thy of mention, as they may correspond to the experience of other practitioners'. This letter was a catalyst in the process which led to the linking of congenital abnormalities to the taking of thalidomide in pregnancy. Indeed, present day over-emphasis on the methodology of biomedical science and complex statistical analysis may explain why many general practitioners, who have chosen a career in patient-centred medicine, abstain from any involvement in research activities and resist approaches which seem to reduce people to lists of numbers. There is an urgent need to develop qualitative as well as quantitative approaches. Clear clinical outcomes are easily counted. Outcomes such as the relief of anxiety, helping to change a patient's attitude to disability, chronic pain or terminal illness are much harder to measure reliably. The patient may regard outcome in different ways from the health professional: the medical treatment for his or her complaint may be less important to the patient than understanding what is happening, how long he or she had to wait and how the practice treated him or her as a person.

Research-based information is vital to meet the changing medical needs of practice patients and develop useful measures for disease prevention and health promotion by encouraging an inquiring, analytical attitude to the problems of daily clinical work. As hospital treatment becomes even more costly and hospital management more cost-conscious, it becomes urgent to investigate health problems in the community. Do practice clinics for asthma, diabetes or hypertension make worthwhile savings on hospital referrals? Can retinopathy be spotted earlier, can amputations be avoided and can quality be maintained by a well-resourced professional practice team? Can we measure 'softer' outcomes such as relief and prevention of pain, anxiety or disability in a meaningful way? Health promotion activities such as three yearly checks have not been shown to be helpful to patients[11] and published research suggests that such activities are neither effective nor an efficient use of health care resources. Further research work and observance of the principles identified by Wilson and Younger[12] should secure more worthwhile alternative contributions to the delivery of care and the promotion of health.

A strong research culture in general practice is necessary to enable the general practitioner and the primary care team to maintain and develop the clinical skills required to meet the evolving medical needs of their practice population. Also, as Buckley[13] points out, 'in a society which is increasingly well informed, we need to prove our value'. Times of change and crisis also present opportunities — opportunities to increase the number and proportion of practitioners questioning, testing and thinking about the way they work. General practitioners work at the front line of medicine[14] rather than in hospitals or central institutions. As a result, solutions must reflect the decentralization of general practice. Accessible local research resources are needed to promote a research-friendly environment. Support at local level is required to help researchers develop their research proposals before they are submitted for funding. A laudable start has been made in the Syntex awards[15] which provide an incentive for trainees wishing to start a project and in the critical reading paper recently introduced in the MRCGP examination. RCGP research training fellowships have been successful but relatively few are available. Such fellowships are less about learning statistical techniques and more about exposing doctors to a stimulating environment where ideas can be nourished and nurtured. The recently announced MIA/RCGP research training fellowship is a welcome addition.

Research represents a commitment to the future of general practice. Good care depends ultimately on the quantity and quality of research and of continuing education within general practice. The College's standing places it in a position to influence the climate of opinion within and outside the medical profession and part of its responsibility is to forward the research and academic future of our discipline. The opportunity exists to enable interested general practitioners to get into research and for the College not only to identify research needs but to influence the planning and implementation of research studies. Are we moving forward on research?

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Statistics — with confidence?

OVER the past 10 years, the statistical analysis of articles published in this *Journal* has improved, at least by common consent. It would be difficult, if not impossible, to identify the causes of that improvement scientifically. Nevertheless, it is tempting to attribute part of the improvement to a change in *Journal* policy dating from 1982. Since then, inferential articles (those that seek to go beyond descriptive statistics by inferring conclusions from data) have been seen by a statistical assessor as well as by medical assessors.[1] If that change of policy has indeed resulted in an increase in the statistical quality

of the average *Journal* article, then the credit belongs to the small band of professional statisticians who have advised the editor on the scientific merit of articles submitted over the past nine years. The *Journal* acknowledges their contributions — sometimes controversial, usually careful and always unpaid — with gratitude and admiration.

Despite the efforts of these statistical assessors, it is doubtful whether the statistical content of *Journal* articles has become any clearer to general practitioners. Among the reasons for this are an overemphasis on the testing of scientific hypotheses and an overuse of statistical jargon, as in the hypothetical example, 'statistical analysis rejected the null hypothesis that antibiotics do not affect the outcome of acute otitis media in children ($P<0.05$)'. Of course this statement could be made more reader-friendly by removing the formula in brackets and recasting the sentence as 'children who were prescribed an antibiotic for their acute otitis media showed a statistically significant improvement in outcome after seven days, relative to children without such a prescription'. Even so, general practitioners would still be unsure of the implications for clinical practice; and statisticians would be disappointed by the vagueness of the conclusion.

Both practitioners and statisticians would surely welcome more emphasis on the basic results of the research, expressed in terms such as 'children who were prescribed an antibiotic for their acute otitis media were 9% more likely to have recovered after seven days than children without such an antibiotic'. Unfortunately this sentence no longer enables us to judge whether the improvement could be a mere artefact of chance variations in the allocation of children between the group prescribed an antibiotic and the group without prescriptions. What we need is an additional statement about the likely effect of antibiotics across the entire population of children with acute otitis media, for example 'we can be 95% confident that the improvement of 9% within the sample of children studied reflects a true improvement of between 6% and 12% in all children with acute otitis media'. Statisticians describe such a range as a '95% confidence interval'; the phrase '95% confident' is intended to convey the important concept that in the long run 95 out of 100 such intervals will include the true improvement to be expected in a large population of children.

A confidence interval as narrow as that cited could only result from a study that included at least 1000 children in each sample. If the same improvement of 9% had been generated by a study that included only 100 children in each sample, the confidence interval would have extended from a deterioration of 1% to an improvement of 19%. Since this interval includes zero (that is, no change in outcome) we could not be confident that the prescription of an antibiotic had led to any improvement in recovery from acute otitis media. In other words, if the analysis of this smaller study had been summarized in a hypothesis test rather than a confidence interval, it would have reported no statistically significant effect of antibiotics on the outcome of acute otitis media in children.

This example illustrates three advantages that confidence intervals enjoy over hypothesis tests. First, they can (and should) be expressed in terms that are more easily understood by, and thus more helpful to, general practitioners. Secondly, while the result of the corresponding hypothesis test can be deduced from a given confidence interval (as shown in the previous paragraph), the converse is not true: hypothesis tests provide no information about the corresponding confidence interval. Finally, since the width of a confidence interval is inversely proportional to the square root of the sample size, it conveys information about the size of the sample from which it was derived; but a hypothesis test gives the reader no clue whether it originated from a sample of 1000, a sample of 100, or even a sample of 10.

For all these reasons, the *Journal* will henceforth encourage the authors of inferential papers to express their results in the form of confidence intervals rather than hypothesis tests. Fortunately, this change in policy is unlikely to make the preparation of articles more difficult in the long term. When the *British Medical Journal* introduced the same change,[2] it published a series of articles that described how confidence intervals could be calculated for different types of statistical parameters including means, differences between means, proportions and correlation coefficients. These articles have since been revised and expanded to form the first part of an inexpensive but potentially helpful book.[3] The second part of this book is devoted to the *British Medical Journal's* statistical guidelines for contributors to medical journals — guidelines that the *Journal* was not slow to recommend to potential authors.[4] Perhaps most helpful of all is the user-friendly computer program *Confidence interval analysis* (CIA), specially prepared to carry out the calculations described by Gardner and Altman[3] (available from the British Medical Journal (CIA), BMA House, Tavistock Square, London WC1H 9JR).

Previous editorials have emphasized the wide range of sources of statistical advice available to general practitioners.[1,4] These sources have long included departments of public health and medical statistics within medical schools, statistical departments in universities, polytechnics and health authorities (or their equivalents in Scotland and Northern Ireland), and the research units and faculty research committees of the Royal College of General Practitioners. The introduction of medical audit in general practice is likely to make more statistical resources available to general practitioners, in particular through medical audit advisory groups, and to encourage better adherence to basic statistical principles.[5] Furthermore, there is an increasing number of introductory textbooks on medical statistics that are both sound and readable; Bland[6] is a good example. But the increasing availability of good computer programs such as *Confidence interval analysis* may prove even more productive; they give researching general practitioners more opportunity to explore their own data and more power to summarize their findings in ways that are comprehensible to their peers. In short, the use of confidence intervals in preference to hypothesis tests is both feasible, and helpful to researchers, authors and readers.

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