a rapid release of Ca^{++} into the cytoplasm: the cytoplasmic Ca^{++} concentration often rises briefly to $\geq 0.5 \mu\text{mol/l}$ within seconds after the application of a stimulus. $\text{Ins}(1,4,5)\text{P}_3$ is inactivated both by dephosphorylation and by entry into a complex pathway that interconverts several previously unknown inositol polyphosphate isomers, the biological functions of which are still uncertain.¹⁰ 1,2-DAG, the other messenger molecule formed from $\text{PtdIns } P_2$, activates a protein kinase (protein kinase C; PkC) that can also be activated by phorbol ester tumour promoters. The latter compounds were originally of interest because they enhanced the tumour yield in skin treated with carcinogens, but they were later found partially to mimic some effects of cell stimulation (such as platelet aggregation), so suggesting that they might act by subverting some normal cellular signalling process. Some of the intracellular targets of Ca^{++} and PkC are known: for example, Ca^{++} (in combination with the intracellular Ca^{++} receptor protein, calmodulin) activates glycogen breakdown, smooth muscle contraction, and the pumping of excess Ca^{++} from cells; and PkC regulates a plasma membrane ion channel that exchanges intracellular H^+ ions for extracellular Na^+ and thus controls intracellular pH. However, we understand neither the mechanisms by which these two signals often synergise in the activation of cells nor those by which they control longer term cell decisions such as the choice between proliferation and differentiation.

The future

We have now identified, and partially understand, some of the biochemical mechanisms by which cells respond to extracellular controls, several of which are reviewed in reference 11. In the future we must explore the details of the known signalling processes and identify an as yet unknown number of others. A known mechanism that was not mentioned above is the control of intracellular cyclic guanosine monophosphate (cyclic GMP) concentration: in the

retina the photoreceptor protein rhodopsin activates a G protein (G_t or transducin) that controls the enzyme that degrades cyclic GMP. Gene cloning and protein purification studies have recently identified an unexpectedly large number of G proteins, including the proteins that are encoded by the *ras* oncogenes that are frequently mutated in human tumours: these have not yet been assigned roles in known signalling pathways. And other evidence has begun to accumulate for novel biochemical reactions under G protein control: examples include a membrane K^+ channel; phospholipase A_2 (which liberates free arachidonate and thus initiates eicosanoid synthesis); a phospholipase C that liberates 1,2-DAG from phosphatidylcholine rather than $\text{PtdIns } P_2$ (and which may therefore activate PkC without an accompanying rise in intracellular Ca^{++} concentration); and another phospholipase C that is activated by insulin and liberates 1,2-DAG and a glycan derivative of inositol monophosphate as potential intracellular mediators of insulin action. Doubtless other mechanisms will emerge, some of them from quite unexpected quarters, over the next few years.

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How To Do It

Use electronic mail

MICHAEL S BUCKINGHAM

The National Health Service is a large user of the Post Office. New technology in the form of word processors linked by the telephone system may result in letters being replaced by electronic mail. What follows is based on my own experience of the introduction of such a system into a district general hospital.

Introduction

Information may be transmitted from one person to another in a number of ways. Talking face to face is informative, direct, and immediate but may not be convenient. Talking by telephone is also immediate but is slightly less informative and may entail delay while

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the second party is located. Letter writing is much slower but has the advantage of providing "hard copy" which may be filed and used for future reference. This is important for continuing patient management and for legal purposes. Good overall communication between hospital and community depends on a combination of these three systems of exchanging information.

Changes in the office

In the past, many referrals of patients were made by handwritten

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letter. Unfortunately the legibility of handwriting is variable, and so most letters are now typewritten, which is also faster. Typewriters have improved over the years from the heavy manual machines to electric typewriters and electronic typewriters with limited text editing facilities. The most important recent development has been the word processor, consisting of a visual display unit, a typewriter type keyboard with integral computer facility, and a printer. The word processor may be used as a conventional typewriter but, depending on the capacity of the computer, a large number of additional facilities are available such as text editing, data storage and retrieval, formation of letters, spelling checks, list processing, and text duplication. In many offices the major advantages of a word processor over a typewriter are that documents may be typed and subsequently edited without having to be retyped and that many identical "top copies" of a document may be produced from only one typing.

The word processor is therefore a desk top computer designed for office use. It does not, however, have to be an isolated unit. Because the machine can retain the information typed into it this information can be transmitted to a second word processor. A suitable communication network is the British Telecom telephone system, and as long as a suitable connection can be made word processors can be made to communicate by telephone. Documents may thus be prepared in one office and transmitted by telephone to another office, the document being reproduced on the recipient word processor's screen or printer. The transmission of information in this way, without paper being physically moved from place to place, is known as electronic mail. The principal advantage of electronic mail is that information is transmitted instantly and directly from the point of origin to the recipient. As far as hospitals are concerned this avoids the inevitable delay incurred in sending letters through the internal mail system and subsequently through the Post Office. (This may take up to a week or so while the electronic mail is received almost immediately after dispatch.)

A number of electronic mail systems are already in widespread use. The telex system (short for *teleprinter exchange*) has been used for many years. This is a text oriented system and is similar to the telephone system but with teleprinter rather than audible signals. It transmits signals at the rate of 50 bits/second or approximately 6.6 characters a second, and, with teleprinters that are a combination of a keyboard and printer, provides a paper record for both sender and recipient. Nevertheless, useful though it is, telex is relatively slow and not very versatile. A development of telex called teletex—as distinct from teletext, which is a system for receiving broadcast information on specifically modified television receivers—has recently been established. This new system transmits at 2400 bits/second and so is considerably faster than telex. Because information is transmitted from one computer memory to another, using a word processor rather than a teleprinter, messages may be received without interrupting other work already being performed on the equipment. Teletex can also tie up with other word processor functions so that a highly flexible international telecommunication system will ultimately become available. This system is, however, very elaborate and expensive and best suited for large international corporations.

For the purposes of electronic mail within a health district a similar though less elaborate electronic system may be established. If such a system is to be comprehensive terminals need to be sited throughout the district general hospital, in any outlying hospitals, and in the general practitioners' surgeries and health centres in the district. Any terminal will then be able to communicate with any other at any time. As well as being used as an electronic mailing system between the hospital and community, there may of course be communication between terminals within the hospital. This may be particularly helpful if it provides access to the pathology department's computerised records. Results of investigations will then be readily available, night or day, without any need to interrupt the laboratory's work or wait for the result to be found.

Using the system

The Winchester Health District is in the process of introducing the British Telecom Merlin business system. Each terminal consists of a simple microcomputer with a printer but no disk store. The computer terminal has a built in coupler that connects it to the telephone system. The computer may be programmed to store up to 10 master copies of forms which may be used, for example, for hospital discharge summaries. When completed such a form may be sent to as many destinations as wanted.

The visual display unit (VDU) consists of a small monitor screen divided into two parts. The upper part displays the document to be prepared, either a letter or memo, or in a programmed form that may be selected and completed. Twenty five lines of typing space are available on screen with a screen width of 80 characters. The prepared document is typed on to paper with 52 lines a page. The text may be moved line by line, in 20 line blocks, or in a complete 52 line page, so that documents may be reviewed and edited.

The lower screen consists of five lines displaying the various commands available to the operator (the "menu") which allow such operations as copying, editing, printing, or dispatching.

If a document is to be dispatched the telephone number of the recipient is typed on the monitor, and the computer then stores the document for automatic sending. A limited number of messages may be stored at any one time and there may be some delay if the recipient's number is engaged. The terminal will attempt to transmit the message five times within an hour. If it fails it prints out the entire message on the sender's printer to draw attention to the failure. The sender may then make further attempts to transmit the message at a more suitable time or, as a last resort, may send the printed message by post.

The hospital terminals may also be used to receive communications from general practitioners, either items of information or formal referral letters. Letters may be personalised by being directed to an individual, and an electronic "signature" may be applied. This takes the form of a personal identity number which is known only to the person concerned and which does not appear on the VDU screen. Once entered from the keyboard the document is secured and no further editing is possible.

Privacy of information transmitted by electronic mail should not be a problem in a system of limited size such as that used by a district health authority although care must be taken to ensure that the information is directed accurately. Interception seems unlikely but if information is particularly sensitive then it may be sent by post, appropriately marked in the traditional way, or delivered personally.

Word processors such as the Merlin system can also be used for collecting hospital statistics. This may be reported to regional health authorities and the DHSS according to the recommendations of the Steering Committee of the Health Services Information (Körner information). Information dispatched from the hospital on prepared forms may also be directed to the hospital computer for storage and analysis.

Conclusion

When new technology is introduced there is always some degree of resistance from those who have to use it. In addition the operator will attempt to use the new equipment in the same way as the old. A change such as that from typewriter to word processor will result in the new equipment being substantially underused, so wasting many useful features. Staff must be adequately trained before such technology is installed or used. This is essential both for getting the best use out of the equipment and for maintaining good staff morale.

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