The corollary to expansion of production is expansion of use. Seventy per cent of New Zealand health expenditure goes into hospitals. The world's nations know, as the director general of WHO, who spoke so persuasively in Dunedin a few months back explained, cost-effectiveness is in, broadly speaking, public health and prophylaxis. The public meeting gave him a standing ovation for his eloquent pains. The economists deny the service this title of "health" saying that it is a sickness service—echoing Dr Mahler with their implied emphasis as to where the energy should be diverted. As the *New Zealand Medical Journal* editorial concludes, these matters are politically decided, and one might wonder whether we are not suffering at the mercy of an exacerbation of chronic progress. 1978 being an election year, the leader of the National Party promised to support the irrationality of the Department of Health's invited advisor, J Keith Ross's, advocacy of a second cardiac surgery unit in the South Island, total population 854 000; there are suggestions that it would cost $2 million. One might wonder, parenthetically, on the paradox of Mr Ross's advice to establish five cardiac surgical units in a nation of 3 million people, when his own one unit serves 2·7 million in Southampton. It may be that the political resolve on this matter is weakening a little, a trend that might be aided by the recent opinion of the Department of Health's guest, Professor McKinlay of Harvard, as to its superfluity.

But the sadness of the control of our profession by political moods was humourously highlighted recently when a Dunedin Labour Party candidate in the coming election voiced the opinion that a government of that persuasion, if brought to power, would reconsider the allocation of a CAT scanner promised to the city. My word, if the election had been held that week, the long-held, safe Labour seat of Dunedin Central would have vanished overnight. The error was emphasised by an amazing series of explanations and elucidations from party spokesmen over the next few days. You see, we have the problem of fierce and often exclusive local pride of achievement and possession in New Zealand, a factor that gives fertile ground for the exercise of political manipulation—and so we recircle to, and within, the problems of the health service, its changing face, values, and virtues.

If it is not too late already the profession, world wide, will have to be careful that the technological advances do not master it, and drown it and our community of patients in a rising tide of economic misuse and social ineptitude disguised as progress.

How to do it

Choose and use a calculator

T D V SWINSCOW

British Medical Journal, 1979, **1**, 326-328

A potential customer looking at the glittering ranks of calculators in a shop window is apt to be amazed at the wonders of science. This is the shopkeeper's intention. The object of this article is to reduce the bewilderment that may supervene.

Choosing a calculator

The first question a doctor, like any other customer, should begin by asking himself is what purposes his calculator must serve. Is it to do the household accounts, for example, or his daughter's A-level maths, metric conversions, arithmetical computations related to his practice, or correlation coefficients? Many individual calculators can perform all these functions and more, but so many specialised models are now available that if a restricted function is intended for it a calculator designed for that purpose is worth getting. And, as often in life, it pays to buy the best; that generally means—with calculators—avoiding the cheapest. There are plenty on the market that are unreliable and short-lived owing to shoddy workmanship. Be prepared therefore to pay more than the minimum. From time to time the Consumers' Association publishes *Which?* reports on calculators, and one that appeared in September 1977[1] is worth consulting despite the continual introduction of new models.

In addition to the basic functions of +, −, ×, and ÷ most simple calculators offer %, a key to change the sign from + to − and vice versa, and an exchange key to enable the displayed number to be used as a divisor into another number subsequently entered on to the display. These are the minimum functions required in a calculator to be put to almost any use.

The potential user will then find that there are two main systems by which calculators are operated, and he may wonder which to opt for. One is known as "algebraic logic," the other as "reverse Polish notation" (named after a man, not Poland). Most calculators work on algebraic logic, and they are sometimes marketed with the claim, expressed or implied, that they are more "natural" to use and therefore easier. Algebraic logic deals with calculations in the same order as we say them. In $2+3=5$, for example, keys are successively pressed for 2, +, 3, and =. In the reverse Polish notation there is no key for =. Instead there is a key marked Enter, and the above addition is done as follows: 2, Enter, 3, +. The answer then appears. This order of working is in fact akin to how we do a sum on paper, and it comes perfectly readily after a little practice. Each system has advantages. The only real difficulty is to switch from one to the other, and so it is advisable for the owner of more than one calculator to have them all in the same mode of logic.

Even cheap instruments nowadays provide a memory, and this facility is well worth having whatever the calculator's

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purpose. It saves writing down intermediate stages of calculations. Some calculators have more than one memory, so that the results of several stages in a long calculation can be stored. Another facility of this kind is the provision of parentheses within which a subsidiary calculation can be carried out, the result of which is then combined with the result of a previous calculation. This is a useful addition but not perhaps so essential as a memory. A "continuous memory" that stores its contents even after the instrument is switched off, so that they remain to be used in further calculations later on, is a further refinement sometimes offered.

After considering these additional but fairly basic functions the potential customer should think more specifically about the tasks he will set his calculator. Here three types of models may be roughly distinguished—namely, scientific, statistical, and financial. With their plethora of keys, often dual function, those in the first category—scientific calculators—offer a challenging attraction to potential buyers. Few doctors will have any need of them, and those who do are unlikely to learn anything from this article.

Until recently few calculators were particularly suitable for the kind of statistical operations that doctors are likely to carry out—for example, standard deviation, chi-square test, product moment correlation, and regression equations. But now several can be found at two levels of complexity. The first offers in addition to the basic functions listed above a key for x^2 and $\sqrt{\bar{x}}$. With a calculator so equipped the ordinary statistical computations are quickly carried out. The second type provides keys that save time on some of these computations, so that pressing one key will give the standard deviation, for example. It is important if buying one of these to check the formula used.

They work on the identity

$$\Sigma(\bar{x}-x)^2 = \Sigma x^2 - \frac{(\Sigma x)^2}{n}.$$

To calculate the variance (= square of standard deviation) it is necessary to divide this expression by $n-1$. Calculators that divide by n should be rejected.

Since doctors, like lesser citizens, sometimes do their own income tax returns, buy and sell stocks and shares, and keep business accounts, they can obtain help from a variety of calculators specially designed for functions of this kind. Such instruments have many general uses too, but are probably not well adapted to doing medical statistics. Consequently the proper question to ask may be, not which calculator, but which calculators, should I buy? There is much to be said for having two moderately specialised instruments rather than one that offers a multitude of functions but probably also includes many that will never be needed. The total cost might be about the same.

Having got so far, the potential customer will find that many calculators are now offered with a facility for inserting a set of instructions, or "program" (so spelt), that the machine will operate automatically. For most people these would probably not be the first choice, because considerable experience is desirable before programming becomes worth while.

Just as cars, microscopes, and forceps have physical properties that please or vex their owners, so do calculators. Though they all look much alike, they handle very differently—for instance, in some the keys give a small click when depressed, while in others they provide little or no sensation to the finger tip. My own preference is for a distinct sensation of finality to the pressure put on the key. Incidentally, when trying out the feel of the keys it is worth pressing firmly on those round the periphery to make sure that the instrument is stable, for some tend to tip up.

Again, some numbers are displayed in green, others in red, and I happen to prefer green. Other people may prefer red and others be indifferent, but it is worth testing this sensation when buying a model. Unfortunately, neither colour has the advantage of readability in direct sunlight: both are invisible.

In deciding whether to buy a model with expendable or rechargeable batteries the question to consider is what facilities there will be for recharging. Running costs are cheaper with rechargeable batteries, but access to a main electricity point is necessary after 3-4 hours' use. This was brought home to me when I was sitting in a friend's house watching the sun set on Kilimanjaro. I began fiddling with a calculator on the table—but he cried out in alarm, "Please don't touch it, the batteries last such a short time, and I've no means of charging them."

Using a calculator

The manufacturers of calculators provide their customers with instruction books, but many have not taken the trouble to ensure that their authors are literate as well as numerate. Here, for example, is what the handbook of a particularly useful calculator tells us about what it calls its "auto-constant mode": "The first factor of multiply and the second factor of addition, subtraction, and division are stored by the calculator logic after execution is complete." The handbooks are full of this kind of stuff (often in several languages), and I believe that a reader who fails to understand it at his first attempt need not blame his education. But unfortunately he must persevere, calculator in hand, because it is all he will get. There are no general rules for the use of calculators, for different models vary in all sorts of tricky computational details, some of which are discovered only after considerable experience. For example, an instrument I use has a parentheses facility, but some operations such as $\sqrt{\bar{x}}$ cannot be carried out within the parentheses—a limitation, incidentally, not mentioned in the handbook.

In fact, after working through the handbook's instructions and practising them on his calculator the novice would be well advised to try out all sorts of further calculations. He will find that the handbook may fail to tell him of some that are possible as well as of others that are impossible on his particular instrument. The following type of calculation, for instance, is commonly needed: A series of numbers add up to a total. What percentage of the total is each number? $51+42+37=130$; percentages $39{\cdot}2+32{\cdot}3+28{\cdot}5=100$. By using the same constant, for example, $\frac{100}{130}\times$, it is easy to cut down the amount of computation needed. But each of the two calculators I use requires a different series of operations to do this, and neither's handbook gives any guidance on them.

Many calculators limit the display to eight digits, though some have facilities (varying from one model to another) of handling numbers with more digits. But the user needs to beware of losing the significant digits beyond the bounds of his instrument. In statistical calculations, where squares can quickly produce surprisingly large or small numbers, it is important to ensure that the significant digits are within bounds. And while very large and small numbers can obviously cause trouble, quite ordinary numbers may do so too if the differences between them are relatively small.

The example of this given below is taken from *Statistics at Square One*.[2] The standard deviation of the following numbers is computed on an eight-digit calculator: 64·22, 64·23, 64·24, 64·25, 64·27. Here $\Sigma x=321{\cdot}21$, $n=5$, $(\Sigma x)^2=103175{\cdot}86$, $(\Sigma x)^2/n=20635{\cdot}172$, $\Sigma x^2=20635{\cdot}172$, $\Sigma(\bar{x}-x)^2=0$, $SD=0$. But since the numbers differ from each other they must have a standard deviation.

What is needed here is to get the size of each number nearer to the differences between them. If 64 is subtracted from each we get 0·22, 0·23, 0·24, 0·25, 0·27. These give $\Sigma x=1{\cdot}21$, $n=5$, $(\Sigma x)^2=1{\cdot}4641$, $(\Sigma x)^2/n=0{\cdot}29282$, $\Sigma x^2=0{\cdot}2943$, $\Sigma(\bar{x}-x)^2=0{\cdot}00148$, $\Sigma(x-x)^2/(n-1)=0{\cdot}00037$, $SD=0{\cdot}0192353$, which can be rounded off to 0·02.

A general rule, therefore, is to watch the significant digits in any calculation. If they get far away from unity, whether very large or very small, a simple transformation to cut them down to manageable size should be considered.

As well as respecting the limits of a calculator it is worth remembering that the human brain is not inexhaustible. Boring and repetitive calculations are tiring and can lead to errors from carelessness or sheer fatigue. A telephone call from a patient or an unexpected visitor from Porlock can likewise cause the operator to press the wrong key or lose track of the calculation. To guard against this I often write down the intermediate results of a laborious calculation, even such a simple one as adding up long columns of figures. I jot down, for instance, the sum of each column separately or the cumulative sums: column 1, columns 1+2, columns 1+2+3, and so on. This procedure helps the operator to carry out the final and most important part of his calculations, and that is to check them.

Always check the calculations. Check them right through, and check them if possible in a different order from the first set of calculations.

References

1 *Which?* September 1977. Consumers' Association, London.
2 Swinscow, T D V, *Statistics at Square One*, 4th edn. British Medical Association, London, 1978.

A Modern Epidemic

Road accidents—priorities and possibilities

BY A SPECIAL CORRESPONDENT

British Medical Journal, 1979, **1**, 328-331

The experts I have talked to in the last few months are unanimous about the main priorities: more effective action against drinking and driving, and legislation to make seat-belt wearing compulsory. There is also considerable agreement about the need to reduce accidents in children and in young men (both motocyclists and drivers) under 25, a group in which road deaths account for nearly half the deaths from all causes.[1] Road behaviour can often be most readily changed—or made less important—by changes to the road environment, but at the same time improved behaviour may be enough to surmount difficulties of the environment[2]—in other words, there must be a combination of approaches.

Children

When a 3-year-old boy on his own at a junction crossing is knocked down by a driver who says that he had "eye contact with him" and expected him to let the car pass,[3] the blame must be shared by two people—the driver and the mother or other person looking after the child—for not recognising the child's limitations. This is true of most accidents to children, whether they are pedestrians or cyclists. Adults must be given much more precise guidance in this respect.

Driving instructors could show the learner in detail what to look out for—Sandels gives a long list of such points, particularly variations on the theme that children on the pavement are apt to dash into the road for no apparent reason.[3] In her study a disproportionate number of the drivers had had their licences for seven years or less, and of those injuring children on crossings over a third were under 25, often probably with little experience of children. Similarly, we need to spell out the pitfalls to parents very precisely, as Sandels does, with their practical implications, such as using a harness with young children. Welfare clinics and so on could help here. Road safety education at school and children's traffic clubs may be effective if they influence parents, and if possible directly involve them[4]; and games that children play with their parents, such as the one produced by RoSPA on the principle of snakes-and-ladders, seem worth encouraging. But the road environment remains the easiest thing to change; and health workers, teachers, and residents' associations must press for minor improvements even where there is no scope for major planning. Small changes such as limited rerouting of traffic in residential and shopping areas, guard rails on pavements, and (when they become generally legal) speed humps may have an important effect—for example, an 80% drop in pedestrian accidents in residential areas (which are mainly to children) might come from restricting access to traffic and reducing speeds.[2]

Motorcyclists (including scooter and moped riders)

Riders of two-wheeled motor vehicles are the one category of road user with more fatal injuries—and higher death rates for distance ridden—than 10 years ago,[2] even though crash helmets have become compulsory. In this time the smaller motorcycles have become capable of higher speeds. It is therefore more than ever important that riders not only should have conspicuous and protective gear and safety devices but should be properly instructed. One chief constable speaks of motorcyclists' apathy about safety, adding that "only a small number took the trouble to attend" a course on motorcycling technique.[5] In some areas there is more enthusiasm, but will voluntary courses ever reach enough riders? Though methods of instructions could probably be improved, there is no doubt about the need for emphasising safety margins to allow for drivers not noticing motorcyclists —in other words, "defensive" riding, which has been defined as "riding as if everyone else is an idiot."

Young drivers

Young drivers are also inexperienced drivers but they appear to have a worse accident record than older new drivers, who are more likely to be cautious; the under-20s had twice the accident rate of the over-50s in the year after passing their driving test in a recent study by the Transport and Road Research Laboratory. Thus young drivers particularly need instruction emphasising safety margins and the need to avoid aggressive driving. But possibly the most potent way of making this group safer would be to bring in "probationary" licences, to last for at least a year after the driver passes his test, as in France. Here the car carries a "P" sticker during this time and any accident or offence prolongs the probationary period.[6] Special retraining courses might also help in some of these cases.