It is most important to tell the parents that this placement is for a period of training (which may need to last several years) and is *not* for life; and that they should keep contact with the child, have him home for weekends, summer holidays, etc.

AUTISM

The pure syndrome of childhood autism is evident by the time the child is 3 years old—language failure, eye avoidance, finger flicking and other mannerisms, obsessional need for sameness, phobias (for example, fears of animals or going out into the street).

Hyperactivity, repetitive games, and nocturnal screaming attacks are also characteristic. However, there are many other children who show some of these features but not all of them. In every case there are four characteristics. (1) Language is disturbed: someone described these children as being tone-deaf to language. They often show echolalia, repeating the end of the questioner's sentence, and pronominal reversal, so that the child refers to herself as her. (2) They are withdrawn, detached children who show eye avoidance. They will climb on to mother—or a visitor—for a hug but they use the person like an armchair. Parents get no feedback from such children and feel nonplussed, even defeated. (3) They show finger flicking or other hand mannerisms. Sometimes they have a manneristic gait or engage in repetitive skipping, rocking, or body spinning. (4) They seem afraid of change and insist on the table arrangements—for example, their own plate, fork, and spoon—or the going-to-bed ritual becoming fixed and invariable. Often they have a special object—a piece of string or a piece of cloth or plastic from which they cannot be separated.

These children need specialized education and social training based on learning theory. The family doctor's role is to recognize what sort of problem it is and then, alerting the clinical co-ordinator of child health services, arrange an appointment at the child psychiatry department of the children's hospital or with a consultant from the mental handicap hospital. The parents should also be advised to join the local branch of the Society for Autistic Children. Sometimes residential care becomes imperative and the alternatives are usually those mentioned earlier for the hyperkinetic child.

Advice from Family Doctor

Though the family doctor has little to contribute on mental handicap which is specifically medical, he can by his knowledge of the family advise other agencies and secure appropriate services for the child and the parents. He can secure genetic counselling for parents with a severely handicapped child and get support for the parents in the early years when they often feel isolated. When the burden of caring for the child weighs heavily, he can negotiate residential placement so that the parents get a much needed holiday. Because he knows the family he will know best how to handle their anxieties about the future. Unfortunately there is little "curing" to be done in the field of mental handicap but a great deal in the way of "caring."

Computers in Medicine

Simplified Computer-aided Diagnosis of Acute Abdominal Pain

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Summary

A simplified version of a system for computer-aided diagnosis of acute abdominal pain has been tested by "new" personnel unfamiliar with the previous system. After a two-month learning period the system proved more accurate in its diagnoses than the unaided clinician, and during the first five months of using the system the unaided clinicians' accuracy rose from 73% to 84%. When computer "feedback" was withdrawn the clinicians' diagnostic accuracy reverted towards the previous, "unaided" level.

These findings further validate the concept of the computer as a potentially valuable diagnostic aid but indicate that a training period and computer feedback are important factors in its use.

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Introduction

In a paper describing a system for computer-aided diagnosis of acute abdominal pain[1] we showed that in a practical setting the computer-aided system made significantly fewer errors than did the unaided clinician.[2] Nevertheless, much work remained to be done before it could be asserted with any degree of confidence that a system of that type could have any wider application in medical practice.

In particular, the system was open to three criticisms. Firstly, it used a medium-sized computing system no longer in production, and (even with present day technology) that size of system is expensive and difficult to operate. Secondly, though the system worked well in the hands of its instigators there remained no guarantee that it could be operated by other persons without extensive training. Thirdly, it could be argued that the computer itself was unnecessary and that any benefit was derived from clarification of the clinical data rather than use of the computer.

We therefore devised a further series of experiments in an attempt to overcome these points of difficulty. Firstly, we created a much simpler and cheaper system. Next we assessed its performance on a prospective, unselected group of patients with acute abdominal pain, data being fed into it by three of us (P.J.L., C.K.Y., and P.D.W.) with virtually no experience of this or any other computing system. We then continued the system as before but withdrew computer "feedback" to the clinicians —that is, though the clinicians fed data into the computer as

before we no longer routinely provided them with feedback about computer probabilities and their own performance. The results of these further studies form the basis of the present report.

Materials and Methods

Clinical Materials.—The 295 patients studied formed a consecutive, prospective group admitted to this hospital under the care of the professorial surgical unit suffering from acute abdominal pain of less than one week's duration. The series ran from 1 August 1973 to 30 June 1974. Criteria for inclusion were identical with those used previously.[2]

Computing System.—In this study we used a simple desk-top computing system.[3] Briefly, it comprised a Wang 700C desk-top computer/calculator together with an input/output writer. Later a 256K disc was used to speed the diagnostic process. The time from data entry to probability generation varied from three minutes without the disc to about one minute when the disc was attached to the system. This ensured that no delay occurred in the management of any patient as a result of these studies. Programs were written by J.C.H. for both disc and calculator, and the (Bayesian) analysis of symptoms and signs in a test series of 50 cases gave disease probabilities virtually identical with those obtained from our original, larger system. The total cost of the basic system was just over £3000; the disc, which was added for our own use, cost £2750. A disc of this type, however, would not be necessary for most users.

Conduct of Study.—As previously, each case was analysed in "real time" before operation or final diagnosis on the basis of symptoms and signs elicited by one of three registrars (C.K.Y., P.J.L., or R.E.P.). Each case history was coded on the basis of the registrar's notes and entered into the computing system by a single operator (P.D.W.). The registrar's diagnosis was noted, as was that of the most senior clinician who saw each case (usually, as in our previous series, the registrar himself). These diagnoses together with the computer's prediction were compared with the final (usually operative) diagnoses, the diagnostic criteria being identical with those already described.[2]

Training.—Since none of the registrars had previously fed data into the system in this way and the operator had not seen the system before 1 August 1973 some training was necessary. The operation of the computing system can easily be learnt in under half an hour, and most of the difficulties centred around the meanings of the data provided. For example, regarding the "type" of pain it takes only a few seconds to learn which numbers on the keyboard represent "colicky," "steady," and "intermittent" pain but it takes far longer for all concerned to agree on the precise meanings of these terms. Training in this respect was given in informal "feedback" sessions, usually held once a week, in which those familiar with the system discussed the problems of the previous week's cases with the "new" personnel. No other special training was given.

Findings

The first experiment lasted five months (August to December 1973) and was conducted with 113 cases. The purpose was to see what happened when persons unfamiliar with the system took over its operation. The results are described below.

INITIAL SERIES

The final diagnoses in the 113 cases are listed in the table. The pattern of admissions to the unit was similar to that in the previous series, though there were fewer patients with appendicitis. Four further patients were excluded from the trial because no firm diagnosis was made, in two instances even after study of the histopathological reports.

Performance of Clinicians and Computer.—Overall the two diagnostic modes showed virtually identical levels of accuracy, the senior clinicians making correct diagnoses in some 86 of the 113 cases and the computer-aided system's diagnosis being correct in some 88 instances. Such an overall picture is, however, misleading, as is shown by the monthly analyses set out in fig. 1. In August 1973 the overall accuracy of the clinicians was

Final Diagnoses in Present, Initial Series (August to December 1973) of 113 Cases Compared with in Previous Series. Figures are Percentages

	1973 Series (113 Cases)	1971 Series* (304 Cases)
Non-specific abdominal pain	52·3	49·0
Acute appendicitis	17·7	28·0
Cholecystitis	9·7	8·6
Perforated peptic ulcer	5·3	2·3
Small-bowel obstruction	4·4	5·6
Pancreatitis	1·8	2·6
Diverticular disease	1·8	1·3
Other	7·1	2·6

*de Dombal *et al.*[2]

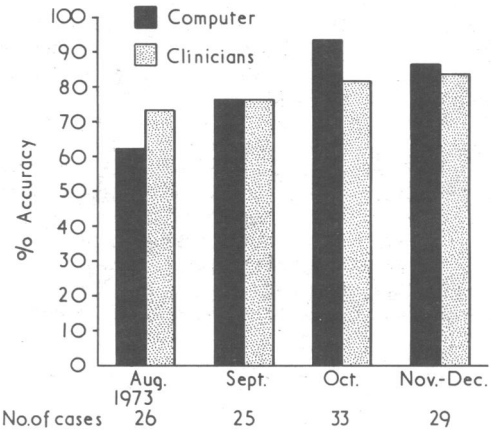

FIG. 1—Monthly analysis of diagnostic accuracy of computer and clinicians from August to December 1973 showing effect of training and familiarization.

73%, whereas that of the computer was 63%. Apart from April 1974 (see below) this was the only month in which cases were diagnosed successfully by the clinicians and erroneously by the computer. In September the overall levels of accuracy were identical at just under 80%. In October the computer system for the first time showed an advantage in accuracy (91% as against 82% for the clinicians), and this was maintained during November and December (two possibly unrepresentative months owing to the industrial dispute affecting the ambulance service, when relatively few cases were admitted). Also noteworthy was the improvement in the clinicians' diagnostic accuracy, from 73% in August to over 80% from October onwards.

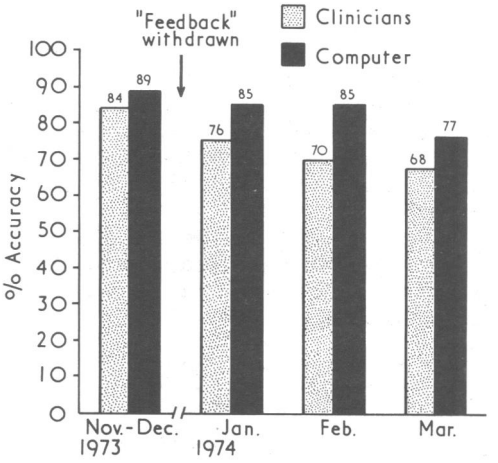

FIG. 2—Monthly analysis of diagnostic accuracy from November 1973 to March 1974 showing effect of withdrawal of "feedback" from computer.

SUBSEQUENT STUDIES

In January 1974 we changed the format of the study. Though the registrars continued to collect data and feed them into the computer they were not routinely given feedback about computer diagnoses and their own performance. During the next three months 92 cases were studied in this way. The results (fig. 2) showed a relatively rapid fall-off in the overall diagnostic accuracy of the clinicians, from 76% in January to only 68% in March, a drop of around 15% on their October to December levels. Also a comparable but delayed fall in the computer-aided system's accuracy was noted, from 85% to 77%. These results indicate that feedback played an important part in the improved performance levels noted hitherto.

For the next three-month period the studies were extended to include a further 90 patients, the system being run on a "demand" basis—that is, feedback and performance figures were given to each of the clinicians on request. The results (fig. 3) showed a rapid rise in the clinicians' diagnostic accuracies to levels comparable to those found in our earlier studies,[4] again with a delayed rise in the accuracy of the computer-aided system. Indeed, during June 1974 (a possibly unrepresentative month since only 18 patients were admitted) the overall accuracies of clinician and computer were startlingly high, and we do not think that it is reasonable to look for this type of diagnostic accuracy on a long-term basis. We conclude, however, that such results validate the comparable results of our previous studies.[2 4]

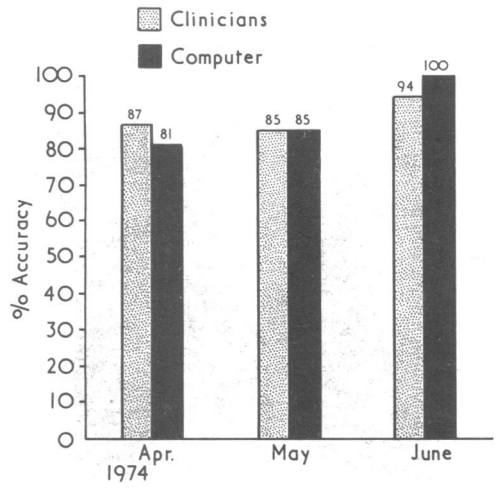

FIG. 3—Monthly analysis of diagnostic accuracy during final three months of trial.

Discussion

We believe that this system, originally devised in 1971 and tested rigorously over the past three years, gives a higher degree of diagnostic accuracy in respect of patients with acute abdominal pain than the unaided clinician. Hence the finding that our modified system's accuracy (after the first two months) was generally higher than that of the unaided clinician is unremarkable in the light of these previous studies.[2 4] Mere repetition of earlier work was not, however, the purpose of the present study, and some of the implications of these most recent findings are considered below.

Firstly, we have shown that the results obtained previously can also be obtained using a reliable, simple, low-cost system which can be made available on a round-the-clock basis and whose operation can be learnt in less than 30 minutes.[3] No less important is the fact that the system can be learnt and operated successfully by other persons without prior knowledge or training.

An important proviso must, however, be added. *These results were obtained only after a "learning" period of two to three months,* during which much discussion took place (mostly over the problems of data coding). Indeed, during the first month of its operation the computer-aided system was *less* accurate than the unaided clinicians (fig. 1).

Secondly, we again saw a marked rise in the performance of our clinical colleagues comparable with that noted in our earlier studies.[4] Indeed, the rise in diagnostic accuracy between August and December 1973 (73% and 84%) together with a concomitant fall in the rates of negative laparotomies and perforated appendices (to under 10% in each instance) indicated that the discipline of using a computer and being provided with immediate feedback about computer probabilities and performance does seem to provide substantial and measurable benefits in terms of real-life performance. This, it should be noted, was the case *even though feedback was withheld until the clinician had made his decision about each patient.* Of course, it could again be argued that we were merely demonstrating a "learning" process, but there are two factors against this. Firstly, the level of final performance was far higher than that of most comparable clinicians, and, secondly, when the feedback was withdrawn the performance regressed.

On this second point we (albeit reluctantly) conclude that for the present there appears to be no way of achieving a high performance level without the provision of some sort of feedback to the clinicians from the computer-aided system. The marked fall-off in performance levels during January to March 1974 reinforces this point. Clearly we are open to criticism on this score since one of the surgical registrar posts changes in January. Nevertheless, we defend our conclusions on two grounds. Firstly, there was little individual variation in these results, and, secondly, the "incoming" registrar had already achieved performance levels similar to those shown in fig. 1 using the comparable system we have established in the emergency room.[5] We conclude that feedback is important, and the results from the final three months of our trial tend to validate this impression.

Conclusions

A number of conclusions emerge. Firstly, computer-aided diagnosis of the acute abdomen is feasible using simple equipment. Secondly, such a system is not "specific" to its originators. Thirdly, a period is required (apparently two to three months) for learning the system, particularly the data-coding methods, before reliable results can be obtained. Finally, some form of feedback from computer to clinician seems essential if the clinician's own performance is to improve.

We cannot stress too highly, however, that even after these trials we have *not* yet shown computer-aided diagnosis to be universally applicable. There remains the problem of geographical variation, for though different personnel can apparently work with the system, in different geographical areas the patterns of symptomatology may be at variance with those we have observed in Leeds. It is to this problem that we are now turning our attention.

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