48 000	48 000	48 000	48 000
Service and cryogen§	65 000	65 000	65 000	85 000
Variable	38 000	49 000	65 000	98 000
Total costs	256 000	267 000	333 000	386 000
Total annual cost	383 000	394 000	460 000	585 000
Direct cost/patient	170	137	120	102
Net effective cost¶	89	56	39	21
Net effective cost	27	-6	-23	-41

*Mid-field includes 0.5 T and 1.0 T systems; high field is 1.5 T systems.

†Assumes that equipment has a seven year life and accommodation a 25 year life at 6% discount rate. Average prices are mid-field equipment £600 000, high field equipment £1.0m, and accommodation £250 000.

‡Staff costs increase to account for extended hours.

§Assuming improved management benefit from magnetic resonance imaging of £80.

||Assuming reduction in existing procedures, saving £62.