The clinical workstation

It doesn’t really matter how you look at it, the promises of the computer revolution, the information highway, or whichever snappy title you give it have been slow to appear. The technology has clearly leapt ahead, and the concept of a clinical workstation is well established, but the practicalities have been difficult to resolve.

What is a clinical workstation?
Evolving technology has provided an increasing variety of tools to help the clinician. Many of these have been developed individually, using different machines in different areas. The concept of the workstation was created to amalgamate these technologies and tools into a single ‘computer’ allowing access to all its different components from a single environment. The clinician can then perform multiple tasks from a single site, collecting data from many different sources, and reducing the wastage of duplicating data entry. This ‘comprehensive’ definition of a workstation is not universally applied, but is one used by most authors, although others use the term for any system that interprets data intelligently or even one that collates complex imaging.

‘PC’ FACILITIES
We must all by now be familiar with the basic functions of a desk top computer. Word processing is perhaps the most fundamental of these, but they can also include many other commonly used programs. Spreadsheets and databases (Excel, Access, FoxPro, etc) allow data handling so that local information can be stored. Programs such as Powerpoint generate slides and there are many programs (Papyrus, Reference Manager, etc) that allow the storage and recall of references. These latter will often allow the automatic entry of data from disc or on line sources, allowing storage of a greater volume of data, such as abstracts. Graphics and statistical packages (Graph, FigP, SPSS, Statview, etc) are further powerful desktop packages.

The development and universal availability of CD ROM has vastly increased the volume of information accessible, meaning that entire volumes of text can be absorbed onto a local computer. All of this has been accompanied by a concomitant (and essential) improvement in hardware. Memory size, and particularly processor speed, have increased dramatically. The development of the new MMX processor will speed this still further.

INTERNET, INTRANETS, AND ‘ON LINE’ ACCESS
For the addition of a modem (preferably 28,800 baud minimum) and a phone line, PCs can access the limitless information available on the ‘net. This is developing so fast that it becomes pointless to describe it in detail, but warrants brief mention. It can be difficult to find important and valuable data amidst the enormous volumes of information, and much time can be wasted trying to find the right place to go. Help navigating around the ‘net is available with excellent books such as Kiley’s Medical Information on the Internet (website "http://www.churchillmed.com/BOOKS/medinter.html"). Many medical schools have also set up web pages (for example Cambridge at http://www.his.path.cam.ac.uk) and the University of Iowa even have a ‘Virtual Hospital’ (http://www.vh.org) with access to advice, textbooks, and quizzes. Bookmarking the useful sites once you’ve found them greatly reduces time wasted relocating helpful sites. A more recent development is the concept of an intranet. This is a site based network that contains a limited version of the internet, with textbooks, bulletin boards, etc. Its advantages are both speed (as it is so much smaller) and editorial control, as the facility to update the pages can be controlled.

The other benefit of a modem and line is the facility to e-mail, either messages or entire files. Not only is contact easier as instant messages or complete files can be left even in the absence of the recipient, but the process is entirely independent of time zones!

COMMUNICATION
This is clearly a central component of any clinical information system. Access to e-mail within and between hospitals has clear benefits. Data on previous admissions, general practitioner (GP) records and results from prior investigations can be rapidly identified. Current technology, however, allows for more sophisticated possibilities such as producing rapid and timely reports on patients (or units, departments, etc) that can be sent directly to GPs, other hospitals, grant giving bodies, or wherever. GPs or referring hospitals can be automatically notified of admissions or discharges. Important information about changes to medication or results can be sent to all important carers immediately. Summaries can be wholly or partially automated, being produced automatically, with a predefined mailing list and to a standardised format. Data can be automatically retrieved from the databases to complete these reports. At a more esoteric level, telemedicine, or the transfer of complex clinical data between centres, is already here. This is especially useful for digital images (for example computed tomography or other radiology) but can be used in a variety of ways. This includes the recently publicised ‘live’ access in accident and emergency centres to video from cameras in the helmets of attending paramedics at the roadside. ‘Smart cards’ containing detailed information on patients are already being tried out in some areas.

HOSPITAL INFORMATION SYSTEMS
A further component of a workstation must involve an effective hospital based information system. Hospital systems collate clinical data, results, demographics and many administrative details (including financial data, current location of each patient, staffing levels, etc) into a central file server. Comprehensive data on the patients served by a hospital, whether inpatients or outpatients, can be collected. Results can be made available to any (authorised) clinician as soon as they are available. This is one of the more contentious areas of development, as such systems have historically been poorly designed. In many cases this results from a managerially driven design process that has focused on administrative issues (payroll, supplies, bedstate, etc) or laboratory issues (test ordering and results, sample processing) rather than clinician based issues (such as providing helpful clinical data at the point of consultation). Technical difficulties with amalgamating patient data and poor interface design between computer and user lead to the duplication of data entry and therefore cumbersome data entry screens. Data is frequently poorly delivered to the clinician and may be inaccessible for other uses (for example graphical presentation). The model for collecting and storing data is often complex (fig 1). The
Decision support software is an area of huge potential for the workstation. Entry of clinical data allows its comparison with a ‘knowledge base’ within the computer. This can be designed to look for clinical similarities, prompt for further specific information and advise on diagnosis, investigation, or management. Levels of expertise can be set, so that, for example, junior doctors might be advised of all potential drug interactions when prescribing, while senior doctors might only be warned if unusual combinations of drugs were being used.

Teaching packages are an undervalued but rapidly expanding area and an important component of any clinical information system. Specially designed packages, such as interactive programs testing resuscitation skills, can be particularly helpful especially if they can be available to staff at the bedside whenever they have an opportunity to use them. The use of video clips for practical procedures, such as central line insertion, can be created and called up whenever wanted. Guidelines for the management of particular conditions could also be included as they can help to teach junior doctors and nurses by offering up treatment options for particular clinical situations.

Automated data collection and research

Many of the modern pieces of electronic equipment are designed to allow access to the data they use. In intensive care areas especially, there is now the facility for a great deal of clinical information about treatment to be collected automatically. Infusion pumps, ventilators, and monitors can be connected to a computer and data about the patient, their infusions, and other parameters can be stored as frequently as wanted. Electronic scales can be used to measure urine output, drain losses, or the patient’s weight. This allows the potential to control infusions according to these parameters. Inotropes can be titrated against blood pressure, or fluid intake against urine output. Complex alarm parameters can be set, and in one system in the United States, the combination of certain parameters has been designed to automatically bleep the clinician looking after the patient! There is an enormous potential to overcollect data however. The ability to measure or store a piece of information bears very little relationship to its value (indeed some might argue that they are in inverse proportion) and computers can be filled with information of little or no clinical use. Nevertheless it is remarkable that intensive care units still rely on extremely complex handwritten and hand calculated charts on a patient’s fluid balance for critical decisions.

The vision

But how might it all fit together? The value of combining all of these disparate functions in a single workstation may best be seen by considering a hypothetical case. The admission late one night of a child with bloody diarrhoea and poor urine output, and the entry of their clinical information onto the computer (using the patient’s smart card for the demographic information) might prompt a reminder about the possibility of haemolytic uraemic syndrome. The doctor involved could then directly access an up to date textbook on screen, or even pull out abstracts from recent journal reviews. Appropriate blood tests and cultures could be organised, and ‘consult’ requests made as appropriate. Fluid regimens could then be ordered and the further management planned. If dialysis became necessary and a peritoneal catheter were needed, a video clip showing the technique for insertion could be shown at the bedside. Direct links to a specialist unit might provide video links with a renal expert to provide specific advice and allow them to view results and charts as well as the patient. Appropriate data collection for later research would automatically occur, results and radiographs appear as soon as they were available—the possibilities are endless!

The problems

Such systems are not yet available, at least not as a total package. This reflects a number of problems, of which three are worth specific mention. Firstly, and perhaps inevitably, is money. The development of these packages and the integration of the many different components, is expensive as is technical support. Although the technology is available for each component their combination is not straightforward. Software can rarely be brought in directly from commercial packages and needs to be adapted for the particular area in which it is to be used. This comes on to the second problem. Every clinical area within a hospital or even the same clinical area between hospitals has unique requirements. Each workstation therefore needs to be adapted for that area, in terms of the method of data collection, or format of output, etc. Such adaptations are extremely costly. Links to the laboratories may be easy to identify but for the data to be complete all information must be available, meaning that each hospital has to consider areas such as endoscopy suites, lung function laboratories and obstetric ultrasound departments to ensure that results from these areas is complete and available. Equally, much easily accessible data is of little long term use and the collection of vast quantities of redundant data must be avoided. Even today not every clinic (or clinician) is computer literate (let alone friendly) and their needs must also be addressed. Lastly there is the difficulty of balancing easy quick access to data with the need for...
adequate security, particularly if access to the internet is to be available. This is a large and difficult problem and not one that can be easily solved.

Summary
We have spent many years hearing about the benefits that we are about to reap from computers, but often seem to find that workloads are increased rather than decreased by the demands for ever more complex data. I certainly hope that the possibilities being offered up in this review represent more than idle dreams, and may be the first signs of computer systems that genuinely help to reduce our workload.

Glossary
- **Baud**—the speed of data capture. The higher the baud the quicker the device.
- **Bookmarking**—recording the internet address of particular site allowing rapid return to a site of interest.
- **File server**—central computer serving a network of different terminals.
- **Processor**—the engine for the computer. In increasing order of speed these include 386, 486, Pentium, or MMX processors.

**Children in residential care; what cost?**

Young people 'looked after' in residential care by social services can be viewed as a significant problem for child health and mental health services and for education authorities. They are frequently victims, in terms of abusive backgrounds that lead many into the care system, and perpetrators, in terms of child abuse and/or committing offences such as stealing cars. These characteristics, combined with emotional and behavioural problems as well as learning difficulties, lead to great difficulties in meeting these young people's needs. Considerable input is often required from health, education, and social services resulting in inevitably high expenditure. This paper explores these needs and their associated costs.

'Health of the Nation Targets' with regard to teenage pregnancy, sexually transmitted disease, smoking, suicide, and poor diets are particularly important for those cared for in residential community homes. Although these health concerns are shared with this age group as a whole, prevalence is likely to be higher among children in residential care. Frequent moves from both outside and within the care system before a long term home is found can lead to health problems being overlooked or to poor continuity of health care.

There has been a successful drive to keep children within their own homes whenever possible and to foster those for whom this is not an option. Despite this, 19% of those being looked after nationally remain in residential care. Personality problems and deviant behaviour are prevalent among young people in this group. They require protection, supervision, support, education, consistency of environment, and stimulation. Meeting these needs successfully demands parenting of a high standard supported by personnel from health, education, and social services. Communication and coordination are essential, as well as agreements on how costs are shared. Failure in this respect leads to ineffective services, although costs may remain high.

Despite high costs, residential care is frequently associated with poor outcome with regard to employment, (50–80% unemployment among 16–24 year olds compared with the national rate for this age group of 15.4%); 75% have no academic qualifications (compared with an average of 6% for the same age group); homelessness (30% of single homeless people having been in residential care); mental health, future parenting ability (one in seven young women leaving care are pregnant or already mothers); and risks of criminal conviction (38% of young prisoners are said to have been in local authority care as a child). These costs have been quantified in order that the cost benefit of future strategies to reduce numbers in residential care may be evaluated.

**Illustrative costs**

Data are presented (table 1) from published national and local sources to indicate the expenditure that is associated with children in residential and foster care that might be incurred by local authorities and health authorities. Other expensive services need to be weighed against potential future costs, for example, unemployment vs employment, mental health vs mental illness, and the costs or lack of costs incurred by the criminal justice system. These figures are intended to be illustrative only of the comparative costs of different types of residential provision. Individual costs may be much higher, for example intensive care after overdose, orthopaedic care after serious injuries sustained while driving a stolen car, or insurance costs due to loss of vehicles or damage to property.

**Discussion**

Placement in residential care is approximately seven times as expensive as foster care. It is comparable with residential special school placement, although some may also attend day special school. Children receiving residential care (including specialist psychiatric care) in these settings may...
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