ABC of Computing

A J ASBURY

COMPUTERS IN MEDICAL EDUCATION

Multiple True False

Osteitis deformans (Paget's disease of bone)

- A Is more common over the age of 50 than below that age
- B Gives rise to symptoms in the majority of affected patients
- C Is accompanied by elevation of the serum alkaline phosphatase activity
- D May be complicated by cardiac failure
- E Responds to treatment with prednisone

Correct key A C D

One from Five

A 46 year old male patient who is moderately obese is suspected of having Cushing's syndrome. The *single* observation which would give *most* support to this diagnosis would be

- A A urinary 17 oxosteroid excretion of 60 μmol/24 hrs
- B A midnight plasma cortisol concentration of 700 nmol/l
- C A blood pressure of 170/110
- D A diabetic glucose tolerance test
- E The presence of pink abdominal striae

Correct answer B

Five Choice (Simple) Association

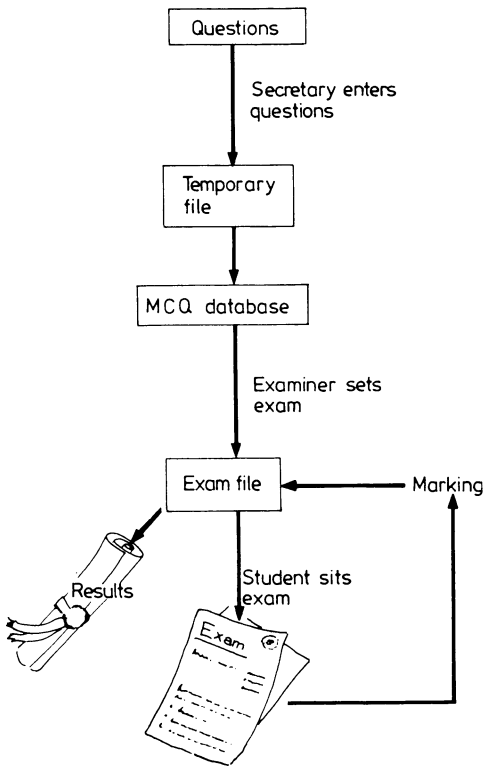
A Proximal muscle weakness
B Hyponatraemia
C Hypoglycaemia
D Paroxysmal hypotension
E Hypocalcaemia

		Correct Answers
1	Ectopic ACTH syndrome	A
2	Inappropriate secretion of ADH syndrome	B
3	Insulinoma	C
4	Primary aldosteronism (Conn's syndrome)	A
5	Hypoparathyroidism	E
6	Type I glycogenosis (Von Gierke's disease)	C
7	Phaeochromocytoma	D

Computers are used extensively in medical treatment and diagnosis, and there is an increasing trend to use them in medical teaching. Obviously computers cannot do clinical tasks such as demonstrating abdominal palpation, but they are useful in examinations, in audit, and for medical and biological simulations.

The multiple choice question is a common examination technique, providing an objective assessment of a student's performance. There is much discussion about the desirability of multiple choice questions, some suggesting that these examinations tend to concentrate on small details rather than testing a candidate's ability to reason. This does, of course, depend on how well the questions are devised and the kind of knowledge to be examined. Nevertheless, multiple choice questions are ideally suited to computer methods, and both the computer and the multiple choice question are here to stay. For a long time multiple choice examinations were set and marked by hand, but several universities are now developing multiple choice systems on mainframes and microcomputers.

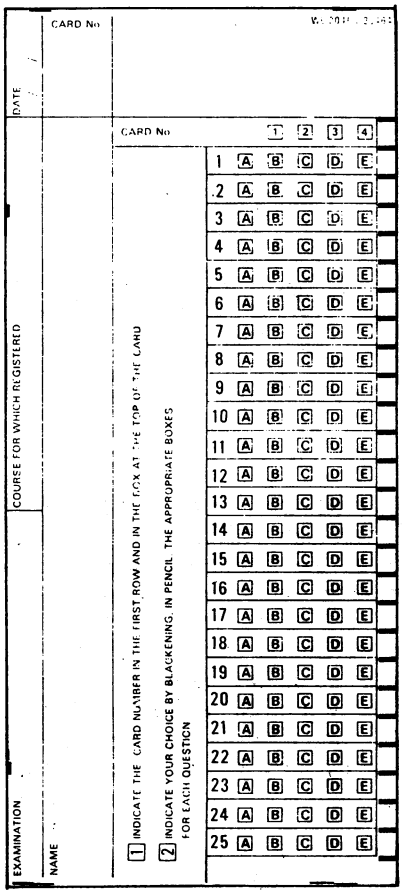
A multiple choice examination system



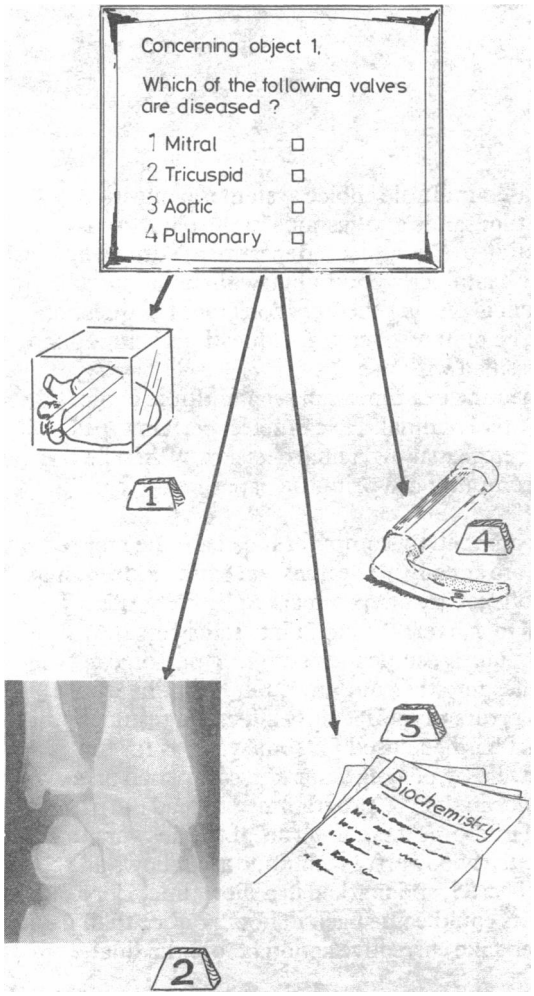
The core of a computer based multiple choice system is a question database. Each of the many thousands of questions in the database is catalogued and coded according to the subject, department, time when last used, and so forth. From the examiner's point of view the main work in using a multiple choice system is putting the questions into the question bank. A bank can, of course, be built up over years, questions being added, deleted, modified, and reclassified with use.

Once the bank is established the examiner can set a multiple choice question paper from a computer terminal. He can select certain types of questions and display them before making a final decision. When he has selected those he wants the computer can print the paper ready for duplication.

Once the paper has been compiled by computer it can also be marked by computer, since the answers are already in the question bank. Indeed, many examinations for the royal colleges are already marked by computer. The major problem in marking is to convert the candidate's answers into computer readable form. Obviously, some long suffering person can type the responses of 200 candidates into the computer, but he or she would inevitably introduce enough errors to significantly affect the results of the examination. One system that has been used for some years is for the candidate to indicate his answers by placing a mark in soft pencil on a computer card. The computer can then be programmed to read the pattern of marks (mark sensing) and interpret them in terms of the answers to the examination. This is a particularly powerful technique as it allows an examination to be set, administered, and marked in a short time. For a class of say 100 students, the results could come back in hours rather than days. The errant student could then take corrective action before the final exams.



Learning with microcomputers



Apart from taking the drudgery out of setting and marking examinations, the computer can improve the examination from the point of view of the assessment. For example, it can be used to calculate a discrimination index—the ability of the question to separate good and bad students—and a facility index—how easy the question is. These indices can be used to select the best set of questions and can be used to weight the marks for a question. A question which discriminates well between good and bad candidates can be given a higher score than one which does not. These indices can be calculated by hand, but few examiners have the time to do this, and it is easy for the computer. The calculated indices can be inserted into the question bank so that in the future the examiner can select questions not only by their subject, age, etc, but also by their ability to discriminate between the good and bad candidates. These indices can provide examiners with a useful clue about which questions to retain or discard when they consider the results of the examination at an examiners' meeting.

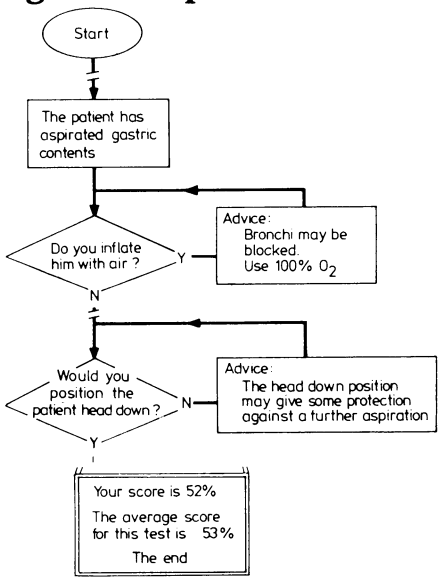
One logical extension of the mainframe multiple choice question database is for a multiple choice examination to be run using the terminals. Most university computers have rooms with several terminals for engineering and mathematics students to learn computing. These facilities could be used out of term time to allow a small class of students or doctors to test themselves. The mainframe computer would merely operate in the normal multiuser mode.

Computers may also be used to run a "personal" multiple choice examination for a candidate. A small database is held on a floppy disc, and the candidate does the examination sitting at the microcomputer: each question is displayed and the candidate is invited to type his answers. The candidate can be told whether he is correct either immediately or at the end of the session. One useful embellishment is for the computer to print out a list of references to guide the learner into the paths of rectitude. The immediacy of response makes the computer an attractive learning aid.

This technique is still in its infancy but one could imagine a department holding a library of discs so that trainees could go and test themselves at regular intervals. Some microcomputers can be linked to tape slide units, so that the computer could pose a question based on a projected slide—of, for example, a pathological specimen, a step in an operation, a diagram with labels for identification, an electrocardiogram, or a chest radiograph. The only limitation of this type of system is the imagination of the examiner.

In examinations the microcomputer has an advantage over the mainframe as a response time for the examination can be fixed—not only the total time for the examination, but also a time for each question. The concept of timed questions has not yet been explored, but in some conditions the time taken to come to a decision is crucial. For example, if a candidate were faced with a multiple choice question on resuscitation and asked whether he would first inflate the arrested apnoeic patient by mask or set up an infusion, he should not only advise inflation; he should also give that answer immediately.

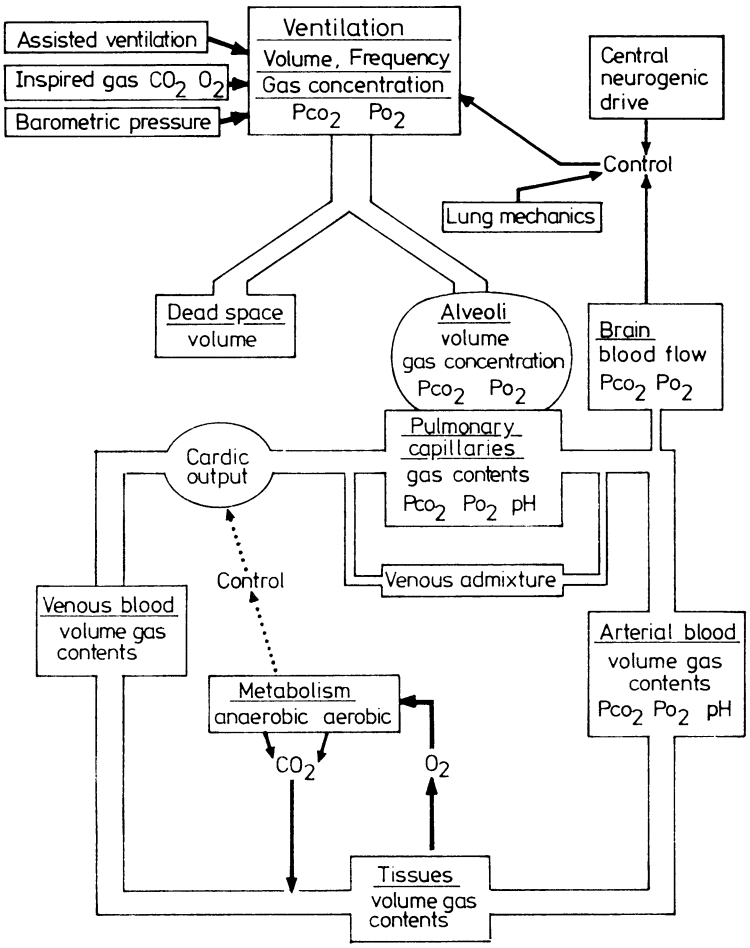
Using the computer for on line audit



An interesting extension of the use of the computer as an aid to assessment is its use for audit. The doctor can pit his wits against an objective standard of practice devised by his peers, all in the privacy of his own office.

An excellent system was devised in Glasgow for the self-audit of anaesthetists. Several programs are available which take the doctor blow by blow through a developing situation—for example, the management in an intensive care unit of endotoxic shock, a burns case, an obstetric case, etc. The computer asks questions at specific points, and if the doctor gives a wrong answer it gives advice. Plainly such a system audits and educates. At the end of the day the computer can give a final mark and the doctor can find out where he stands in relation to his peers. Inevitably some disagree with the "correct" answers, but so long as they are motivated to look up the answers or read about the subject the educative function has been achieved. Audit is a sensitive subject and perhaps the impersonality of the computer is an advantage.

The use of the computer for simulation



The computer may be used to simulate physiological and pharmacological phenomena. For example, the decay in plasma concentration of a drug can be programmed on the computer so that the student can see a real time graph of the concentrations. The effect of other conditions can be examined by entering different drug doses and compartmental details.

More complex simulations have been available for some time—for example, MacPuf, the complete simulation of the respiratory system. The student can interact with the model and change its variables, such as cardiac performance, brain bicarbonate concentration, and so forth, and observe the effects. Under these circumstances it does not matter if he "kills" the "patient" so long as he knows why and learns the correct way by the time he manages a real patient. MacPuf even performs necropsies. In these simulations a realistic time element can be added so that the student realises that not only must he do the right thing, he must do it at the right time, since few biological systems work instantly. Hitherto these useful simulations were not readily available for microcomputers, because the programs were too large, but now most microcomputers with 64 kilobytes of memory should be able to cope. Renal and cardiovascular models are also available.

The Massachussetts General Hospital has produced a useful series of clinical patient simulations, the programs falling into three types. In the first the computer acts as the patient and the student questions the computer to discover the diagnosis, by eliciting the history, physical findings, laboratory results, etc. In the second the computer acts as a patient whose condition is changing, and the effects of the student's therapeutic decisions are displayed. The third is a mathematical physiological model. These simulations are safe, self pacing, and individualised and provide instant feedback. Programs are available to simulate problems such as coma, fluid imbalance, diabetic ketoacidosis, abdominal pain, jaundice, hypertension, and many others.

Simulations available at the Massachussets General Hospital

1 Abdominal pain
2 Arterial blood gas
3 Anticoagulant simulator
4 Cardiac arrhythmias
5 Cardiopulmonary resuscitation
6 Coma
7 Diabetic ketoacidosis
8 Digitalis teaching program
9 Drugs in renal failure
10 Fluid and electrolyte management
11 GI Bleed
12 Hypertension diagnosis
13 Hypertensive emergencies
14 Hypertension management
15 Idiopathic respiratory distress in the newborn
16 Orthopaedic problems
17 Jaundice
18 Paediatric cough and fever
19 Trauma

Another form of simulation can be used to teach doctors how to perform difficult techniques. For example, a doctor placing a flow-directed catheter in the pulmonary artery is guided by observing the pressure recorded from the catheter tip; the location of the catheter can be deduced from the pressure traces as the tip measures central venous, right atrial, right ventricular, and, finally, pulmonary artery pressures. Unfortunately in very ill patients this may not be quite so simple. The computer can simulate the problems with no risk to the patient and allow the doctor to try methods of circumventing them.

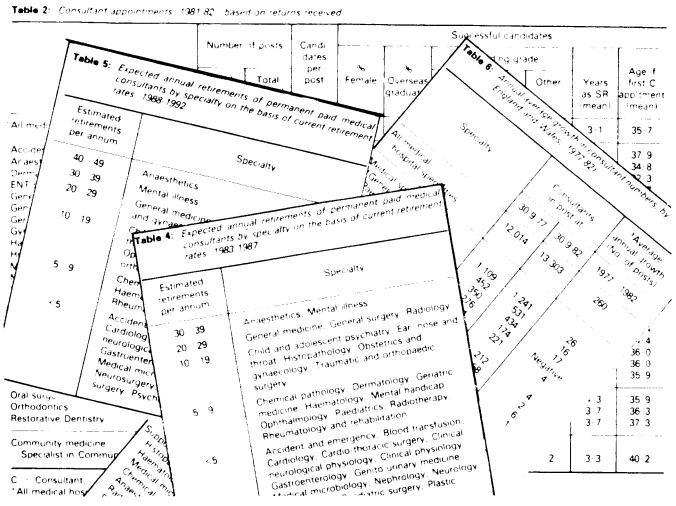
Computer simulation has recently been used in workshop teaching to give doctors experience in running clinical trials, enterprises in which vast amounts of money can easily be wasted by bad management and planning. A fictitious drug, Asperton, similar to sodium cromoglycate, was proposed, and the computer was given the basic drug information. A program was used to generate realistic results appropriate to the investigation protocols specified by the participants. The results, FEV_1, FVC, clinical states, etc, were then analysed by the participants.

Clinical trials proposed by course members to evaluate asperton

Group	No of patients required	Entry requirements	Exclusions	Design	Treatment, dose, and period	Factors to be monitored	Methods of assessment
1	40	Previous response to DSCG; 15-40 years of age; allergic asthma	Severe asthma; concurrent steroid treatment; liver disease; alcoholics; pregnant women	Two-way crossover, random allocation	Asperton (200 mg four times daily) and placebo in pollen season, six weeks each		Patient diary card; lung function tests; laboratory assessments, patient and physician assessments
2	48	15-70 years of age	Women of childbearing potential; DSCG users	Three-way crossover, randomised blocks	Asperton (100 mg twice daily), DSCG, and placebo, two weeks each	Allergic history	Diary card; bronchodilator usage; airflow readings; physician assessment; spirometry; plasma concentrations of drug
3	100-150	Over 12 years of age	Pregnant women; renal or hepatic dysfunction; too ill	Two-way crossover, stratified randomisation	Asperton (400 mg/ day) and DSCG, six weeks each	Asthma type and severity; age	FEV_1, FVC; physician assessment; diary card; plasma concentrations
4	120	15-60 years of age	Severe asthma; pregnant women	Three-way crossover, stratified randomisation	Asperton (100 mg four times daily), DSCG, and placebo, four months each	Asthma type; obesity	Spirometry; bronchodilator and steroid usage; patient assessment

DSCG = Disodium cromoglycate. FEV_1 = Forced expiratory volume in one second. FVC = Forced vital capacity.

Planning careers



The use of computers for career guidance is also being investigated. To plan his training a doctor needs to know more than the annual manpower statistics. Factors such as the number and location of available posts, expected vacancies, how long people stay at selected grades, and rotation facilities are all constantly changing, and one year old statistics may be misleading for the doctor with his hand poised over the telephone.

Dr A J Asbury, PHD, FFARCS, is lecturer in anaesthetics, Sheffield University.

The first illustration was reproduced, by permission, from Anderson J, *Medical Teacher* 1981;3(4):158, that of MacPuf from Dickinson CJ, *A Computer Model of Human Respiration*. MTP Press, the table of proposed clinical trials from Paterson JW *et al*, *Br Med J* 1978;ii:1333, and the manpower tables from *Health Trends* 1983;15:33-9.