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The Impact of Information Technology
upon Primary Health Care in Great
Britain

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by

Penelope Ann Grubb BSc (Sheff)

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To my parents

Preface

This is a study of the impact of information technology on health care in Great Britain. Its major aim is to identify means by which information technology may improve the quality of health care in specific areas within the health services.

The study concentrated upon general practice and was split into three stages. The first was a survey of general practice computing, conducted to give an overview of the use of computers in general practice. Following this, was a more detailed study of general practice miniclinics. The final stage was an in-depth investigation into the use of computers in the care and treatment of diabetes.

The first chapter of the report summarises the aims, objectives and structure of the project.

Chapter 2 gives the background against which the study was made. This begins with a short history of the development of the medical profession and the creation and development of the National Health Service (NHS) showing the position, of the general practitioner within the medical hierarchy, and of general practice within the NHS. Following this is an account of the use of computers within the NHS and specifically the computerisation of general practice. This chapter concludes with a summary of the potential advantages to general practice of effective computerisation.

Chapter 3 is a report of a survey made into the use of computers in general practice – this being the sole work of the author. The aims of the survey are explained at the start of the chapter. The rest of the chapter details the methods by which the survey was conducted, gives an overview of the results and finishes with the conclusions drawn from these results.

Chapter 4 is a study of miniclinics in general practice followed by a more detailed study of diabetes and diabetic miniclinics. This chapter explains why miniclinics in general practice and the care of diabetes were chosen for detailed study.

Chapter 5 is a report of the study into the care of diabetes in general practice miniclinics. The background is given to the decision to develop a software system. An overview of the system is given. Following this, there is an account of the system in use and the conclusions drawn from its use concerning the design of systems for effective use in the clinical environment. This chapter includes some information about a specialist diabetes centre. This is included for the comparisons which can be drawn between it and the general practice miniclinic. The chapter concludes with a summary of the investigation. Other than the results quoted from investigations carried out in the specialist diabetes centre, this chapter is the sole work of the author.

Chapter 6, also the sole work of the author, gives a detailed account of the design and development of the software system. All aspects of the system are described. The chapter concludes with an overview of the system and ideas for future development.

Chapter 7, the final chapter, summarises the study and draws overall conclusions about the use of information technology in health care. This chapter is the sole work of the author.

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Chapter 1

Introduction

1.1 The Objective

The specific purpose of the project is to study the effects of computerisation upon general medical practice in England and Wales.

A general study was conducted to give an overall view of computers in the surgery. This identified a specific area, the care and treatment of chronic illness, where the computer may be of particular value in terms of patient care. To investigate this in depth, a controlled environment within general practice – the miniclinic – was studied.

General practice encompasses a wide range of differing environments from the small single doctor practice operating from old and inadequate premises to the new purpose built medical centre catering for tens of thousands of patients. It has been affected not only by purpose built computer based systems but also by the computerisation of other parts of the National Health Service (NHS). The installation of computer systems in hospitals and the computerisation of the Family Health Services Associations (FHSA) has affected the work of the general practitioner (GP). Computer systems built specifically for general practice vary enormously and are used very differently within the different practice environments.

This study concentrates upon the computer systems built specifically for use in general practice and concentrates upon particular groups and types of general practice. Within this framework, some of the wider issues, concerning information technology across the NHS, were explored.

1.2 An Overview of the Project

This study is divided into three distinct stages.

An Overall Assessment How practice staff and patients have been affected by the installation of a computer system. For this part of the study, a single computer system was chosen and practices in England and Wales, who had installed this system, studied.

A Controlled Environment within General Practice Leading on from these results, a study was made of miniclinics in general practice, and particularly the diabetes miniclinic. This was a precursor to a detailed study of the effects of computerisation upon the care of diabetes.

Information Technology and the care of Diabetes A study of the effects of computerisation upon the care of diabetic patients.

The Structure of the Report The report is structured into five sections. The first section describes the background against which the study has been made. The next three sections deal with the three main stages as described above. At the end of each of these sections are given the results and conclusions drawn from the work carried out during that stage. The final section summarises the project as a whole and draws general conclusions from the results of all three stages.

Chapter 2

The Development of Medical Practice in Great Britain

2.1 The Emergence of Medicine as a Profession

Medicine and medical practitioners currently hold a position of high professional status in Great Britain. Originally, however, medicine was regarded as a trade and medical practitioners had little social status in society.

The Medical Act of 1858 established a single register for all recognised medical practitioners. These were categorised into three separate groups; the physicians, the surgeons and the apothecaries. Physicians and surgeons were the forerunners of modern day consultants and specialists. Apothecaries were the forerunners of GPs. Each of these groups had its own professional body and this division of the three groups had, and continues to have, a considerable influence over the development and structure of medical practice.

Physicians were regarded as the elite of the medical profession, superior socially and educationally to the surgeons and apothecaries. Historically, physicians attended the aristocracy and the wealthy upper classes. The Royal College of Physicians was established in 1518.

The surgeon did not begin to gain in social status until the separation from barbers in the eighteenth century saw surgery gain the respectability of a profession. The Royal College of Surgeons was established in 1800 with the help of the Royal College of Physicians. The Royal College of Physicians, in rendering this assistance, also consolidated its own position as the elite of the medical profession, by reinforcing the distinctions between the two groups.

Apothecaries, originally shopkeepers, obtained a distinct identity in 1617 when, as a profession, they broke away from the Mystery of Grocers. However, the apothecary did not establish the right to treat patients, as opposed to just selling medicines, until the plague of 1665. Those with the means to do so moved away from London to escape the plague. These were the wealthy patients of the physicians and the physicians themselves followed. This left London in great need of medical expertise and very short of medical experts. Inevitably, the apothecary expanded his medical function. Opposition to this expansion came from the Royal College of Physicians. These objections were officially overruled by the House of Lords in the early eighteenth century.

Physicians practiced in major towns and cities, had university degrees and

treated patients from the upper social classes. The rest of society relied upon the apothecaries and surgeons. The GP of the time was one who acted as both surgeon and apothecary.

At the start of the nineteenth century there was a well established hierarchy in the medical profession with the physicians still firmly at the top. The Royal College of Physicians had increased its sphere of influence and played a major role in areas of public health, for example, in its work on vaccination [1]. However, during the nineteenth century, the Royal College began to lose its unique social standing. This came about with the rising status of the apothecary and apothecary-surgeon. In 1815, the Apothecaries Act gave the Society of Apothecaries the power to examine and license apothecaries.

The increasing affluence of industrial cities in the mid nineteenth century established the importance of the GP as doctor to the rising middle classes [2]. In 1832 in Worcester, the medical association was formed which later became the British Medical Association (BMA). The association was set up largely to counter the power of the Royal Colleges. The BMA represented GPs in negotiation and general matters. It did not oversee educational requirements or award diplomas. In order to gain equal status with consultants, GPs needed their own college. However, the College of General Practitioners (RCGP) was not formed until 1952 and did not receive a Royal Charter until twenty years later, over 450 years after the establishment of the Royal College of Physicians.

The Medical Act of 1858 integrated the three streams of medical practice. It created the General Medical Council (GMC). The purpose of the GMC was to supervise medical education, regulate the examining bodies and maintain a medical register and pharmacopœia. It was purposely independent of both the Royal Colleges and the universities. Despite this integration, there was no simplification of structure of the medical profession and the concept of rank within the profession was still retained. The general medical practitioner was still of inferior professional status to the consultant physician and consultant surgeon.

In the nineteenth century several trends led to an increasing rivalry between the GP and the physician. One was the rise of the affluent middle class, for whom both types of practitioner found themselves competing; another was the increase in specialist clinics in general hospitals. There was much debate into this undercutting of the GPs practice by the hospitals [3]. The consultants successfully fought all proposals which would have allowed the GP direct access to hospital beds and, as a result, the referral system was evolved. A consultant could be called in to give a second opinion on a case but the GP retained the relationship with the patient.

2.2 The National Health Insurance Act

The National Health Insurance Act of 1911 provided a scheme of free medical care for the insured by GPs but not hospitals. The BMA was very influential in deciding the terms upon which doctors entered the scheme. The Act, by focusing on the GP, accentuated even further the division between the GP and the consultant but at the same time, strengthened the GPs position. The number of GPs increased, as did the income of the average GP. The concept of the family doctor was born. The scheme itself was superseded by the NHS in 1948.

2.3 The National Health Service

The NHS Act was passed in 1946. The Minister of Health, Aneurin Bevan, made many concessions to the medical profession in order to ensure its cooperation. There was substantial medical representation at all levels. As a result, hospital consultants became salaried professionals and GPs retained their position as independent contractors.

The establishment of the NHS had both positive and negative effects upon the GP. On the positive side, there was an increase in income, a narrowing of the social distinction between the GP and the hospital consultant and more overall security. On the negative side, bargaining powers were considerably less for the GP than for the hospital consultant; the role of the GP was not clearly defined and the overall structure of the NHS effectively reinforced the inferior status of the GP [4].

Overall, general practice was isolated within the structure of the NHS. A career structure for GPs was ill defined and financial incentives were few. While the status of the GP, and standards within general practice, fell, hospital medicine enjoyed increasing status with the advance of technology.

Many reports and surveys around this time [5, 6, 7, 8] looked at the problems in general practice. These all agreed that standards in general practice needed to improve but none addressed the root problems; the ill defined role, and the lack of status, of the GP within the NHS.

Conditions in general practice reached crisis point in the mid 1960s when mass resignation by GPs from the NHS was threatened. Prolonged negotiation with the government resulted in a new contract for GPs. Even then, the underlying problems in general practice were not properly addressed. But, although not all the GPs' demands were met, the pay structure and conditions of service were greatly improved. Significantly, there was now a financial incentive for the improvement of standards within general practice.

The Dawson report of 1920 [9] pointed out the advantages of GPs working within group practices and health centres but, it was not until 1965 that there was any financial incentive for general practice to organise itself in this way. The GPs' role was also being altered by the advances in medicine. The GP was treating more and more chronic illness and dealing with the social implications of disease. There was a shift in emphasis towards team care and the establishment of group practices. In 1951, only 20% of GPs worked in group practices. In 1971, this figure had risen to 80% [10] and by 1980 one fifth of GPs worked from health centres.

Nowadays the emphasis is on a primary health care team. Health care has become too complex to be managed by any one branch of medicine and team care has long been recognised as the best approach. However, until reorganisation in the mid 1970s, the structure of the NHS discouraged the establishment of primary health care teams. Organisation of the different branches of medicine was fragmented. GPs were under contract to executive councils, hospital staff were employed by the regional hospital boards and district nurses and health visitors were employed by local health authorities.

In 1975 the area health authorities took over responsibility for all these groups except GPs. The GP service was overseen by the Family Practitioner Committees, who later became the FHSAs, who were accountable to the area health authorities. The area health authorities have since been disbanded and the hierarchy of the NHS is divided as follows:-

- The Minister of Health
- Regional health authorities

- District health authorities
- Unit management teams (including FHSAs)
- Primary health care teams (including general practice)

The Minister of Health in the Department of Health and Social Security (DHSS) has ultimate responsibility to the crown, parliament and the people. With the disbandment of the area health authorities, the Family Practitioner Committees became directly responsible to the DHSS.

2.4 Computerisation Within The National Health Service

Before the 1980s, NHS computing consisted of little more than accounting and payroll packages. Since then, funding has been made available for the development of systems in almost all areas of the NHS.

The NHS, together with computer systems suppliers ICL, formed an Inter Regional Consortium (IRC) to develop its own patient administration system (Pas) designed for use by the health authority regions. A database package used by the health authority districts feeds information back to the regional system. IRC has developed standard interfaces to Pas from systems designed for use in such areas as pathology and radiology.

The main aim now in NHS computing is towards resource management systems. The key areas for development, in computer terms, being communications, networking and relational databases.

2.5 Computerisation In General Practice

The position of the GP within the structure of the NHS has not favoured general practice computerisation. The GP, being self-employed, must look to the DHSS for guidance on computerisation. Little guidance and no financial help from the NHS was forthcoming for GPs in England and Wales until the 1990s.

Computerising general practice records is a very different proposition from the computerisation of hospital records. Computer systems in hospitals are essentially patient administration systems and are not directly comparable with general practice systems because of the basic differences in patient management in the two environments.

GPs who computerise their practices have been faced with a large variety of systems and no real means of evaluating them. General practice systems were developed by a variety of people for a variety of reasons. Computer systems suppliers, seeing a potentially lucrative market, developed their own general practice systems. GPs, seeing the potential for computer systems within general practice, teamed up with computer professionals, or even developed systems themselves.

In the 1960s and 1970s, few GPs had, or wanted to have, computer systems. There was strong resistance to computerisation in general practice well into the 1980s. Studies investigating computerisation of general practice [11] have shown various reasons for this resistance, broadly falling into three categories; financial, professional and technical. With no real guidance from the DHSS, GPs had to rely on hearsay and information from the computer system suppliers in an effort to evaluate the systems available.

Early computer systems were marketed with a bias towards administration and other areas in which the GP does not tend to become personally involved. As it is usually the GP who makes the decision as to whether or not to buy a computer system, it is not surprising that this style of marketing was not successful.

Less than 10% of GPs were using computer systems in their surgeries by the end of 1986. This compared with over 80% for accountants and over 40% for architects. Even by 1990, the percentage of GPs using a computer was small compared with other professions. The major reasons for this stemmed once again from ^{the} position of the GP within the NHS and within the medical profession as a whole, and could be summarised as a lack of incentive for GPs to computerise and a lack of guidance for those who did.

This latter reason led, in many instances, to the installation of inadequate and inappropriate systems. This, in turn, lessened the incentive for other general practices to computerise. In several instances, GPs, wanting to computerise their records, but unable to find suitable software, developed their own systems. The G-Pass system now adopted throughout Scotland was originally developed by GP, Dr David Fergusson. GPs who successfully computerised their practices were enthusiasts happy to spend time overcoming the problems of inadequate systems and, in many cases, reorganising their practices to accommodate the computer. This led to the fairly widespread, and in the early days of general practice computerisation, justified, belief that in order to install an effective system a GP must not only acquire extensive knowledge of computer technology, but also be prepared to spend an inordinate amount of time on his system.

Computer systems suppliers were unable to make money in the general practice market and many pulled out of the market entirely or went out of business. This left some general practices with unsupported systems or systems which were very expensive to maintain. Any such computer systems soon became obsolete, forcing practices to change to different systems. The systems suppliers, being in competition with each other, had no incentive to produce compatible systems. This meant that changing from one system to another was usually a major undertaking. A general practice could find itself in the position of having invested too much time and money in a system to be able to change it.

There are now a variety of systems in use. At the start of the 1990s, there were over forty companies supplying computer systems to GPs. The problems of evaluation of these systems for the general practice wishing to computerise were, and still are, considerable [12]. The market for general practice systems expanded considerably in the late 1980s and the systems themselves became very much more reliable. However, there has been no serious attempt towards standardisation or compatibility of systems. Standardisation will now be very difficult to achieve, leaving general practice computer systems isolated, not only from each other but also from other NHS systems.

General practice computerisation was never centrally organised. The considerable benefits which could have been gained from standardisation have been lost to general practice through this lack of organisation. Computers, for example, greatly facilitate epidemiologic studies. Such work would benefit enormously if it could take advantage of a standard general practice system. The value of such studies is well documented [13] and it is very unfortunate that studies centred upon general practice should be disadvantaged in this way. This point is amply illustrated by contrasting the situation in general practice with the organised computerisation of FHSAs throughout the country which has led to the development of a standard FHSA system.

The government White Paper on the NHS published in January 1989 outlined plans for increased computerised control over both hospitals and General

Practice. These included the computerisation of the health service central register. The aim being to have operational by November 1990, a fully computerised, accurate record of everyone registered for NHS treatment in England and Wales, showing which FHSAs holds each patient's current registration with a doctor. There was widespread concern inside the NHS over the funding and proposed time scale for the projects outlined. There was a fear that new information systems, introduced too quickly and without the backing of experience, may prove disastrous. Initially, only £400 million was to be allocated for all aspects of the White Paper but without details as to how this money would be divided. In the event, this timetable did prove over optimistic and computerisation of the central register has not yet been achieved.

Government reform of the NHS in the early 1990s included plans for the integration of primary care with the rest of the NHS. Undoubtedly, this has played a large part in forcing general practice, as a profession, to computerise. Unfortunately, this 'incentive' to computerise was not accompanied by effective guidance on how to computerise; how to evaluate existing systems or where to find information on existing systems.

It was the pharmaceutical companies who first provided general practice with the practical help it needed. A small number of companies, in conjunction with medical systems suppliers, worked out various schemes by which the company would supply a computer system at a reduced cost in return for statistical information from the practice. Originally, such schemes were said to provide *free* systems. However, the cost to the practice in terms of time and effort was quite considerable. So much so that in several cases, the companies were forced to reduce the demands made upon the practices in terms of the information required.

There is concern about this involvement of the pharmaceutical industry with general practice computerisation and debate as to whether it is in the best interests of patient care. Nonetheless, the emergence of the *free* systems succeeded where the DHSS had previously failed (as described in the following section). The publicity surrounding the systems generated interest in, and awareness of the possibilities of, computerisation within general practice.

2.5.1 The "Micros For GPs" scheme

It was to address the problem of evaluation of general practice systems that the DHSS funded various projects in the early 1980s. The "Micros for GPs" scheme was set up as part of Information Technology Year in 1982. The general aims of this scheme were to investigate the problems of, and attitudes towards, general practice computing. Specifically, the scheme sought to investigate the following areas; costs, reliability, effects of attitudes upon implementation and of computers upon attitudes, safety, efficiency, preventive medicine, benefits to patients and changes in practice administration. Of the 20,000 practices notified of the scheme only 5% applied to take part. Of these, 150 were chosen. Systems were installed in most of these practices by the end of 1984.

The assessment was in two parts, a technical survey assessing the speed of response of the systems and a user survey which was essentially a subjective assessment by the users of the systems.

The scheme attracted a fair amount of criticism [14]. At the start, it was specifically criticised on two counts :

1. Only two large companies were chosen to take part.
2. Despite representation on the steering committee from both the BMA and the RCGP, there was no consultation with the Joint Comput-

ing Policy Committee set up by the RCGP or the General Medical Services Committee of the BMA.

The report [15] was also criticised for making no attempt to produce a 'value for money' assessment.

The general aim of the scheme was to make GPs more aware of the possibilities of computerisation. It can be said to have succeeded in this although, probably because of the standard of system available at the time of the study, it alerted GPs more to the problems of computerisation than to the advantages. Before the start of the scheme, approximately 4.5% of general practices were computerised. By the end of 1986, the level of computerisation was between five and ten percent. Thus the scheme cannot claim to have greatly increased the level of computerisation in general practice.

The majority of the staff participating in the scheme thought it worthwhile to continue with a computer system despite the many problems they had experienced during installation. It was probably the implication that every practice would have to overcome these and similar problems in order to computerise that accounted for much of the negative response to the scheme.

One of the conclusions of the report was that the main benefits of general practice computerisation lay in the potential for data analysis.

2.6 The Advantages Of Computerisation In General Practice

Many of the advantages of computerisation stem directly from the way in which computers store and retrieve data. Computers can store vast amounts of data quickly, accurately and in a small physical space. Computer data are very much easier to maintain than manual records. Computers are also capable of retrieving data very quickly, very accurately and very flexibly.

A patient's records can be retrieved at the touch of a key. Any particular cohort of patients can be found within seconds. Contrast this with manual records; if the patient group required cannot be retrieved according to the physical ordering of patient records within the file (usually alphabetic on surname) then the practice must rely on manual indexing. The maintenance of manual indexes is time consuming and it is impossible to rely completely on their accuracy. Of all the ways in which medical records can be indexed, a practice could realistically expect to maintain manual indexes for only a very small percentage. A computer system, on the other hand, can retrieve records and data according to any combination of index criteria. Furthermore, it can do this accurately, reliably and quickly.

A computer not only retrieves data more quickly and more reliably than does a manual system, it also retrieves data which it would *not be possible* to retrieve from a manual system. A practice wishing to find an unusual cohort of patients from a manual records system would have to search through their entire files. If the records were required as a matter of urgency, the task would be impossible. A computer, on the other hand, could be given any set of parameters and could retrieve the relevant records very quickly.

The identification of patient groups is vital if patients are to receive the care and attention they need and this is one of the areas where the computer can make a very valuable contribution to health care.

Many administrative tasks are made easier by a computer system; form letters may be sent out to patients; forms which had previously to be handwritten or typed may be printed. Very little information has to be entered twice into

the system; once a patient's address is recorded, it will appear automatically on prescriptions and hospital forms; repeat prescriptions will be printed automatically. Lists of patients overdue for clinics or appointments can be generated easily.

It was initially suggested that a computer system would considerably decrease the workload in the practice, particularly in terms of administration. However, this has not proved to be the case. The computer has removed the drudgery from many administrative tasks but it has, at the same time, actually increased the overall workload through its data retrieval capabilities. The computer system, by dealing efficiently with routine and repetitive tasks, allows the practice to make better use of its time.

It must be stressed that the advantages detailed above refer to good, well designed and well maintained software systems. The technology and expertise is available to provide systems which supply all these advantages and more. If a particular system does not match up to these requirements, it contains some inherent weakness in the way it has been developed. If such a system is not brought up to standard, it will be over shadowed by superior systems and will become obsolete. It is a result of the ad hoc way in which general practice has had to computerise, that so many surgeries still have to cope with inadequate systems.

The advantages of computerisation in general practice go beyond those specifically related to patient care. The Korner steering group on health services information was set up in the early 1980s because of concern about information management in the NHS. The need to ensure quality of health care was one of the things identified in the first report [16]. The steering group states in its fifth report [17] that incomplete information about the work of GPs must inhibit district health authorities ability to plan, evaluate and account for the service that they provide. It was suggested that many people within the NHS, particularly administrators, misunderstood the role of GPs, wrongly believing, for example, that most asthmatics, diabetics and hypertensives were treated in hospitals.

Despite the fact that general practice stores vast amounts of information on its patients and the work it does, it has always been very difficult to access enough of this information selectively to give an accurate picture of the role of the GP. If computers can make this information accessible they will be providing the evidence to help ensure that general practice gets its fair share of future resources.

Chapter 3

An Overall Assessment of the Effects of General Practice Computerisation

With the aim of assessing the impact of information technology on general practice, a survey was carried out. The objective was to gain an overview of the effects of the computer from the point of view of both the practice staff and the patients.

Although surveys had been carried out previously [15, 18, 19], these had either been concerned with the earlier systems or had not contained subjective assessments by staff and patients. Problems with the early systems had had a disproportionately high profile in these surveys. Now that reliable general practice systems were beginning to come onto the market, it was deemed important to carry out a similar survey for such a system. The early systems had intruded into the practice environment in a largely negative way. Subjective assessments of the ways in which the computer system had affected the surgery cited technical problems and disruption to surgery routine as being amongst the most noticeable. It was hypothesised, and proved to be the case, that such problems would be minimal with the newer systems. This being the case, the less intrusive effects of the computer system would come to the fore.

3.1 How the Study was Conducted

A single general medical package was chosen and all practices in England and Wales who had installed this system were invited to take part in the survey.

The main criterion for choosing the medical package was that it should be a completely new one. It was felt important that problems of inadequate technology, such as had characterised some of the early systems, should not have been an issue in the design and development of the system being investigated.

It is never possible to accurately predict all the repercussions of introducing information technology into a new environment. It requires people with specialist knowledge of the environment – in this case, the medical staff – to see the potential benefits, and people with specialist technical knowledge to realise that potential. Technical knowledge of computer systems means, amongst other things, knowledge of their shortcomings. Such knowledge can sometimes restrict the overall view. A lack of technical expertise can be a positive asset in seeking a comprehensive overview of the role of information technology in a specialist

environment. For these reasons, views and assessments from new users were considered particularly valuable.

Because general practice was largely uncomputerised until very recently, the vast majority of customers for a new system are first time users and not users changing from other systems. Thus, choosing a new system was a guarantee that the majority of users would be new to computing; their perceptions and expectations would not be restricted by past experience.

The package chosen¹ was not then, and is not now, a market leader. It currently holds a less than 5% share of the market [20].

3.1.1 The overall structure of the survey

The survey was in three parts:-

1. An initial questionnaire
2. Interviews with practice staff
3. Patient questionnaires

The initial questionnaire

Each practice was sent an initial questionnaire asking general questions about the practice, and a covering letter explaining the purpose and proposed structure of the survey.

There were three sections to the initial questionnaire:-

1. *Practice details*

For how long had the computer system been in use in the surgery?

Which staff used the computer?

Was the computer used during consultation?

2. *Interviews and questionnaires*

Details of practice staff willing to be interviewed.

Would the practice be willing to distribute questionnaires to patients?

3. *Results summary*

The final question asked if the practice would like to receive a summary of the results of the survey.

Staff interviews

Interviews were carried out with practice staff. If possible, the interviews were carried out in the practice. Where this was not possible, the interviews were conducted by telephone.

The number and type of staff willing to participate varied from practice to practice but, when possible, both medical and support staff were interviewed.

¹A small general package designed to keep a basic summary of patient data, do searches, capitation and screening and particularly designed for ease of use. The user interface was a menu driven and form filling one. The package has since extended the facilities it offers quite considerably, with some increase in complexity of the interface.

The interview strategy The interviews were conducted within a framework of specific aspects of computerisation. However, the tone was kept deliberately informal. The main aim was to gain an accurate picture of the way the computer was used and perceived within the practice.

Not all the relevant areas could necessarily be predicted, and it was important that the people being interviewed should not feel that discussion was constrained within set boundaries. The aim was to make the interviewee feel free to talk about any aspect of computerisation that they felt was significant.

Areas covered The following specific areas were covered:-

How computerisation was planned. What specific plans had been made prior to computerisation? What had been the initial plans for use as regarded different areas of the practice; in particular, reception, consultation and miniclinics? What had been the initial strategy for registering patients on the system? How closely had these plans been followed?

Who used the computer and in what way. What specific tasks did the computer perform and which practice staff were responsible for them? What difference did the computer system make to the way things were done?

Specific aspects of computer use. Was the system being used for anything for which it had not been planned? Was the computer doing anything that the practice would not have been able to do manually? How did the computer system affect the workload of the different members of the practice staff?

Patient reactions Had any patient reaction to the new system been noted in terms of change of attitude or comments made?

Perceived advantages and disadvantages What were perceived to be the greatest advantages and disadvantages of the system? Was there any way in which the practice would wish to change the system? If computerising again from scratch, what would be done differently?

Software and hardware support What standard and level of support did the practice get from the system suppliers?

Patient questionnaires

Practices who had agreed to do so, distributed questionnaires to patients. The aim of the questionnaire was to assess patient reactions to the presence of the computer system in the surgery. The questionnaires differed according to whether or not the surgery used the computer during consultation. Details of the questionnaires are given in appendix A.

3.2 Results

3.2.1 The initial questionnaire

The computer system suppliers provided a list of 60 practices – their estimation of the total number using their system at the start of the survey.

Four of the addresses supplied proved to be for practices who had subsequently decided to install different systems. Two other practices were eliminated from the survey for other reasons. This left a total of 54 practices.

Of the 54 practices originally approached, 44 (81.5%) replied. Of these, 12.9% (7 practices) did not wish to take any further part in the survey.

The following results are given as percentages of the 37 practices remaining in the survey:-

For how long had the computer system been in use in the surgery

Less than 6 months – 51%
6 months to 1 year – 38%
1 to 2 years – 8%
More than 2 years – 3%

This helped to confirm the supposition that the vast majority of users would be new to computing. Information from later staff interviews confirmed that this was the first computer package to be used by over 90% of the surgeries.

Which staff used the computer

The receptionist staff – 95%
Doctors – 76%
The practice manager – 65%
Practice nurses – 46%

Information from later staff interviews showed a pattern of usage. In general, the reception staff and often the practice manager used the computer from the start. The medical staff followed later.

Was the computer used during consultation

Yes – 38%
No – 62%

Information from later staff interviews showed that the majority of practices were considering the possibility of using the computer in consultation and many had definite plans to do so.

Practices whose staff were willing to take part in interviews – 92%

Practices who agreed in principle to the distribution of patient questionnaires – 76%

Practices who wished to see a summary of the results of the survey – 97%

3.2.2 Staff interviews

Initial planning The vast majority of practices did not have detailed plans for computerisation. Essentially, they allowed the system suppliers to advise them on their initial needs.

On the positive side of pre-computerisation planning, the thing generally cited as the most helpful was discussion. The more discussion there had been prior to system installation, the smoother was the installation process and the greater the initial acceptance of the system.

Detailed planning of the practical aspects was also thought important. Advice from the system suppliers, good as far as it went, was limited

by their lack of specialist knowledge of the needs and problems of general practice. Their view centred on their previous successful installations where the surgery environments may have been very different²

General attitudes Attitudes to computerisation before, during and after installation could be summarised as follows:- Negative before, wavering during and positive afterwards.

Worries beforehand were largely concerned with proposed time scales. Many staff felt that computerisation was being forced upon them too quickly. Specific worries were:-

- Would the system be easy to operate?
- Could data be lost³?
- How much extra work would there be?

Overall, the reception staff were the ones with the more positive attitude from the start.

All pre-computerisation worries stemmed from a lack of information about the system.

Disruption during the actual installation of the system was minimal in most cases. The main disruption occurred in the period after installation when the surgery was changing over from their manual systems. The major problems came from having to maintain two systems – the computer based and the manual – alongside each other.

The level of the problem depended very much on how initial data entry was arranged. Basic registration details of patients would usually be on the system when it was delivered. The task facing the practice was to check that the registration details were correct and to add the relevant medical details. Basically, there were two ways in which practices chose to organise this:-

1. A small number, sometimes a single member, of staff would take responsibility for adding medical data. This had the advantage that the task was organised and there was no duplication of work. The success of this method varied according to exactly how it was arranged. However, in general it proved to be very slow. Not only was the computer not in full use for a long time, but also some of the staff were excluded from using it.
2. All, or almost all, members of staff participated in data entry. Once again, the level of organisation varied from practice to practice. In general, there was an ad hoc feel to this method. A typical model would be as follows:-

A patient would come to the surgery to make an appointment. The receptionist would take the opportunity to check their registration

²One comment which was repeated many times concerned demonstrations of computer systems. It would seem that almost all would be suppliers were guilty of answering the question "Can it do X?" with "You wouldn't want to do that." This reply, as well as irritating would be customers, is realistically open to only two interpretations. Either it means "In our own limited experience no one has wanted to do that" or "We don't think we have the ability to provide that facility." A third interpretation, "Modern technology cannot yet provide this," is almost never valid in terms of the facilities required by general practice. Bear in mind that the technology which took man to the moon is now considered obsolete.

³Apocryphal tales abound, but this survey found only one case where a practice had actually lost data. In this case, a software bug caused the loss of several weeks updates.

details and correct them if necessary. During consultation, the doctor or nurse would put some medical details onto the system. Time would seldom allow that all relevant data could be entered during a consultation, but data relevant to the consultation probably would be. The medical staff would go through patient notes after surgeries to complete the data entry. Repeat prescription data would be entered by the reception staff, usually at the time of a patient's first request subsequent to system installation.

The most advantageous aspect of this method was the way it involved the whole practice. By the time the system was fully operational, everyone in the practice felt confident about using the system.

Once the system had been in use for six months or more, a majority of the staff in all the practices were happy with it. The general view was that the system had lived up to expectations and was of benefit to the practice.

Initial registration Two methods were used to register patients on the new systems :-

- By download from the FHSA computer.
- Manually from the age sex register.

Both methods had advantages and disadvantages and neither was as efficient as it might have been.

Download from the FHSA would seem to be the obvious route to take. The data is already recorded electronically; typing it all again is an apparent waste of time and resources. However, this was not always the case. Direct transfer of information from FHSA to practice computer was not possible because the systems were not compatible. This meant that the task was not a straightforward one. The accuracy of FHSA data was, in some cases, well behind the standard of the practice's own manual indexes [21]; the percentage of inaccuracies making manual re-entry of data the more efficient option.

As computerisation spreads, this situation will change. Before computerisation, information exchange between general practice and the FHSAs was slow and inefficient, certainly as regarded patient lists. The level of inaccuracy of FHSA data did not come to light until the FHSAs were computerised and general practice started to computerise. Now that information exchange is easier, records are updated more often and more efficiently. The lack of any direct electronic link between general practice and the FHSAs means that this process is more time consuming than it need be, but evidence from this survey suggests that computerisation has led to a marked improvement in the accuracy of FHSA data.

Areas of use

The overall pattern of use

Registration information	– over 95%
Repeat prescriptions	– over 95%
Call and recall	– over 70%
Acute prescriptions	– over 35%
Miniclinics	– less than 20%

The areas of greatest use were for registration data, repeat prescriptions, call and recall. Acute prescribing and use in consultation was something that most (over 80%) practices were planning.

The majority of GPs, including many who had had worries about the computer intruding into the consultation, found that they made more and more use of it as they became accustomed to the system. Several GPs commented that the presence of the computer had made the consultation less formal.

There was a general belief that use of the system would, in time, spread to almost all areas within the practice. In general, this degree of use had not been foreseen.

There were several areas identified where the computer system was doing things which could not have been done manually. Most often mentioned was the flexibility with which it was possible to search through patient information. Call and recall systems could be set up very easily. One practice quoted the setting up of a manual cervical smear recall system which had taken ten months. On the computer, such a system could be set up in seconds.

Workload There were some areas where the use of the computer system greatly eased the workload. The one most often mentioned was the issuing of repeat prescriptions. However, it was unanimously agreed that overall the use of the computer system caused a considerable increase in workload.

Call and recall systems were much easier and quicker to set up using the computer. This meant that more recall systems were in operation and hence more patients were being seen.

To be used to best effect, the computer system required up to date information. Data entry was very time consuming. GP's and nurses still wrote conventional notes during consultation and the salient points from these had to be later transferred to the computer system. A minority of GPs added data to the system during consultation but most felt that to do so would intrude upon the consultation. The reason most often given was that their keyboard skills were very poor. There was no marked improvement in this area even after several months of use of the system⁴. However, greater familiarity with the system did mean that more GPs were considering the possibility of adding data during consultation.

The general view was that the computer greatly increased the workload, particularly in terms of generation of paperwork, but that, as a result, the practice was making far more efficient use of its time.

Observed patient reactions Patient reaction, as noted by the practice, to the installation of a computer system, was effectively nil. It is probable that people are so accustomed to seeing computers, that the installation of a system in their surgery is a wholly unremarkable event. Computerisation in general practice, after all, lags far behind computerisation in most other professions. In particular, people are used to seeing computers in use in such places as banks, building societies, supermarkets and, more recently, hospitals. It is not surprising that the advent of the computer into the surgery environment should go unnoticed.

However, the few instances of patient reaction which were noted are of interest.

⁴It may be that the average doctor will not become a competent typist until someone invents an illegible typeface!

- Printed prescriptions were considered a good thing.
- Patients liked being able to see exactly what information was recorded about them.
- Any negative reaction to the computer system came almost exclusively from the older patients.

These may be considered significant in that each was mentioned by more than 20% of the practices surveyed. However, none of these practices spoke of any of these reactions as related to more than a few patients.

A major point of interest was that patients were noting errors in the information held on the computer. This was not an overt reaction to the presence of a computer, but a result of information being accessible to the patient. Most often noted was that patients were correcting registration information. However, mistakes in medical data had also come to light. In particular, patients were querying changes in repeat prescriptions. One surgery reported the discovery of an error in dosage in this way.

In the surgeries where patients had been asked their reaction to the computer system, the overall response had been favorable. Specifically, patients liked being able to see their computer record during consultation.

Advantages – Specific advantages noted were:-

- *Speed.* Increased speed and efficiency of call and recall schemes, searching the patient database and issuing prescriptions.
- *Flexibility.* Greater flexibility for searching and identifying patient groups.
- *Legibility.* Legible prescriptions were mentioned most, but the improvement was noted for all computer generated documents.
- *Improving standards.* GPs noted improved standards of prescribing. Particularly, generic prescribing: the system could be set up so that the GP typed the name they were accustomed to using for a drug, but the generic form appeared on the prescription. Also noted was the fact that it was now possible to study prescribing habits and, as a result of this, GPs were tending to be more organised in their prescribing.
- *Standardisation.* There was a degree of standardisation in that all computer print outs were in a standard form. This led to smoother information exchange within the practice.

Disadvantages – The disadvantages cited fell into distinct groups:-

- *Specific to the system hardware* The main complaint about the system configuration was a lack of terminals or badly placed terminals. This stemmed from the lack of expert guidance during system planning.
- *Specific to the system software* Once people had realised how flexible a computer system could be, they became dissatisfied with parts of the system which were at all restrictive. A particular restriction was that patient records could not be accessed by name from all parts of the system. This meant that patient numbers had to be found which was inconvenient.

Registration and medical data were sometimes mixed and many of the users would have preferred a stricter separation of data.

- *The initial stages* Many staff felt rushed during the initial stages. They felt that there had been insufficient time devoted to training and to allow them to learn to use the system. Allied to this was the fact that what training there was, was inadequate. There was no priority given to training, or experts available. Training was usually done by the systems programmers and designers – a group not noted for teaching ability.
- *Problems with a new system* Because the group surveyed were new users of a new system, they had to contend with the problems which beset all new software – bugs in the system. This is a far lesser problem than it has been in the past, but it was still apparent. There were some bugs in the programming. For example, drugs incorrectly added to the drug dictionary, incorrect address formats, program crashes. These were reported by new users and usually corrected quickly. Errors in design also came to light. The database had not been made sufficiently large to hold all required data in some cases. The system would sometimes re-order lists. For example, putting lists of drugs on a repeat prescription into alphabetical order and re-numbering them, thus making the data inconsistent with the corresponding drug card. This type of problem stemmed from the system designers' inadequate knowledge of surgery procedures.
- *Problems related to the system* Although the majority of users were satisfied with the system as far as it went, many thought that the supporting packages – for example, word processors and accounts packages – were inadequate and hard to use. Despite the fact that the system was generally considered to be easy to use, it was still found difficult to keep the information up to date. This problem was worse the higher the turnover of patients in a particular practice.
- *Problems related to the practice* Users new to computing found it hard to trust computerised data and, as a result, some practices found themselves running manual systems alongside the computerised for far longer than they needed, causing a vast increase in workload. This problem was magnified in practices where one or more member of staff refused to be involved in computerisation.

Alterations to the system Alterations that many of the practices would have liked:-

- *Alterations to the displayed information* Many practices would have liked to alter the information that was displayed; having more information on some aspects and less on others. Many would also have liked to have had different formats for certain aspects. Desired changes were not uniform and reflected the varying nature of the general practice environment. It is a restriction of many systems that every practice must have exactly the same.
- *Extracting information* Many practices would have liked to be able to extract much more information from the system. For example, there was no information stored about acute prescribing. Useful information had been gleaned from studying repeat prescription data and many practices would have liked to do the same for acute prescribing.

- *Shortcut keys* The basics of the system were said to be easy to use. But, once learned, it was found tedious to have to go through all the menus to get to a particular part of the system. Users would have liked a system of shortcut keys for experienced users.

The practices surveyed were asked what, if anything, they would do differently if computerising again. A more disciplined approach, more time and more discussion were the things considered the most important.

System support System support was said to be good on the whole. When problems occurred, the suppliers usually reacted quickly. Oddly, there was a correlation between the length of time the system had been in use and the supplier's response time to problems. The newer the customer, the quicker the response. This was so marked that customers of several years standing had had to complain on occasions about the lack of response to their requests for assistance⁵.

There were very few problems with system hardware, reflecting the greater reliability of equipment today.

Training and documentation were said to be confusing and inadequate. Both were done by the people who programmed the system. No technical writers or people qualified to train people in the use of computer systems were employed. This follows the pattern of computerisation in other fields. However, in other fields, this is now recognised as a problem and documentation and training are given a much higher priority. It is generally recognised that people who write computer software are the very worst to document it or to train others to use it. Depressingly, it seems that instead of learning from the experience of others, general practice computing is following exactly the same learning curve.

3.2.3 Patient questionnaires

Of the 37 practices asked to distribute patient questionnaires, 75% agreed initially and were sent questionnaires. Of these, 18% were unable to distribute the questionnaires for various reasons.

In all, 28 batches of questionnaires were sent out. This was a total of 1400 questionnaires. Questionnaires were returned from 23 practices (82%). In total, 602 questionnaires (43%) were returned. The number of questionnaires completed in the different practices was as follows:-

Number of surgeries	Percentage returned
3	Over 90
8	Over 60
6	Over 50
2	Over 20
4	Under 10

An overview of the responses to the questionnaires is given in the following section. Detailed results are given in appendix B.

⁵None of the practices had any explanation for this. The suppliers denied that it was a problem.

3.3 Conclusions

3.3.1 From the point of view of the surgery

Although the situation is improving, a general practice, deciding to computerise, will have difficulty finding constructive and objective guidance.

There are still a large number of systems on the market which offer a variety of facilities in a variety of ways. Advice on which system to choose comes mainly from two sources: the system suppliers and other practices.

System suppliers can give useful advice on technical aspects but have an obvious bias towards their own systems. Demonstrations of systems are helpful but can be misleading. All systems have shortcomings but, if these are at all apparent during an official demonstration, they will be minimised. System suppliers, in general, are not sufficiently knowledgeable about general practice to be able to give the best advice.

Many of these disadvantages can be overcome by taking the advice of other practices who are computerised. The main disadvantage with this is that they will lack the technical knowledge to be able to advise on specific aspects of computerisation in a particular practice. A very valuable source of advice is a user group. Here there will be a variety of people who have had the system in use for different lengths of time and who have used it in different ways. The users of a system are usually willing to discuss its shortcomings as well as its good points.

Preparation for computerisation within the practice is too often a neglected area. The computer will affect all the staff of the practice and should be discussed with all of them. The computer will almost certainly be used in ways which were not originally envisaged and it is a mistake to see it as a tool which will only be used by a particular group within the practice.

It is important that the computer should be fully in use as soon as possible. The best way to do this would appear to be to involve as many people as possible in initial data entry. This also has the advantage that everyone is learning to use the system at the same time. A member of staff who feels less confident with a system will tend to use it less. Many uses for the computer within the practice are discovered by staff 'experimenting' with it. If they do not feel confident enough to do so, there is a good chance that the computer is being used less effectively than it might be.

General practice computerisation has had a 'bad press', often deservedly. However, systems nowadays, though far from being as good as they could be, are vastly improved and attitudes are changing. A good number of practice staff were against computerisation but were almost unanimous in finding the system more useful and easier to use than they had expected. Of the staff who had been involved in previous computerisation schemes, those involved more than ten years ago had not had high expectations and had been pleasantly surprised. Those involved within the last five years had been enthusiastic from the start.

Administrative uses were always given the priority in a practice. In general, the terminal was on the receptionist's desk before the doctors'. It was generally agreed that for best results on the administration side, a disciplined approach was needed, particularly with regard to keeping information up to date. Most practices had some system of double checking with manual records.

The computer was seen initially as office equipment; a tool to help with practice administration. This is the way in which most general practice systems are marketed and this would explain the greater initial acceptance of the system by reception staff. GPs, in general, did not make heavy use of the computer until both the benefits and ease of use had been clearly demonstrated. The less

obvious advantages are rarely advertised overtly. For example, the benefit to the consultation, the extra information which can be gleaned to give a clearer view of the practice and the way it works or the accessibility of information as a direct aid to patient care. General practice computerisation has not yet been studied in great enough depth, and indeed is not yet of a sufficiently high standard for these things to be exploited to the full, or even fully understood. This type of function is potentially of as much benefit to a practice as the more obvious uses.

The major benefits stem directly from the way in which the computer increases the accessibility of information.

Information is accessible to practice staff – complex call and recall systems can be set up easily. The patients are effectively indexed by any parameter the practice chooses. Therefore, patient groups can be identified accurately and quickly.

Information exchange is more efficient. General practice can exchange data more easily with FHSAs and hospitals. Because the information is easier to access, it is easier to keep up to date. Even without direct electronic links between general practice and the FHSAs, the standard of FHSA data is improving rapidly with the spread of computers into general practice. Potentially, information exchange between different parts of the health service could be far more efficient. It could all be done electronically. At present, it tends to be that one computer system will produce a document, the information from which will be entered into another computer system. To link the two systems directly would be quicker and leave less margin for error. However, although the benefits of this have been recognised, the resources are not generally available to do it.

Many of the less obvious benefits spring directly from the fact that the computer makes information accessible to patients. There are practical benefits of increased accuracy of data. Patients are checking information they see on the screen and mistakes, which may otherwise have gone unnoticed, are being corrected. There is also an element of an extra safeguard. Legible prescriptions mean that patients become familiar with items prescribed for them and query any changes.

Other benefits have not been immediately obvious. There is the reported benefit to the consultation. The presence of the computer can make the consultation less formal and discussion with the patient easier. Far from intruding upon the consultation, as many had been concerned that it would, the fact that data was visible on the screen was of positive assistance. Patients felt able to discuss things that they read from the computer screen in a way that they would not have done with data gleaned from written notes. An inhibiting factor, with written notes, is the patient's feeling of reading "over the doctor's shoulder." Not only is there no such problem with data on a computer screen, it is also more legible. The positioning of the screen is important. The doctor who sits at the opposite side of the desk from the patient with the computer between them, will experience no such positive results⁶.

The management of chronic illness and the running of preventive medicine schemes has been made much easier and can be done more efficiently. Because the computer can deal with the administrative side – the identifying of the patient groups, the preparation of forms and mailshots – the practice can be involved in many more projects.

⁶One practice reported putting pressure on a colleague to add relevant data to the computer during consultation. The colleague agreed only on condition that a secretary was present to type data in. Neither patients nor doctor found any advantage in this arrangement and it was soon abandoned.

3.3.2 From the point of view of the patients

Overall, there was a positive reaction from patients to the computer system. Two things in particular stood out from the questionnaire results:-

1. There was more enthusiasm for, and positive response to, the system from younger patients.
2. Patients, in general, were far more aware of the computer system than the practices had realised.

In practices where the patients routinely saw the computer in use – where it was used in consultation – almost 70% saw it as having improved the surgery to some extent. In the under 65 age group, over 70% thought that it had improved the surgery. However, although there was less enthusiasm in the over 65 age group, over 60% thought that there had been an improvement.

In the practices where the computer was not used during consultation, almost half thought that it had had a good effect upon the surgery, but over 40% were unaware that the surgery was using a computer. No one said that it had had a bad effect upon the surgery. Considering the reported results of patient access to computer information, it would seem that potential benefit is being lost where the patients are not routinely seeing the computer in use.

More than half felt that the computer played a large part in the consultation; the greatest area of use being interrogation of the system. There was a sharp contrast according to age group. Over 60% of the under 40s thought the computer had a significant role to play in the consultation and less than 40% thought it did not. In the over 65 age group, under 50% thought it played a large part in the consultation and only a few less thought that it did not.

Patients either saw information about themselves on the computer screen or they saw none at all. No one reported seeing information about other patients. The older patients gleaned less than the younger ones⁷. However, 75% of patients wanted to see the information that was recorded about them. Once again, although the over 65s were less likely to want to see this information, almost 60% of them said that they would like to. For the under 40s, this figure was over 85%.

Very few patients said that they had learned anything about their treatment or condition from data gleaned from the computer and, of those that had, only a small minority said that this was something they would not otherwise have known.

On the question of graphical information, less than 20% of the patients claimed that the system did show graphical information (which it did not). There was a marked correlation with age. Far more of the younger patients answered the question correctly. The probable reason being that the older patients were less likely to be paying attention ^{to} the system. A large percentage (over 50% of the over 65s) did not answer this question at all.

Asked if graphical information would make things easier to understand, the responses were either that it would or that it would make no difference. In the under 65 age range, twice the number (over 45%) thought that it would make things easier than thought that it would make no difference (under 25%). Only a very small minority thought that it would make things harder to understand. In the over 65 age group, equal numbers (30%) thought that it would make things easier or make no difference. 10% thought it would make things harder.

⁷Several of the older patients wrote on the questionnaire that they could not see the computer screen well enough to read information from it because of bad eyesight.

Patients who did not see the computer in consultation thought, in general, that it would make no difference if it was used. However, a substantial percentage thought that it could make discussion with the doctor easier. Interestingly, it was the over 65 age group who were the most in favour. 45% thought it would make discussion easier and 37% thought it would make no difference. In the under 40 age group, over 50% thought it would make no difference as opposed to less than 35% who thought it would make discussion easier.

However, an overwhelming 89% of these patients would have liked to see the data stored about them on the computer. This included over 80% of the over 60s and over 90% of the under 40s. And despite thinking that the computer would make no difference to the consultation, the vast majority would have liked to be able to see their record while they were with the doctor.

Responses to computer 'advice'

The vast majority of patients were willing to follow computer given advice, however it was phrased. However, slightly more were willing to take note of the 'polite' message than the 'rude' one, and conversely, slightly more would have ignored the 'rude' message.

The older patients were more likely to say that they would *definitely* follow the given advice but overall, more of the under 40s would probably have followed it.

The majority of patients overall said that they were more likely to follow the same advice if given by a doctor or nurse. But, in the under 65 age range, equal numbers said that it would make no difference. How the message was phrased made little difference to this response.

The response to the informative message was overwhelmingly (over 90%) that the patient would ask the doctor or nurse about it.

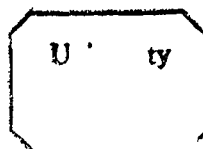
Summary

Comparing the responses from patients who had experienced computer use in the consultation with those who had not, and also with practice staff reports of patient reaction, there appears to be a tendency to underestimate the effects that the computer can have in terms of facilitating discussion and smoothing the flow of information through all parts of the practice.

Despite the potential benefits, there is still relatively little use of computers in nurse run clinics. The primary reason is a lack of equipment but, in general, an extra terminal for the nurse's room is not a high priority. In this area, the computer is still far from fulfilling its potential. The conventional doctor-patient consultation benefits from the presence of the computer. The nurse-patient consultation could benefit just as much and, in some cases, perhaps more.

Clinics set up for management of chronic conditions are clear candidates to benefit. The clinics deal with patients who visit regularly, who will themselves become accustomed to the system and therefore be in a position to glean more than the patient who visits occasionally. It is often important that a patient understands particular aspects of their condition and the computer has been shown to make patients more willing to discuss things which appear on the screen. There is a possibility here to use the computer to 'prompt' for areas of potential difficulty.

The overall view from practice staff is that although the advent of the computer has not been of benefit to all individuals - it has forced unwelcome change on a minority - it has been good for general practice as a whole.



Chapter 4

Miniclinics – A Structured Environment Within General Practice

4.1 Miniclinics - Their Structure and Purpose

A miniclinic in general practice is a grouping of people with the same type of condition or problem related to health care. This grouping facilitates the monitoring and treatment of the patient groups. Miniclinics can be divided into two main categories:-

Preventive medicine This type of miniclinic monitors particular groups of people with the aim of preventing specific problems from which they are deemed to be at risk. Typically included in this category are clinics for paediatric and geriatric surveillance, immunisation clinics, clinics for cervical cytology and family planning.

The management of chronic conditions This type of miniclinic monitors the condition and treatment of patients with chronic illnesses such as diabetes, hypertension and asthma¹.

4.1.1 The structure of a miniclinic

Although differing widely in specific purpose, miniclinics have a common underlying structure.

The patient group in a miniclinic is a subset of the population served by the practice. The miniclinic will be run according to a protocol decided by the practice. This varies widely from practice to practice and from clinic to clinic, but will involve the establishment of a miniclinic protocol – for example, identifying the staff who will be involved and deciding upon the medical procedures and management of the clinic in terms of equipment and resources – and will incorporate some element of call and recall of patients.

4.1.2 Management of a miniclinic

However it is organised and whatever its purpose, the running of a miniclinic relies upon the identification of a particular group of patients. The means of

¹Chronic disease accounts for over 50% of medical problems.

identification depend upon various factors and may differ from a highly automated to a completely ad hoc system.

Given a means of identifying the patient group, there are different ways in which the running of the miniclinic can be managed. Essentially, there are two means of organisation:-

1. *Formal organisation.* Specific times are set aside for the particular patient groups to visit the surgery.
2. *Informal organisation.* Members of the particular patient groups are seen within normal surgery.

In the first case, patients are given appointments to visit the surgery at the relevant times. This has particular advantages where members of the primary health care team who do not attend the surgery full time are involved – for example, diabetes miniclinics may require input from a dietician or a chiroprapist, who is not based in the surgery.

In the second case, surgery visits are organised on an individual basis. Patients who are due to visit may be notified and given appointments or asked to contact the surgery. This has the advantage that patients have more choice about the time they visit the surgery.

The informal organisation of miniclinics has been considered to be unreliable mainly in that follow up of patients who fail to visit the surgery is difficult and evidence of organised monitoring of the patient groups is hard to produce.

However, there are advantages in this type of organisation. It is sometimes more convenient for a surgery to deal with particular patient groups ad hoc within normal surgery rather than organising special times for them to visit. In a surgery which employs management staff, as do many in the United Kingdom (UK), the organisation of miniclinics at set times is usually a practical option. In surgeries where no non medical staff are employed, the resources to do so may not be available. Sometimes the patient population is such that organised miniclinics are not the best option. This may be the case, for instance, in sparsely populated rural districts.

It has been generally assumed that a formal approach to the running of miniclinics is best. An organised grouping of patients has been shown to facilitate the monitoring of their condition. It has also been demonstrated that an organised approach to screening means that more patients are seen. However, despite the undeniable benefits of the more formal organisation of miniclinics, there are many surgeries where this is not an option².

Since the advent of computers in surgeries, the disadvantages of the second method of miniclinic organisation³ can be overcome. The patient group can be reliably identified, monitored and followed up. Accurate records can be kept and quickly retrieved of a patient's history and treatment. Automatic reminders can be issued both to the surgery and to the patients. Lists of patients due and overdue to be seen can easily be generated. If a patient, who is a member of a miniclinic group, visits for another reason, the computer record can automatically identify the patient as one of a particular group and also

²Surgeries in the UK tend to be organised around a primary health care team. Where such a team exists, a surgery can cope with the administrative and managerial aspects of organised miniclinics. In other countries – the Irish Republic, for example – the provider of primary care is much more likely to be a single handed GP without the administrative resources to run organised miniclinics. A further problem arises in the case where the GP is not the gatekeeper to the health service, as is the case in France. In this situation, the question arises as to whether or not general practice is the place to base miniclinics at all.

³A recent disadvantage in the UK is that the GPs' contract puts a financial penalty on a surgery not running organised miniclinics.

draw the doctor's attention to any relevant fact about their condition or current treatment.

The computer is an excellent tool for the management of miniclinics. A computer system can reliably deal with the administrative side leaving the GP free to deal with the medical side of the miniclinic as best suits the practice. The important issue in terms of patient care is not how the miniclinics are organised but the fact that they *are* organised.

4.1.3 General practice miniclinics versus hospital clinics

Miniclinics in general practice have certain advantages over hospital based clinics. Studies [22, 23] have shown advice to be more effective in a general practice setting. Patients are more likely to attend a local clinic with their own GP or a nurse they know. Patients visiting their local surgery are on more familiar ground than those visiting hospital clinics where the atmosphere tends to be more impersonal. In this setting, the doctor has the advantage, in many cases, of knowing the patient's family and medical history⁴.

People usually find it more convenient to visit their local surgery than a hospital. One of the main reasons being that a local surgery can offer greater flexibility than a hospital clinic over the times that a patient can visit. This means that a greater proportion of patients will attend general practice clinics [24].

Clinics for the management of chronic conditions

Studies [25, 22, 23] have shown that hospital care is more effective than non organised care in general practice. A trial carried out in 1984 [23], comparing routine general practice care with hospital supervision cited the lack of an automatic recall system for patients who did not attend as the most important factor in this less satisfactory care. At the time of the trial, computers in general practice were not widespread and many of the available systems were inadequate. Nowadays, automatic recall systems are available and reliable for whatever type of organisation a practice chooses for its miniclinics. Thus the major factor in favour of hospital based clinics is no longer an issue.

Studies [26] cite various reasons why patients do not attend hospital clinics – the long standing diabetic who “feels ok” and so does not bother to attend, the longer waiting times in hospital clinics, the patients who cannot manage hospital hours because of work or other commitments and patients, particularly the elderly, who cannot manage the journey to the hospital clinic.

Comparisons between hospital and general practice care [22] show a wide variety of factors determining patients' appointment keeping behaviour. In terms of patient care, this is an important issue. The effectiveness of increasing patient compliance in this area has been demonstrated [27]. Appointment keeping can be improved, particularly in high risk patients, by recall and reminder letters and follow up after missed visits. Manual call and recall is a tedious administrative task. In particular, it is difficult to devise a system in which patients are not missed through such reasons as lost records or staff changes. Fortunately, tasks such as these lend themselves very easily to computerisation and it has been shown that a computerised system can largely overcome the problems of the manual system [28].

Another vital factor in the treatment of chronic conditions is patient education. It has been shown that treatment and monitoring of chronic conditions is more effective in patients who understand their condition and have been taught

⁴The average length of time that a person stays with a GP is 25 years

how to manage it. Several studies [29, 30, 31] have demonstrated an increase in patient compliance in these cases.

Clinics for the management of preventive medicine

British general practice is well suited to implement preventive medicine programmes. The vast majority of people are registered with a doctor who they see at least once every five years. There are approximately five million GP-patient contacts per week in Great Britain. However, the full potential for preventive medicine in the general practice environment is far from realised. Less than half the patient records kept contain information such as recent blood pressure, smoking habits, diet, weight or alcohol consumption.

Potential benefits of computerisation are substantial, particularly in this area. Fitter et al, in their summary of the DHSS sponsored report [32], 'A Prescription For Change', demonstrated how doctors and staff in general practice have been shown to regard a computer as a better way to organise preventive health care programmes. Despite this, evidence suggests that the majority of computers in general practice are largely under-used. A study of four hundred computerised practices in 1985 [33] showed that only one fifth used the computer for epidemiological studies. More recent studies [34] show no marked increase.

A Canadian Task Force report [25] on cervical cancer screening programs found that general practice screening programs, properly organised, were more effective than those carried out elsewhere. Studies [21, 22] carried out in this country confirm these findings.

There have been moves to organise screening programs at the FHSAs level. Early programs suffered from inadequacies because of the level of inaccuracy of the data [21]. Although this is a situation which is improving as the use of computers becomes more widespread, the lack of standardisation of general practice systems means that information exchange between FHSAs and general practice is still inefficient and relatively slow. Because there is no standardisation of general practice computer systems and data sets, data transfer is not the straightforward matter it may have been had general practice computerisation been centrally organised from the start.

However, even with improved information exchange, it is now generally agreed that screening programs are better run at the primary care level. Primary care accounts for by far the greater part of total health care (only 5% of GP-patient contacts are referred to hospital), thus putting the primary health care team in the best position to organise and run screening programs.

4.2 The Diabetes Miniclinic

4.2.1 Why study the diabetes miniclinic?

The study into the use of computers in general practice showed results, particularly in terms of patient response, deemed to be worthy of further investigation. The particular area chosen for in depth investigation was the effect of the computer system upon the doctor-patient or nurse-patient relationship. Within this, the major aim was to study the effects of the computer upon patient education and compliance as these are areas where positive patient response to a computer system are potentially of great value.

In order to investigate these aspects further, a controlled environment is required. This will be one where the patients visit the surgery regularly, and where there are common factors in their treatment and condition. The obvious choice was the miniclinic.

The intention was to study the effect of the computer upon the miniclinic rather than the effect of the miniclinic upon the practice. Thus it was necessary to study a well established miniclinic and not one which had recently been set up. This was one of the main reasons for choosing the diabetes miniclinic.

Diabetics have been looked after in primary care for many years. Surgeries have established protocols and, although these alter with advances in medicine and as understanding of the condition itself improves, they nonetheless provide a stable background against which to assess the impact of computerisation. Another advantage of studying a well established miniclinic was that it gave scope for comparing the running of the clinic before and after computerisation.

The other major factor in choosing diabetes as the condition to be studied, was that this is a condition in which patient education and compliance is of particular importance.

4.2.2 What is diabetes?

This section gives a brief description of diabetes – its causes, symptoms and treatments. Short descriptions of some of the less common medical terms are given as footnotes. For fuller descriptions and further detail, the cited publications should be consulted.

Diabetes⁵ results when blood sugar is not properly metabolised because of lack of the hormone insulin. It is a condition which, untreated, can lead to coma and death. There are over 600,000 diagnosed diabetics in Great Britain.

There are two types of diabetes:-

- Type 1 – The insulin dependent diabetic. The patient produces no insulin and has to rely upon insulin therapy to control the condition.
- Type 2 – The non insulin dependent diabetic. The patient produces some insulin and the disease is controlled by drugs or diet depending upon its severity.

About 70% of diabetics are non insulin dependent.

The causes of diabetes are varied and not fully understood. Obviously, damage to, or loss of, the pancreas can be a cause as it is the beta cells in the Islets of Langerhans in the pancreas which produce insulin.

The cause of type 2 diabetes may either be malfunctioning of the pancreatic beta cells leading to abnormal insulin release or an abnormal response to insulin in the peripheral tissues; or it may be a combination of both.

It has been suggested that such viruses as rubella, mumps and possibly colds and flu may cause diabetes. It is known that the disease can be triggered by shock or emotional crises.

Heredity also plays a part in the development of the disease. The risk of developing diabetes run by children who have diabetic parents is greater for type 2 diabetes. The average percentage of children, with diabetic parents, who contract the disease is as follows:-

Diabetic Parents Risk to children	
1 type 1	Average 3% — Type 1
Both type 1	Average 12% — Type 1
1 type 2	Up to 20% — Type 2
Both type 2	Up to 40% — Type 2

⁵The full name for the condition is diabetes mellitus. Diabetes – inordinate and persistent increase in urinary secretions. Mellitus – Honey (from the Latin). Melituria – the presence of any sugar in the urine.

The discovery of insulin in the 1920s led to a dramatic fall in mortality from ketoacidosis⁶. This, in turn, led to an increase in the development of long term complications and chronic ill health, avoidance of which is a major concern in the treatment of the disease. Early detection is important before permanent tissue damage has resulted but, even so, biochemical abnormalities are very difficult to control.

The basic aim in the treatment of diabetes is to obtain and maintain a normal blood glucose level. Despite advances in treatment, this is still very difficult.

4.2.3 The diagnosis of diabetes

Correct identification and diagnosis of diabetes is something to which a high priority is given, as accurate and early diagnosis is important to prevent the long term complications. However, the diagnosis is not always straightforward and incorrect diagnosis can be damaging as it puts unnecessary restrictions and fears upon a patient. Population surveys indicate that there are a large number of undiagnosed diabetics.

The World Health Organisation (WHO) have published criteria for the diagnosis of diabetes. These are given in appendix C.

The acute and classical symptoms lead to easy diagnosis, but diabetes can be asymptomatic. Diagnosis may come from routine urine testing, or from the patient presenting to the optician or chiroprapist.

Commonly, urine and blood tests are used to diagnose the condition. The urine test is used to detect the presence of glucose in the urine and is essential to establish the correct diagnosis. Blood testing gives a measurement of blood glucose levels, and this is the test used to confirm the condition in 80% of cases referred to diabetic clinics.

The glucose tolerance test, referred to in the WHO criteria, is more often required to exclude the condition than to confirm it. However, using the WHO criteria, abnormal results from glucose tolerance tests for patients whose results from other tests are doubtful, delineates a further group of patients. These have impaired glucose tolerance but rarely show the complications of diabetes and only a small proportion go on to develop the disease. There is evidence of increased frequency of macrovascular disease in this group, but whether or not such patients should be followed up at a diabetic clinic is arguable.

4.2.4 The treatment of diabetes

The major treatments of diabetes can be divided into three groups:-

1. Diet.
2. Drugs – Oral hypoglycæmics.
3. Insulin therapy.

Most diabetics require early treatment despite the fact that metabolic disturbance will, in many cases, have been present long before the condition was diagnosed. The reasons are:-

- to relieve acute symptoms and

⁶The build up of ketones from the abnormal fat metabolism which occurs because the body cannot adequately metabolise carbohydrates.

- to reduce the long term risks. In particular, the consequences of prolonged hyperglycaemia on the cardiovascular system.

Ideally, treatment aims to reduce fasting plasma glucose concentrations to 6 mmol per litre or less [35].

Two of the major contributory factors to the development of non insulin dependent diabetes are obesity and poor diet and the first 'line of attack' in treating the condition is always diet.

Diet

People in general are unable to follow complicated dietetic instructions over long periods of time. It is unreasonable to expect diabetics to be able to do what no one else can in this respect. Nevertheless, diet is of vital importance in the control of diabetes.

Advising a person to alter their everyday eating habits is something which needs to be done with care, and with regard to the individual patient, if it is to be successful. Dietary advice must be regularly repeated and compliance checked. It is unrealistic to expect advice to be assimilated properly without such checking.

An investigation of dietary knowledge in diabetic patients in Leeds in the 1950s showed 16% with satisfactory dietary knowledge, 44% with moderate knowledge and 34% "hopeless". There is no reason to suppose that there has been any great improvement since then.

The reasons for lack of dietary compliance are varied. Some patients follow advice only for a short time. Some, particularly the elderly, are not prepared to change the habits of a lifetime. Sometimes, patients are given unrealistic diets, for example, diets which take no account of the needs of hard physical work. Some patients are not accustomed to a set pattern for mealtimes and some have no understanding of basic terms such as protein, fat and carbohydrate.

Many factors need to be taken into account when giving dietary advice. Dietary requirements change in illness. Children have different dietary requirements from adults. Diets may need to account for unusual activity. A patient's alcohol consumption will affect their dietary requirements. Religious and cultural dietary requirements must be accommodated.

The most successful dietary advice will combine simplicity with the needs of the individual patient.

Drug therapy using oral hypoglycaemics

The use of these drugs is controversial but they continue to be widely used in Europe. Oral hypoglycaemic drugs are used in the treatment of non insulin dependent diabetes to lower the blood sugar. They work either by inhibiting carbohydrate absorption, stimulating insulin production or enhancing peripheral tissue response to insulin.

Initial treatment of hypoglycaemia with drugs to enhance insulin production is associated with immediate release of insulin and studies on long term insulin release have shown levels to be sustained over several years.

It is possible that these drugs have a beneficial effect upon peripheral tissue response to insulin but studies [36, 37, 38] have been conflicting in their results. The risk of hypoglycaemia can be fairly high [39]. Drug treatment of non insulin dependent diabetes is not used as a substitute for diet and is usually only used if the symptoms cannot be controlled by diet. 50% of non insulin dependent diabetics will eventually need drug therapy.

It has been shown [40] that initial poor response to diet means a higher probability that insulin therapy will be needed eventually. This is therefore a group of patients worth identifying and monitoring.

Insulin therapy

A primary aim of insulin therapy is to relieve symptoms, the majority of which arise from a blood glucose concentration which exceeds the renal threshold. Another aim is to prevent the disabling complications of long term diabetes. Good control of blood glucose levels is important in this respect. However, the actual degree to which blood glucose levels should be controlled is still a subject for debate.

With insulin, good control of the condition is not as feasible or as logical an aim as with oral hypoglycaemics or diet. This is because of the risk of hypoglycaemic attacks.

The normal range of blood glucose concentrations throughout the day can vary from 3.5 to 8 mmol per litre and symptomatic relief can be obtained without good control of blood glucose levels. Although there is conflicting evidence as to whether the degree of control affects long term complications, most studies suggest that control does matter.

4.2.5 Assessing control of diabetes

There are various ways in which diabetic control can be assessed:-

- Severity of symptoms.
- Urine and blood glucose monitoring.
- The glycosylated hæmoglobin test.

Severity of symptoms

This may be used as a crude assessment. This would obviously not be a very satisfactory method as symptomatic relief in diabetes is not necessarily indicative of good control.

Urine and blood glucose monitoring

These are the most commonly used methods. The majority of these tests are done by the patient at home, but random tests will also be done when the patient visits the clinic. There are problems because these tests are open to manipulation by the patient. Tests done by a patient at home are obviously open to manipulation and random samples taken at a clinic can be "improved" by the patient by such means as missing a meal.

The glycosylated hæmoglobin test

This is the best test for assessing control. The results give an indication of control over the preceding few weeks and not only the situation at the time the test is done. The test works as follows:- As red blood cells are formed within the body, some of the hæmoglobin in them combines with glucose. This is glycosylated hæmoglobin or hæmoglobin A1. The amount of glycosylated hæmoglobin formed is directly proportional to the circulating glucose concentration. In any blood sample taken there will be red blood cells of varying ages and so the amount of glycosylated hæmoglobin present will reflect the degree of

blood glucose control over the preceding six to eight weeks. This test has been introduced relatively recently and is less open to manipulation by the patient. This being the case, a comparison of the usual blood sugar and urine test results with the results of the glycosylated hæmoglobin test provide a means of measuring patient compliance.

4.2.6 The complications of diabetes

The two types of diabetes, insulin dependent (type 1) and non insulin dependent (type 2) differ ætiologically and in their long term complications.

Acute complications

Acute complications – typical examples being hypoglycæmic attacks and diabetic coma – are rapid in onset, usually reversible and often due to metabolic abnormalities.

Chronic complications

Chronic complications are relatively slow in onset and usually irreversible. The exact causes of these chronic complications are only partly understood but most are due to structural damage to the small and large blood vessels – micro and macrovascular disease – and the nervous system – neuropathy.

The development of chronic complications is influenced by the severity of the metabolic disturbance, the duration of the diabetes and the susceptibility of the individual patient.

Although background retinopathy⁷ is very common in type 2 diabetes [41] and needs to be looked for carefully, proliferation is unusual. Exudative maculopathy⁸ is a more common problem [42, 43]. Death from diabetic nephropathy⁹ is unusual in type 2 diabetes but probably because patients succumb to macrovascular disease first [44].

The various forms of neuropathy which may be present can be the cause of symptoms which are difficult to treat. Such symptoms include diabetic amyotrophy¹⁰, diabetic neuropathic cachexia¹¹ and painful peripheral neuropathy. Neuropathy can cause loss of sleep, depression and weight loss. These symptoms tend to be self limiting unlike those caused by autonomic neuropathy which can cause diarrhoea, sweating, postural hypotension and impotence.

Common problems encountered in a diabetic miniclinic

The type and frequency of the problems encountered in a diabetic miniclinic will vary, but the following table, from a study of a particular miniclinic [26], gives an indication of the frequency of the problems encountered.

Angina	17.3%
Retinopathy	16.5%
Cataracts	14.0%
Claudication	11.6%
Painful neuropathy	8.3%
Foot ulcers	2.5%

⁷Non inflammatory disease of the retina.

⁸Deposits in the fundus of the eye.

⁹Kidney disease.

¹⁰A painful condition with wasting and weakness of muscle.

¹¹A state of malnutrition, emaciation and debility.

Causes of death in diabetes

The following table gives a typical breakdown of the causes of death in the two types of diabetes [45].

Cause of death	Type 1	Type 2
Cardiovascular disease	15%	58%
Cerebrovascular disease	2%	12%
Diabetic neuropathy	55%	3%
Diabetic coma	4%	1%
Malignancies	0%	11%
Infections	10%	4%
Other	14%	11%

The major cause of premature death in type 2 diabetes is large vessel disease – ischaemic heart disease, cerebrovascular disease and peripheral vascular disease. These diseases occur more frequently and are more severe in type 2 diabetes.

It has been estimated that over 5% of all patients with myocardial infarction have undiagnosed type 2 diabetes [45].

A summary of the specific complications of diabetes

- Damage to the eye – cataracts and retinopathy.
- Renal disease. This is one of the most serious long term complications and one of the commoner causes of death in younger patients.
- Damage to the peripheral nerves.
- Damage to the large blood vessels – peripheral vascular disease, coronary artery disease and cerebral artery disease.
- Damage to the feet, hands and skin.

10% of diabetics have symptomatic disease of the peripheral nerves. Type 2 diabetes can cause blindness, premature coronary death, amputation, painful neuropathy, impotence, angina and claudication.

In Western society, surveys [35] show that diabetics have twice the incidence of myocardial infarction, five times the incidence of gangrene, seventeen times as much renal failure and twenty five times more blindness than non diabetics.

4.2.7 Education and the importance of patient compliance in diabetes

Self management in diabetes is essential for survival. It can be argued that education is the single most important aspect of treatment. In practical terms, there are four main areas in the education of diabetic patients:-

- Diet

- Blood glucose monitoring
- Urine testing
- Insulin injections

Medical personnel with no specific training in teaching have to tackle problems such as lack of motivation and apathy, great variation in intellectual ability and age, and physical handicaps. In addition, there are practical problems such as limited time, inadequate space and lack of teaching aids. Nevertheless, good patient education is still a necessity.

One conclusion of a study of diabetics [42] carried out at a London hospital was that the best place to question diabetics about their condition was in the GPs surgery. However, studies have shown over 40% of patients not having had yearly follow up and almost 15% not having been seen at all. [46]

There are many aspects to patient education in diabetic care. For example, insulin dependent diabetics need to be taught injection technique, mixing of insulins and care of syringes. Most patients test their own urine and many their blood glucose levels. There is much to be gained from home monitoring for various reasons, not least that it has been shown to be an excellent educational tool. Home blood glucose monitoring is of particular value because urine tests do not necessarily reflect the current blood glucose situation. They do not, for instance, distinguish between a normal and a hypoglycaemic blood glucose.

Studies comparing home urine testing with home blood glucose testing show some improvements in both groups, yet individual patients may show vast improvements when home blood glucose monitoring is introduced. The main reason for this improvement appears to be due to the effects upon patient education which have led to increased compliance. This is borne out by a study [35] of diabetics in Newcastle which showed a significant improvement in control after intensive education which was not further improved by the introduction of home blood glucose monitoring.

In diabetes, patient education is of paramount importance because the resulting increase in compliance significantly effects diabetic control.

4.3 Summary

Diabetic clinics in hospitals were developed in the 1920s primarily for the supervision of insulin treatment. Inevitably, these clinics became treatment centres for all forms of diabetes. However, clinic facilities and staffing levels did not grow with the increasing number of patients requiring care. This led to problems in caring for people who now comprise at least 2% of the population.

Attendance at hospital clinics is low, and those who do not attend have not been followed up systematically. The need for a change of tactics in diabetic care has long been recognised [47].

Computers have been used in hospital diabetic clinics [48, 49, 50, 39, 51] since the early 1970s.

For various reasons, general practice is an obvious place for the treatment and monitoring of diabetics. Because the absence of symptoms in diabetes is not necessarily indicative of satisfactory control, regular check ups are essential. It has been clearly demonstrated that the most appropriate place to ensure regularity of care is in general practice.

Patient education is important. Studies [30, 52] have shown that patients who are trained to manage their own diabetes achieve a much greater degree

of metabolic control and reduce the risk of serious complications and hospitalisation. Patients who know more about their condition have been shown [29] to be less likely to miss appointments. It has been shown [28] also that treatment of some chronic conditions tends to be less effective in patients who are particularly anxious about their health; a situation which can be amplified by ignorance of the condition.

Recent years have seen the emergence of the nurse specialist in diabetes, but competition for money and resources within the NHS means that there is no immediate prospect of an adequate number of such specialists. Computer systems have already been shown to increase efficiency in a number of areas. If they also have a positive role to play in the education of diabetic patients, then their introduction into diabetic miniclinics would be invaluable as a means of making full use of limited resources.

Chapter 5

The Diabetes Miniclinic

5.1 The System to be Investigated

The study of the impact of computerisation on the diabetes miniclinic was a more in depth investigation than the general survey. However, similar criteria were adopted for deciding which system should be studied. As in the study of a general medical package, it was important that the chosen system be reliable, in order that results would not be clouded by technical problems. It was also important that the system was designed for use in the patient-nurse or patient-doctor consultation and one which was compatible with the protocols used in the practice.

A study of systems in use revealed that none suited the chosen criteria. Most specialist diabetes systems are designed for use in hospital clinics where the patient group is non representative. For reasons detailed in the following sections, it was decided not to study a hospital clinic but to develop a system specifically for use in a nurse run clinic in general practice.

Although the project concentrated on the general practice who ran this system, other diabetes clinics were studied. A number of general practices running diabetes miniclinics were identified. The small scale study of this group of practices was made to gain a wider insight into the running of diabetes miniclinics prior to design and development of the computerised system. During this phase of the study, contact was made with a newly opened diabetes centre. Although this was not a miniclinic as such; having grown out of a hospital clinic originally, it was of particular interest as a clinic purpose built for the care of diabetes. Considerable money and resources had been put into its development. A comparison between this and the general practice miniclinic is given later in this chapter.

Diabetes clinics in hospitals Hospital clinics see diabetics with particular problems or special needs. GPs tend to refer certain of their diabetic patients to hospital depending upon their own resources and facilities. Some GPs, for example, will refer all insulin dependent diabetics. Others will refer diabetics who develop chronic complications and some will refer patients whose diabetic control is unsatisfactory. Patients will not necessarily stay with a hospital clinic. They may return to GP care once their condition has stabilised. Thus, the hospital clinic patients are an unrepresentative group. Hospitals do not deal with the routine care of the 'average' diabetic.

Routine care The vast majority of diabetics are treated in general practice. This number will increase as more general practices run specialist clinics.

General practice deals with the routine care of diabetics and this is the area of care being studied. Clinical procedures are well established and research into curing the condition by transplant procedures is well advanced. It is the routine, day to day, care and control which clinical procedures often fail to address. The solution to many problems of satisfactory control lies in improved patient compliance. One of the most effective ways to improve compliance is through patient education.

5.1.1 The importance of education and patient compliance

In acute conditions, education is not of such great importance. Satisfactory compliance can be achieved without it. A patient, for example, can be told to take a course of tablets for two weeks, and will do so without knowing why they should be taken at specific time intervals. Compliance can be 'bought' on the promise that the condition will be cured. In chronic disease, the patient is not asked to undergo some minor inconvenience for a short period of time, but to alter their lifestyle permanently. It is unrealistic to expect a person to stick to a routine which causes them inconvenience if there does not appear to be a good reason why they should. Control of diabetes, for example, is not necessarily linked to symptomatic relief. A simple instruction to 'follow this regime or your condition will deteriorate' is, therefore, inadequate.

A patient who understands exactly why they are asked to follow a particular set of instructions, and who has been told of the long term consequences of not doing so, has more incentive to co-operate. If the sole incentive is that 'nurse will be displeased' if results are bad, there is temptation to 'cheat' and falsify results of tests - as some diabetic patients are known to do.

Another consequence of asking people to follow instructions without understanding why, is that they have greater difficulty in remembering them. In diabetes, this is particularly relevant to diet. A newly diagnosed diabetic is often asked to make drastic changes to the eating habits of a lifetime. Complex dietary advice has been shown to be ineffective in any situation. People cannot be expected to stick to complex diets for any great length of time.

Some conditions can be helped by a strict diet for a short period of time, followed by a gradual easing of dietary restrictions as the patient identifies foods which appear to affect their condition badly. In fact, dramatic improvements in some chronic conditions have been reported [53] from this type of dietary regime. However, the patient asked to stick to this type of regime, however temporarily, needs to understand why they are being asked to do so. Lack of understanding leads to greater likelihood of misunderstanding the exact instructions and less incentive not to cheat should temptation arise. This can lead to the patient who reports, in all good faith, that they have followed instructions to the letter, but who shows no improvement. This, in turn, can lead to a lack of trust in what may be a valuable treatment.

There are many ways in which the computer can assist in the general area of patient education. As with other areas, the computer can take over much of the administrative load. For example, in the efficient production of form letters, diet sheets, instruction lists and other educational aids.

A way in which computers have proved invaluable in many situations is in the way they can make information more accessible; by presenting it in different forms, for example by use of spreadsheets and databases. It was specific aspects of this ability which emerged as particularly valuable in the miniclinic environment.

Because of the lack of a suitable system, a miniclinic system was designed and developed as part of the project. This worked in conjunction with the general medical package used by the practice co-operating in the study. Thus, instead of a wide ranging study covering many different surgery environments, the main part of the study was a detailed investigation of a single practice. Alongside this, a group of GPs with a particular interest in diabetes were identified and their clinic procedures studied to give a wider perspective.

5.1.2 Communication of information by computer

There are various ways in which the computer is particularly suited to the storage, manipulation and presentation of data:-

- *Administrative* The storage and production of documents is especially efficient. This is particularly true of documents which need to be customised. Diet sheets, for example, can be stored in different forms and are easily altered to suit the needs of particular patients.

The computer is an invaluable aid to general clinic organisation, as has already been shown. Patient groups are accurately and efficiently identified. Computer generated lists and searches greatly facilitate monitoring and follow up.

- *Diversity* The computer can present information in a variety of different ways. Test results which are a list of figures on paper can be shown as graphs or charts. Judicious use of colour can be used to emphasise important aspects. Pictorial representation can be more understandable – underlying trends are more apparent and anomalous results stand out.
- *Projection and prediction* A computer can take recorded results and show what would happen should a particular trend continue or if a particular factor should change. Once again, giving a clearer overall picture of specific aspects of the condition.
- *Accessibility* As shown in the previous survey, patients can glean a lot from a computer screen – certainly more than they would from conventional notes. Doctors were underestimating the amount of information that a patient could assimilate from the computer screen in an ordinary surgery. In a miniclinic, the patient will be a regular visitor and thus, more familiar with the system. This would suggest the possibility of their learning even more.

In the miniclinic studied, the nurse actively encouraged patients to study the computer screen.

It is not only the patients who benefit from this increased accessibility of information but the practice as a whole. The potential benefits cover the whole spectrum of health care.

- *Information gathering* The computer questionnaire – not used in this survey – has been used in other studies with interesting results. In general, people are more honest to a computer than to a human questioner [54]. People do not appear to feel the need to ‘put on an act’ for a computer, where they would for another person. For example, people are more honest about their drinking and smoking habits.

The resources were not available in this study to put home blood and urine monitoring to the test, but this could be a valuable way of collecting

accurate results. The patient who falsifies results does so for the 'benefit' of the doctor or nurse. If the results were to be given instead to a computer, a more accurate picture of patient compliance may emerge. Whether this would directly benefit compliance is open to question. It is possible that the computer, having collated a patient's results, could then present an overall picture back again, giving the patient an accurate picture of their own compliance. Since people tend to underestimate their lapses, this could prove a useful reminder to people who made a habit of 'cheating' on their results.

5.2 The Computerised Miniclinic

The new system¹ was intended as a research tool – a practical means of assessing the use of a computer system in a general practice miniclinic. It was not intended as yet another commercial system on the overcrowded general practice market. An aim was to identify protocols and essentials of design which could be used by future projects addressing the problems of developing general practice miniclinic systems.

In order for the system to work, it was necessary that it should include some administrative functions. For example, patient registration data had to be stored. As far as possible, however, the administrative side was dealt with by interfacing with the general medical package already in use. MINICLINIC, itself, was mainly concerned with the clinical side. There were three reasons for this:-

1. The administrative side of general practice software has been comprehensively dealt with. From a research point of view, there was nothing to be gained from incorporating complex administrative procedures into MINICLINIC.
2. Resources were limited and it was important that they were used to best effect – on the clinical aspects of MINICLINIC.
3. The practice already had a general system which could do all these things. Duplication of administrative procedures is not a good idea for various reasons – it leads to extra work for the system users; it increases the possibility of error and it is proven bad software engineering practice.

5.2.1 An overview of the system

The MINICLINIC system is in three major parts:-

1. *Clinical* – The storage, manipulation and presentation of clinical information is described in detail in the next section.
2. *Patient administration* – As described previously, MINICLINIC does not store detailed registration data for the patients. Instead, it interfaces with the general medical package used by the practice². Obviously, some registration data must be stored. The line between clinical and non clinical

¹The software system was named MINICLINIC

²The co-operation required from a commercial supplier in order to build such an interface is hard won and grudgingly maintained. It is adequate as a means of bridging the gap between a commercial system and a system intended as a one-off research tool. As a general means of communicating between non compatible systems, it is quite inadequate. This problem is addressed in the final chapter.

information is not an absolute one and much 'non medical' data is relevant to a patient's condition. For example, a patient's age, occupation and family history are relevant to the care of diabetes.

MINICLINIC stores a patient's name, date of birth and occupation. It also stores the number by which the patient is identified on the general medical package. This number is used to check that patients registered on MINICLINIC are consistent with those registered on the general package.

A printing facility is included. This allows the production of patient lists giving varying levels of detail of clinical information. Also included is a rudimentary search facility.

3. *Other administrative facilities* – MINICLINIC provides help screens, backup procedures and password protection. These were considered the minimum necessary. Other administrative procedures, practice audit and word processing, for example, were provided by separate software packages.

5.2.2 The clinical functions

The clinical protocol for the system was decided after consultation with GPs and nurses who ran diabetic clinics. An aim was to provide all the information any general practice may need without including too much that the average practice would not need. This was by no means an easy aim to fulfill and a solution is proposed later in the report.

The medical data

The medical data stored divides into four categories:-

1. *Basic data* – Current treatment, height, weight and blood pressure. Current treatment in this context gives only an indication of the treatment, but no details. Also to be included in this section are target weight and body mass index (BMI).
2. *Test results* – Urine, protein, blood sugar, glycosylated haemoglobin, mid stream urine (MSU) and urea and electrolytes (U&E).
3. *New events* – Specific diagnosis and treatment, hospitalisation, hypoglycaemia and therapy changes.
4. *Other tests* – Eyes, feet, teeth, skin, sensation and other symptoms.

With the exception of a patient's height and current treatment, data is recorded chronologically. The system stores data for a nominal five year period³. There is a facility for noting when specimens are sent to hospital laboratories for analysis. The system will then remind the nurse that a result is due. Similarly, repeat intervals can be given for tests. The system will then issue a prompt when the test is due to be repeated.

³Another unforeseen problem. In the surgery environment, the 5 year period turns out to be a flexible unit of time. It can shrink to 6 months or stretch to infinity. This problem is discussed further at the end of the chapter.

The education package

Also to be included is an education package. This is basically a list of things about which the patient needs to know. This list will vary according to the type of diabetes. The nurse can record when a particular topic has been discussed along with any details of the patient's response which seem relevant.

It is hoped that the education package will lead to better use of the nurse's time during consultation. With many different clinics running, and many patients to see, it is difficult for a nurse to remember details of previous consultations as regards reaction to educational advice. Diabetics are no different from many other groups when asked to assimilate information. A person who answers 'yes' in good faith to the question 'Do you know about X?' is often at a loss for a reply when faced with 'Tell me about X.'

Initially, the education package is a check list of about forty items which will give a quick and accurate summary of who was told what and when. The possibility of adding other features – for example, the production of diet sheets or the issuing of warnings based on test results – is being discussed.

5.2.3 The presentation of clinical information

A major aim was to make the information accessible to all who used MINI-CLINIC. The clinical display was built round a single screen. Within this screen, the positioning of information was consistent. Registration data was at the top of the screen. The bottom two lines of the screen were reserved for help messages. The remaining part of the screen was reserved for clinical information.

The underlying aim was for consistent presentation of information in order that a person did not need great familiarity with the system to glean information from it.

The data were grouped according to the four classifications given above; the basic data remaining on the screen at all times. Where there was insufficient room for detailed information to be shown, a heading was given which could be expanded. The format of the data was consistent with the way it would be recorded in the written notes; test results were consistent with hospital forms in terms of units and ordering of results. Problems arose with changes in procedures – some tests were given different priorities; hospital forms altered – which necessitated changes in screen layout. Although these were not, on the surface, large or insurmountable problems, they were indicative of general problems of screen layout for this type of system. This problem is addressed in a later section.

The means of entering data and navigating about the screen were designed primarily for ease of use. This being the aim, the system was made to mimic the general medical package already in use in these respects. In addition to this, shortcut keys were provided to allow for non sequential movement about the screen and help screens were provided. The help information was context sensitive and written in windows which temporarily overwrote the centre of the screen.

Graphical displays

All the clinical data for which chronological records were kept could be displayed graphically. The graphs appeared in windows temporarily overwriting the centre of the screen. The exact form of the graph varied according to the data being displayed and was one of four different forms:-

1. Blood pressure – showing diastolic and systolic pressures on the same graph.
2. Urine and protein results – graphed as bar charts showing the results as negative, trace or different degrees of positive.
3. Other numeric results – graphed conventionally.
4. Free text fields – ‘graphed’ as lists of results.

Further variations are planned for the graphical data. For example, the superimposing of ‘normal ranges’ onto the graphs, or the extrapolation of graphs to predict the outcome of different courses of action or data trends.

5.3 The System in Use

- Out of a total practice population of 3878, there were 87 diagnosed diabetics – 2%.
- 45 were male and 42 female.
- Less than 0.5% were type 1 diabetics – 16 in total; 11 males and 5 females.
- The vast majority were type 2 diabetics – 71 in total; 34 males and 37 females.

5.3.1 Insulin dependent diabetics

Insulin dependent diabetics did not attend the practice run clinics. These patients were looked after by hospital clinics. It was considered asking too much of them to attend the practice miniclinic as well. Traditionally, many general practices have left the care of type 1 diabetics to the hospital clinics – the hospital clinics having originally been specifically set up for their care. This situation may change as general practice miniclinics become more widespread and better organised. Studies, detailed previously, do suggest that general practice is the best place in which to care for all forms of chronic illness.

5.3.2 Non insulin dependent diabetics

The type 2 diabetics are seen in the miniclinic. The frequency of their visits depends upon the severity of their condition and level of diabetic control. Typically, a patient would not be asked to visit more frequently than once a month or not less frequently than twice a year.

Although the clinics are run at set times, allowance is made for particular patients who have special needs. A child of school age, for instance, would not be asked to visit at a scheduled clinic time but would be seen after school hours. The aim being to see that the disease causes minimal disruption to the child’s life. Some patients are unable to attend because of physical problems. These are visited at home. The practice plans to experiment with portable computers for these home visits. There are a small number of patients who continually cancel their appointments or simply fail to attend the clinics. The reasons can only be guessed at, but this is a group in need of follow up. The resources have not so far been available for comprehensive follow up but the computer system does allow that this group be identified.

A typical clinic will see between five and ten patients. The patients are seen by the practice nurses who carry out the relevant tests according to their

medical protocol. The computerised record is shown to the patient during the consultation and used as a basis for discussion of various aspects of their condition. The graph facility is used more than had been envisaged which is the reason for plans to extend it. A particular problem with diabetic patients and the elderly is bad eyesight. This suggests that exploration of colour and large character sets would be worthwhile.

The nurses refer patients to the doctor, the hospital or other miniclinics as appropriate.

5.3.3 Compliance problems

Many compliance problems stem from a lack of understanding of the condition.

Problems with diet are common although regular discussion and reiteration of dietary advice have a positive effect. Lack of understanding occurs in different ways in different patients and, in order to tackle the problem, it is important to identify exactly where the problem lies. It may, for example, be an inability to understand the terms used or it may be misinterpretation of dietary instructions stemming from a lack of understanding of what exactly the diet is designed to do. A patient may be having difficulty in losing weight. This could be because of an inappropriate diet, or because the diet is not being followed for some reason. It is important to identify the real reason in order to provide the appropriate solution. This is an area where the computer system can help to identify the exact cause of a problem by allowing access to the relevant information. The previous history is accessible at the touch of a button – where previously a patient's notes would have had to be searched.

Another area where lack of understanding is a problem is in home blood and urine testing. Once again, the identification of the problem is vital. The computer system, by clear presentation of the information, both identifies that a problem exists and often points towards a solution as well by pinpointing exactly where the problem lies.

The problem of cancelled and missed appointments is a particularly difficult one. It is hard to help a patient who isn't there. The problem can stem from a lack of understanding about the nature of diabetes. The patient 'feels ok' and so doesn't attend, unaware that lack of overt symptoms is not necessarily indicative of good control of the disease. The role of the computer is to identify the problem and the patient group. Patient profiles can be studied and trends may emerge which may help to identify potential defaulters.

Another compliance problem is that of the patient who alters their own treatment to the detriment of their condition. This stems usually from inadequate knowledge, rather than lack of knowledge. This is used as an argument for telling a patient as little as possible about their illness although it has been demonstrated, particularly in diabetics, that compliance improves with increased knowledge of the condition. One solution is to teach the patient more about their condition, in the hope that they will see the inadvisability of attempting ad hoc treatment on their own. This is by no means an easy group to identify. A patient will not necessarily admit to failing to follow treatment programmes, leading to the treatment programme itself being blamed for failure to control the disease. The computer, by analysing results from large numbers of patients, has the potential to identify trends which may help to pinpoint the real causes of failure.

5.3.4 The diabetic "M O T"

The practice carries out what it terms the "diabetic M O T" – a yearly check on diabetic patients. The computer records give the following totals for patients given the check:-

Year	Total patients Checked	Type 1s	Type 2s
1987 and earlier – no figures available			
1988	2	0	2
1989	45	4	41
1990	43	2	41
1991	Record incomplete		

The computerised MINICLINIC was installed towards the end of 1988.

This information does not necessarily mean that the yearly check was not carried out prior to 1988, but that the information is not available. It is likely that the information exists in the paper records, but it is impossible to extract – it is not in a consistent form or place and much of it is not legible.

5.4 Areas to be Addressed in Designing Systems for Miniclinic Use

5.4.1 Flexibility

It became increasingly obvious as the study progressed that the general practice environment – and, by implication, all health care environments – need systems with a great deal of flexibility. Systems which have been developed have built upon the experience of other professions. In some areas this has been advantageous – many of the potential pitfalls in the management and administrative areas have been avoidable⁴. Computerisation of the clinical side is a very different proposition.

Health care professionals deal more directly with people than do other professions. For example, in professions like architecture and accountancy, standard procedures and protocols either lend themselves to computerisation or can be usefully adapted to do so. Preparing an office for computerisation tends to mean a tighter specification of procedures which leads to greater efficiency. This is true of the administrative side of health care. The clinical side, however, is very different. The human condition cannot be fitted to a database. In many areas, the level of specification required by the conventional computer system is not possible. Nor can procedures and protocols dealing with peoples' physiological and psychological welfare be usefully adapted to the computer model. To try to do so is to risk compromising standards of care.

Environments within general practice differ widely. Practice miniclinics have evolved and developed to suit particular patient populations. There are, however, common underlying structures which can be identified. For example, a miniclinic involves the identification of a patient group and some element of call and recall. Within this, as great a flexibility as possible is needed. A practice needs control over which data they record and how it is presented.

⁴The general standard of existing systems was not an area studied but there did appear to be an unnecessarily large number of medical system developers re-inventing the wheel and falling into traps which should have been left behind decades ago.

Some systems do allow a degree of flexibility in that they can be customised in small ways to suit a practice. Other systems, when introducing change on the request of one practice, will insist that all systems are changed to be the same. The exchange of ideas is a good thing but not the insistence upon total compatibility between practices.

There is a need for some form of compatibility between health care systems but not in the sense that all systems should be the same. Communication between systems is discussed in more detail later.

5.4.2 Data entry and catering for different levels of expertise

To fulfill its potential, a computer system, particularly in a miniclinic, needs to be used to the full. In order that it may be analysed and displayed, data must be recorded. A prime requirement, already recognised in many systems, is that data entry should be easy and quick. Data entry into a computer system should be no more onerous than the conventional writing of notes. If it is, then it will not be done. This means that information must be recorded during a consultation in much the same way that notes will be taken. It was the view of both doctors and nurses that data entry during consultation would not be a good thing. However, this view changed in most cases the more a system was used. This was true of all systems studied and not only those that were studied in detail. In practice, data entry into a computer was no more of a distraction to the consultation than the writing of notes or prescriptions. There were two main reasons for this:-

1. The patient could see the data being added and was therefore less excluded from the process.
2. Many standard procedures were quicker - the best example being the printing of prescriptions. Thus, the nurse or doctors' attention was not away from the patient for as long.

Catering for different levels of expertise in the users of a system is a problem which must be addressed in the general practice environment - and cannot be solved by copying the procedures used in other professions.

In the conventional model, the novice user goes through some form of training. In general practice, this often is not possible or feasible. For example, a doctor will employ a locum on a fairly regular basis. There is no time available, for someone who may be in the practice for only a week, to undertake any type of formal training.

A related situation is that of the person who works in the practice on a part time or occasional basis. Some nurses, for example, work in many different practices. This may involve occasional interaction with many different computer systems and it is not possible to maintain familiarity with the complexities of even a single system not used regularly. The same type of situation occurs for people like chiropodists or dieticians who visit surgeries only for particular clinics.

Another group who need to be considered are those who see patients outside the surgery - for example, the district nurses, opticians and dentists. GPs and practice nurses on home visits can also be included in this group.

All these people are seeing the patients. All may have information relevant to a patient's condition; but all lack access to the computer system - some through lack of familiarity with a particular system, some through lack of access to any

computer system and some through lack of access to the surgery computer system.

The latter two points could be addressed by use of portable computers and communication via modem links – discussed in more detail later.

The problem of lack of familiarity with a system can be addressed by the system itself. A system should incorporate a “novice user mode” – a protocol which will lead the user through the sections about which he or she needs to know. The data which is being lost through this type of under use of systems is the clinical data – the data relevant to the consultation. Thus, the occasional user need not be burdened with the entire computer system, only the small section relevant to his or her speciality. The system would need to operate under the assumption that the user has never used it before and knows nothing about it. The aim would be to get the data recorded in as simple a fashion as possible. As this would necessarily involve step by step procedures and full explanations, it would be tedious for the experienced user. It is as important to cater for the experienced user as for the novice. A person finding a system slow and tedious is apt to stop using it, or not use it to the full. The minimum necessary would be to cater for three levels of expertise – the experienced, the intermediate and the novice user.

However, or wherever, data is collected, accuracy is of paramount importance. A computer system can do a great deal towards checking the accuracy and consistency of data entered⁵.

Patients can do a lot towards checking the accuracy of data recorded about them, as was shown in the general survey. This being the case, the area of making data accessible to patients should be explored to the full. For example, if it is recorded that a patient has poor eyesight, the system could automatically produce large displays of particular information.

5.4.3 Automated protocols

A nurse or doctor leaving their clinic in the hands of a locum may wish to have their own medical protocols followed. Thus, a good system will have the ability to navigate through medical procedures according to particular protocols. The type of things that such a system would be able to do would be to say when specific tests were due – in diabetes, for example, there are various tests carried out at defined intervals, perhaps monthly, half yearly or yearly. However, certain results should trigger particular tests more frequently. A result from one test may suggest that others are carried out. An abnormal result may mean certain things being done with greater frequency. Frequency of visits would be decided on the strength of recorded information. None of this, of course, would be immutable. The doctor or nurse should always be able to override the system.

The incorporation of this type of automatic protocol facility would have various advantages:-

- A system which follows a set protocol will be easier for a person, not familiar with the system, to use. It will also mean that a nurse or doctor can ensure that the medical protocols they have developed for their patients will be followed.
- “Standard” protocols can be incorporated. FHSAs in some areas are trying to develop standard protocols for particular conditions. To “sell”

⁵ A great deal more, in fact, than many medical systems actually do. However, this particular topic will not be pursued here because, as a problem it comes under the general heading of ‘solved’.

their protocols to general practice involves the production of much detailed documentation. A lot of time could be saved if this documentation was supplemented by a software version of the protocol which could then be seen "in action."

- A doctor or nurse could "teach" their own protocols to the system. This would speed things up because the system would do its own navigation about the screen, jumping directly to the next relevant section according to the protocol instead of having to be taken through any intermediate stages.

Another advantage would be that the system would always issue reminders about tests or procedures due to be carried out. It is all too easy for a person to forget that, for example, an obscure test should be done because of something which was recorded several months ago. A computer's memory can be relied upon in this situation.

- A practice may not have a formal policy on medical protocols. A computer system, by analysing what the doctor or nurse did during consultation, could give a practice an overview of its own informal protocols. This could be used for evaluation, or development, of protocols.

5.4.4 Facilitating information flow

The usefulness of a computer system in a medical environment, as in many other fields, is absolutely reliant upon information and information flow. The potential benefits to health care which computers can bring about is enormous. Computer analyses of epidemiology and health trends can give very accurate information about where and how disease – and health – spreads. This, coupled with computerised analyses of procedures and protocols for dealing with health care issues can show quickly and accurately where the solutions to problems lie. This type of wide scale application relies upon information being gathered over wide areas and from all parts of the health service.

Unfortunately, far too many health care systems have been developed with little or no thought to information sharing. Particular aspects of information which can be recorded on, and accessed from, specific systems, cannot be collated across systems.

In the general practice environment, communication between systems is a particularly neglected area and also one of great importance.

Within a practice, much information flow relies solely upon the single system in use which makes the lack of electronic communication across systems a less noticeable omission. Nonetheless, general practice does rely on information exchange to and from other parts of the health service. The practice income depends upon accurate information exchange with the FHS. Results of hospital tests could come directly from the hospital's computer system to the practice computer which would mean that they arrived more quickly and with less errors – every time information is conveyed manually, the chance of errors being introduced increases.

The major advantages of direct communication between health care information systems are:-

- Access to information – Patient notes can be where they are needed when they are needed. Often, when people move through the health service – between hospitals, or via referrals from general practice – they remain one step ahead of their clinical notes. It can be vital that particular treatments, episodes and conditions are known about before other procedures

are initiated. With the present system of transferring notes, this information is often not available.

Information for epidemiological studies and evaluation of health services would be available. General practice has suffered in the past through an inability to produce the evidence about the services that it provides.

- Speed – Much data transfer can be automated. Particular test results, for example, would automatically be sent from laboratories to the relevant general practice as soon as they were recorded. Even where transfer must be manually initiated, electronic communications are quicker than conventional methods.
- Accuracy – Less manual intervention means the introduction of fewer errors. Where errors occur, they can be reported quickly. If, for example, an electronic communication fails to get through, the fact can immediately be reported to the sender⁶. Accuracy in transmitted data can be guaranteed⁷ by use of electronic protocols which are used to detect, and often correct, errors in transmission.

5.5 Comparison with a Specialist Diabetes Centre

The diabetes centre studied was a specialist clinic whose medical staff comprised two doctors, two sisters, two specialist nurses, a dietician and a chiroprapist. At that time the general practice medical staff comprised two doctors and a practice nurse.

The specialist diabetes centre used a commercial, computerised diabetes system. The clinic was able to have the system customised in a very minor way, but not with sufficient flexibility to allow substantial change to be made. The system was operational from the day the clinic opened.

The general practice was very much more involved in the design of their clinic system. However, in agreeing to run a completely new system in this way, the practice had to contend with the “teething problems” inherent in any new system. Fortunately, these were not too bad and the advantages of the situation have far outweighed the disadvantages as far as the practice is concerned. There has been considerable scope for having the system modified to suit the practice. The only restrictions being in terms of time or resources available. The diabetes centre, although having only a limited say in how the system was developed, had considerable resources available for the setting up of the centre.

In the diabetes centre the doctors all had computer terminals in their consulting rooms. The specialist nurses had a single terminal in their own room but not in the room where they saw the patients. Terminals would have been put into these rooms had this had a higher priority. However, resources were exhausted by other things considered to be of a higher priority.

The situation in the general practice miniclinic was similar at the outset. The doctors had terminals in their consulting rooms. The nurse had no terminal at all. However, greater priority was given to installing a terminal for the practice nurse to use during consultation.

In both clinics, the medical staff were originally negative in their attitudes to computerisation, not foreseeing any great benefits. In both cases, the benefits

⁶Compare with the letter which doesn't get through. The onus then is upon the receiver to request the information again which presupposes their noticing that it hasn't arrived.

⁷At least, that what is received is the same as what was sent!

in terms of administrative tasks very quickly became apparent. The doctors in both clinics were initially reluctant to use a computer during consultation but having used it became enthusiastic.

In both these clinics, as in the majority of cases, a terminal in the consulting room was reported as having a positive effect upon the consultation⁸. Doctors in both clinics commented upon patient reactions to information seen on the computer screen.

The diabetes centre, from being a traditional hospital clinic, became a high powered educational centre. The centre was able to demonstrate significant improvements in patient care very soon after it opened. The glycosylated haemoglobin results were analysed for the first six months. There was an average decrease of 1.5 mmol. This indicates a significant improvement in patient compliance as well as diabetic control.

Unfortunately, a similar analysis of the general practice miniclinic was not possible because pre-computerisation data was not available but subjective assessments from the nurses and doctors involved suggested improvements, although not such dramatic ones.

It would be impossible to state with absolute confidence that the computer was the only, or even the major, cause for the improvement noted at the diabetes centre. In fact, if any single factor could be singled out it would be the change from a disorganised hospital clinic to an organised care centre. Nonetheless, the computer played a large part in the increased organisation, and the statistics which proved the value of the centre, in terms of patient care, would not have been accessible without the computer system.

5.6 Summary

The study has shown a wide range of benefits, and potential benefits, accruing from the use of computers in general practice. Although the study was set up to look specifically at miniclinics, the interaction between the miniclinic, the rest of the practice and other parts of the NHS inevitably widened the scope of the investigation.

As predictable from the previous, more general study, accessibility of information played a key role. All the benefits of computerisation stem from the way in which information is made accessible.

Patient groups can be reliably identified, monitored and followed up in a way that was not possible prior to computerisation. This is not to say that this was never done. Some practices ran very efficient manual systems. Some were reluctant to computerise for the reason that they could not find a system on the market which could match their own manual protocols. Where the computer has the advantage is in its speed, accuracy and flexibility. The only reasons manual protocols can ever better computerised, lie in poor standards in the computer systems.

Information is being made available that will benefit general practice as a whole. Practices can produce quick and accurate audit of their procedures which has financial implications. Since the setting up of the NHS, GPs have been saying that they do not receive fair recognition or financial remuneration for the work they do [4]. Computerisation will be their way to produce the hard evidence which backs up their claims.

The study has demonstrated improved standards of health care resulting from computerisation. Specifically, it has shown a positive effect on the doctor-

⁸The exceptions have been those surgeries who have experienced severe technical difficulties with the computer hardware.

patient or nurse-patient consultation and a potential improvement in patient compliance in diabetes.

Further benefits will undoubtedly accrue from evaluation procedures. As more information is recorded and available to be analysed, more will emerge. Accurate pictures, for example, of how effective particular clinics are.

Problems occurred over the recording and presentation of data. The only feasible solution is that the system users must have the most possible freedom in specifying the data they record and how it is presented. Clinical data is liable to alter in subtle ways. Different practices will have different ways of treating the same condition because of differences in their patient populations. Medical research constantly changes the way that various issues are dealt with. A computer system designer may aspire to keep abreast of the major advances in medicine but will never know a practice population as well as the GPs who serve it; thus, will never be in the best position to make clinical decisions about the GPs' computer systems.

There has been considerable work done towards defining minimal data sets as a means of standardising medical systems. Working on the results of this study, it is suggested that the most useful course to follow is in the opposite direction. This will be discussed further in the final chapter.

A related point is that of communication between systems. There is no way of making accurate measurements, but the amount of data made accessible by the introduction of good computer systems into health care must be no more than a fraction of the data which is being lost "between" systems – the epidemiological information lost because information, though recorded, cannot be gathered together; the information lost through introduction of error because of inefficient data transfer.

To attempt to standardise general practice systems is both undesirable and infeasible at this stage; to attempt total standardisation across the whole NHS, an even worse proposition. The solution is to build electronic "bridges" between systems. The aim would be to allow everyone to use the system which suited them best while facilitating electronic transfer of data where needed. The solution lies in the definition of clinical data sets and is discussed in the final chapter.

5.6.1 Now where?

The future of the miniclinic study will be the further development of the diabetes miniclinic along the lines suggested previously.

A proposed next step on from this is the development of the computerised generic miniclinic. This follows directly from the identification of a common underlying structure for the miniclinic and a need for flexibility.

A miniclinic must have

- A patient group.
- An accurate means of identifying that patient group.
- A reliable system of call and recall.
- A clinical protocol.

Within this structure, the actual clinic may be for chronic illness, preventive medicine or anything else the practice may choose. This structure accommodates different structured health services and means of organisation. Working within a pre-defined, but comprehensive, clinical data set, the structure can be customised to suit any miniclinic.

Chapter 6

The MINICLINIC Software System

6.1 An Overview

MINICLINIC is a software system designed for use in a general practice diabetes miniclinic. It is designed to assist with both the administrative and clinical aspects of the clinic; but, specifically, to concentrate on the clinical side.

6.2 The Clinical Data

Before the software system could be built, it was imperative to decide which data would be stored and in what way. Discussion with GPs and nurses who ran diabetes clinics led to the development of the medical protocol upon which the system would be based. From this protocol, the exact form of the information to be stored was worked out.

6.2.1 The medical protocol

The following protocol is not followed exactly in the surgery, but it encompasses all the tests that are done. This would be the type of protocol which could be built into the system to aid the occasional user, or speed up data entry for the experienced user.

The route to be navigated through the system of tests and checks depends upon such factors as whether the patient is visiting as a result of specific recall, what previous results were recorded for them and what are the results of tests and checks done in the clinic:-

The protocol

If the visit is NOT as a result of a specific recall:-

1. Record the reason for the visit and the diagnosis.
2. Record whether or not this is an acute infection. Give advice appropriate to the type of diabetes.
3. Check the blood sugar.
4. If this is a non acute episode associated with diabetes, check compliance.

If the visit IS as a result of specific recall:-

1. Is this the patient's first visit to the clinic? If so, record registration data and the patient's height and weight. Work out target weight and body mass index (BMI).
2. Check the results from the previous visits and repeat, or take samples for, any tests which were abnormal.
3. Check and record details of any new events – specific diagnosis, hospitalisation and hypoglycaemic attacks.
4. Test the urine. If the results are abnormal, then carry out blood tests.
5. Record weight. Give dietary advice if appropriate.
6. Check education. Advise as appropriate.
7. If due, carry out the half yearly, or yearly, check – carry out tests on eyes and feet and, depending upon the patient's age and the level of control of the disease, carry out further checks on reflexes, teeth and skin. Record results and action taken which may be none, referral to hospital or instigating further tests.
8. If appropriate, refer the patient to other miniclinics.

- Recall interval

If an investigation has been instigated, recall the patient in 1 or 2 weeks.

If this was an incidental visit and there are no clinic appointments pending or if this is the patient's first, second or third visit to the miniclinic, recall in 4 weeks.

If therapy has been changed, recall in 4 to 6 weeks.

If the patient is stable and therapy is to remain unchanged, recall in 3 to 6 months.

6.2.2 The data stored

The data to be stored could be divided into two main categories:-

1. Registration data.
2. Medical data.

Registration data

Initially, it was decided that the miniclinic should store a patient's name, sex, date of birth, occupation and registration number. The registration number was one automatically allocated to the patient when registered on the general medical package. A far more satisfactory means of identification would have been the patient's national insurance (NI) number and, in many areas of medical computerisation, it is the NI number which is now being used as the unique identifier.

Extending the registration data to include a patient's family history is being discussed.

Because a patient must be registered with the practice in order to attend the diabetes miniclinic, it was decided that the software would only allow registration of patients already present on the general database. This would mean

that a patient kept the same registration number – a vital element in guarding against error. All this registration information, except occupation, was already stored on the general package. It was decided, therefore, that the miniclinic, having registered a patient, would always check for consistency with the general package when that patient's record was accessed.

The assumption was made that a patient's date of birth, sex and registration number would not change, but that their name may do. This interfacing with the general package is described in more detail later.

Medical data

The medical data was subdivided into four groups:-

1. *Basic data* – This was data which would either remain static or would be needed (recorded or consulted) at every consultation.
2. *Test results* – Bio-chemical tests carried out with varying frequency. Some would be carried out in the miniclinic, some by the patient at home and some in hospital laboratories.
3. *New events* – Events whose frequency could not be predicted.
4. *Other tests* – Tests carried out at regular intervals as part of a yearly or half yearly check.

The medical data in more detail

Basic data – Data recorded are:-

- *Current treatment* – This indicates the type of diabetes; type 1 or 2. If subdivision according to treatment is required; insulin dependent, oral hypoglycaemics or diet. A further subdivision according to the type of hypoglycaemic is being discussed.
- *Weight* – A record of weight is particularly important in diabetes and the system records a history of weight readings. Recording of target weight and BMI are also planned.
- *Height* – The recording of height is needed for calculating target weight and BMI. Variations in height are not significant in diabetes and so this information is recorded only once¹.
- *Blood pressure* – A record of blood pressure is important and the system records a history of readings.

Test results – A history of all test results are recorded. Also recorded are repeat intervals for tests. The system will prompt for due and overdue tests. In some cases, samples will be sent to hospital laboratories for analysis which means that results will not immediately be available. It is possible to record the fact that a sample has been taken and the system will then prompt for recording of the result. Data recorded are:-

- *Urine* – Test for sugar in the urine, done in the miniclinic or by the patient at home. The results may be negative, trace or different degrees of positive as shown:-

¹Other miniclincs would require a chronological history of height recordings; for example, in the treatment of osteoporosis or paediatric surveillance

-
trace
+
++
+++
++++
+++++

- *Protein* – Test for protein in the urine, done in the miniclinic or by the patient at home. The results may be negative, trace or different degrees of positive as shown above.
- *Blood sugar* – Test for sugar in the blood done in the miniclinic or by the patient at home. The system will record whether the sample is a fasting or random one.
- *Glycosylated hæmoglobin* – Test for hæmoglobin A1 as described in chapter 4, done in the miniclinic.
- *MSU* – The test is done in a hospital laboratory and records cells, casts, chemistry and colony count. If the colony count is significant, greater than 100,000, then a record is taken of organisms found and their sensitivities.
- *U&E* – The test is done in a hospital laboratory and records sodium, potassium, calcium, alkaline phosphatase, creatinine, phosphate, urea, albumin, total protein and total bilirubin. The system flags abnormal results for U&E.

New events – All data are recorded chronologically:-

- *Specific diagnosis* – Records details of any specific diagnosis and treatment, possibly for incidental visits to the surgery.
- *Hospitalisations* – Records the dates of hospitalisations.
- *Hypoglycæmic attacks* – Records details of hypoglycæmia.
- *Therapy changes* – Records changes in therapy. This field may change if the recording of current treatment is changed.

Other tests – All data are recorded chronologically:-

- *Eyes* – Information is recorded on cataracts, visual acuity and fundi. It is planned to alter the structure of this data to allow for specific recording for left and right eyes.
- *Feet* – Information is recorded on ischæmic changes and ulcers.
- *Teeth* – The type of information recorded is not specified. This field is not used a great deal at present as there is little, if any, liaison between the surgery and the dentists.
- *Skin* – The type of information recorded is not specified.
- *Reflexes* – The type of information recorded is not specified at present. It is planned to extend this field to cater specifically for particular reflexes.
- *Other symptoms* – The type of information recorded is not specified and allows for the recording of any symptoms or information not covered by other fields.

6.3 The Software Package

The system consists of the suite of programs which comprise MINICLINIC, a further number of programs to perform various supporting functions and a number of data files.

6.3.1 MINICLINIC

MINICLINIC is written in Pascal. One of the reasons for choosing Pascal was to give the system a sound software engineering base. The choice now would be Modula or Ada, but neither of these languages was available for the microcomputers used for the project at the time it was conceived. MINICLINIC interfaces with a general medical package. This was also written in Pascal. The decision was made to use the same Pascal dialect – Borland's Turbo Pascal [55] – in order to ease the process of interfacing between the two systems.

The current version of MINICLINIC comprises a suite of 12 inter-linked programs containing 38,000 lines of code. These programs operate on 28 clinical data files and use a further 3 data files which contain configuration and other non-clinical data. The package is modular in structure and each program deals with a particular function.

The programs are built round a menu driven and form filling model. The menus give a list of options written to the middle of the screen. Choice of a particular option depends upon a single key press. This will be a character – the first character of the option. Character clashes were not a problem, particularly because menus were deliberately kept small for ease of use. Exit from a menu is by the 'escape' key, except for the main menu. In this case, a double key press is required. The user is thus able to exit from levels of menus very easily without accidentally quitting the whole system.

The 'escape' key is used throughout the system to signify 'exit this section without altering anything'.

The menu model

The structure of the main menu program demonstrates the overall structure of all the menu procedures and programs. Where the program in question is very small, the options will call procedures and not programs. In this case, the main structure is put inside a REPEAT loop to cause repeated execution until the finish option is chosen.

```
Print_Menu (optionset); (* Print_Menu returns a set of options
                        appropriate to the option list
                        written to the screen *)

Get_Menu_Option (option, optionset);

IF NOT (option = finish_program) THEN BEGIN

    CASE option OF
        diabetes_clinic : program_to_call := diabetes_program;
        print_facility  : program_to_call := print_program;
        search_facility : program_to_call := search_program;
    END;
```

```

Chain (program_to_call); (* Runs the appropriate program
                           while retaining values in
                           global variables *)

END ELSE

Tidy_Up; (* Close/delete files prior to program termination *)

```

Each “program to call” itself calls the menu program when it has finished.

The form filling model

Where user input was required, a form filling model was used. The user typed into a box on the screen. The length of the box determined the allowed length of the input. Illegal keys are ignored. For example, pressing a character key in a numeric field would have no effect. Input is finished in a number of ways:-

- The Return or Enter key signifies ‘input finished - go to next box.’
- The Tab key signifies ‘input finished – return to previous box.’
Neither Enter nor Tab key will cause a change of screen. Tab key in the first box of a screen and Enter key in the last will be ignored.
- An active function key or control or alt key sequence. These keys are used at different stages to signify different things. For example the use of the F6 function key on any ‘graphable’ clinical data field will cause input to be suspended and a graph of available data drawn for that field. When the graph is finished with, the program will continue with the current input from where it was left. Some key sequences will change screens. For example, the Alt and F sequence from the clinical screen will update the records for that patient and cause a blank screen to be drawn in readiness for the next patient; the F1 key from a blank clinical screen will finish the diabetes clinic and return control to the main menu.
- The Escape key, which may only be used from an empty box signifies ‘input finished – go to next field skipping any intermediate boxes’. For example, if the escape key was pressed from the ‘day’ box of a date field, it would cause both month and year to be missed out. This has been included for compatibility with the general medical package.

In summary, the user may go up and down a form using Enter and Tab, or may signify that the form is finished and data from it should or should not be saved. Alternatively, the form filling operation may be suspended while some other operation is carried out, such as the drawing of a graph or consultation of a help screen.

The structure is the same however large or small the ‘form’. In some places, one of the search options, for example, the form consists of a single box. In others it is larger. The medical screen form, for example, consists of twenty boxes, some of which are smaller forms consisting of several boxes.

The overall structure of the form filling process is as follows. This example shows how information on eye tests is recorded. It is a sub section of the medical form.

- Initialise local variables from globals.

- Initialise appropriate parts of record variables *stringwanted* and *stringread*. These determine the length of the strings, the valid characters, the valid function keys and whether input is numeric or not.
- Start at cataracts field.

REPEAT

```

CASE field OF
  first_field -
    If the local variables differ from
    the globals, update the globals
    and set field_finished to true

    cataracts_field -
      Put value of local variable for
      cataracts into string_read.

      Set row and column of box

      Read_String (row, col, string_wanted, string_read);

      IF NOT escaped THEN (* If Esc key not pressed *)
        Update value in local variable

    acuity_field - As for cataracts - read from appropriate
                  box to appropriate local variable.

    fundi_field - As for cataracts - read from appropriate
                 box to appropriate local variable.

    end_field -
      If local variables differ from the
      globals, update the globals
      and set field_finished to true

```

END CASE

```

IF valid function key has been pressed THEN
  field := end_field
ELSE IF data has been cancelled THEN
  field_finished := true
ELSE IF NOT field_finished THEN

  IF tabbed THEN
    field := PRED (field)
  ELSE
    field := SUCC (field)

```

UNTIL field_finished

User input and file operations were each dealt with using a single procedure. Ideally, each of these operations would have been carried out using a generic procedure. However, Pascal does not allow this. Thus, pseudo generic code was written for these operations. This greatly facilitated the maintenance and enhancement of the system and will be of great help should the system be rewritten in a language which allows generic procedures.

User input – This is dealt with by a procedure, *ReadString*. This procedure takes four parameters. *row* and *col* give the screen position from which to read. *stringwanted* contains information on whether the data being read is numeric or a character string; it also holds the maximum length of the string to be read, the minimum and maximum values for numeric input, a set of valid characters which the string could contain and a set of valid 'function' keys which could be used – these include control and alt key sequences. The final parameter, *stringread* is a variant record type; for numeric input, it contains the number read and for character input it contains the string read and the length of the string read. In either case, it contains also the function key read, if any.

In summary, *stringwanted* gives information about the data to be read, *stringread* gives the data which has actually been read. If the field already contains data, this is put into *stringread* before the procedure is called. The structure of the procedure *ReadString* is as follows:-

- Initialise the local variable depending upon the values in *stringread* and *stringwanted*. Write this string to the screen and turn the cursor on.
- The valid keys depend upon the size of the string. If the string is empty, the escape key may be used but the backspace may not. If the string is not empty, the backspace may be used but the escape may not. If the string is at its maximum length, then only the allowed function keys – plus Enter and Tab – may be used.
- Function *KeyRead* reads from the keyboard until it encounters a key in the set given by *keys*. Function keys, alt key sequences etc. will set global variables. For example, the escape key will set variable 'escaped' to true.

REPEAT

character_read := KeyRead (keys);

IF NOT escaped THEN

Decide if the input has been finished. If, for example, the Enter or Tab key has been read.

IF finished THEN

IF a valid string has been read THEN

put the appropriate value into *string_read*
the string to number conversion is done
at this point if required
done := true

ELSE

Beep (* Warn user that input is invalid *)

ELSE

```

        IF backspace THEN
            Alter local string accordingly
            If the string is now empty alter the key set
        ELSE
            If a valid character has been read, add it to
            the string and alter the key set according to
            string length.
    UNTIL done;

    Turn the cursor off

```

File operations – These are dealt with by a procedure, *FileTransfer*. This takes three parameters. *filevar* to identify the file, *position* to identify the position of the record in the file and *fileoperation* to identify the operation as either read or write. In a truly generic procedure, a fourth parameter would be used to hold the value read from the file, or to be written to the file. Because the files were of different types, this could not be done in Pascal. This was also the case with the *filevar* parameter. This could not actually be the file variable, but was instead a user defined type.

Values are read into, or written from, pseudo file buffers which are, in fact, global variables – one per file.

As well as the file operations, the procedure also deals with the opening and closing of files. There are too many files for all to be open at once, thus a set is maintained which keeps a record of which files are open. If the required file is not in this set, then one of the open files is closed and the appropriate file opened.

Procedures were written to deal with the opening and closing of files to mimic the generic procedures that would have been used if the file variables could have been passed as parameters.

The procedure was structured as follows:-

```

PROCEDURE File_Transfer (file_var : file_ids;
                        operation : file_operations;
                        pos : cardinal);

BEGIN
    IF NOT (file_var IN open_files) THEN

        Close_File (OneOf (open_files) );
        Open_File (file_var)

    CASE id OF
        eye_file_id : BEGIN
            Seek (eye_file, pos);
            IF operation = get_file_buffer THEN
                Read (eye_file, eye_file_buffer)
            ELSE
                Write (eye_file, eye_file_buffer)
            END;
        teeth_file_id : etc...

```

An overview of the program structure follows, giving a summary of each program and showing how it is linked to the others:-

1. *Start up* – The program which starts the MINICLINIC. This program initialises the system according to the relevant configuration and checks that all the required data files are present. This calls the logo program.
2. *Logo and password* – This draws the MINICLINIC logo on the screen. Continuation beyond this point requires a password. The user is given three attempts to get the password correct, after which the program will finish. When a correct password is given, the current date is written to the screen and the user is asked to confirm that this is correct. It is possible to alter the date at this point, or to exit from the program. When the date is confirmed, the main menu program is called.
3. *Main menu* – This program follows the pattern used by all menu screens in the package. The options, written in a list in the centre of the screen, may be chosen by a single key press. The 'quit' option will be written in the bottom corner of the screen. Quitting from the main menu finishes the whole program and so two key presses are required, to prevent a user accidentally quitting the system. For the same reason, the quit keys from the main menu are not the same as those from sub menus. Sub menus use the 'Esc' key; the main menu uses 'Ctrl+F'.

There are three options available from the main menu, other than quit. These are:-

- The diabetes clinic.
- The search facility.
- The print facility.

Each of these is a separate program which, when it has finished, will call the main menu program again. Thus, the program continually returns to the main menu until the user chooses to quit. The overall structure of this program is as shown in the previous section on menu structure.

4. *The search facility* – This program is based around a menu in the same way as the main menu program. The current version contains options to search the patient database either by name or by age and to save the result of searches. The user may optionally specify a name, or part name, where the search should start; or an age range. The patients found during the search are listed to the screen together with their computer number and date of birth.

Search 'vectors' are kept by the program. These are lists of pointers to patient records. The lists are maintained in alphabetic and age order and allow for fast access to the patient records. The lists may be accessed directly by first letter of surname or in five year age bands. For extra speed, the lists are held in memory. However, if multiple access to the system was required, these would have to be read from files.

The results of specific searches may be saved. Each search saved is kept in a separate file which holds the registration numbers of the relevant patients. These files may be used by the print facility. The system will

hold up to ten search files². If more need to be stored, the user is requested to delete one of the older searches.

All searches may be carried out on either male or female patients or on the total patient population. The default is total patient population.

5. *The print facility* – This program is based around a menu in the same way as the main menu program. Two options are given. The user may either specify a patient or list of patients to be printed, or one of the search files may be used.

The information printed may be one^{of} three forms:-

- (a) *Short form* – Name, number and date of birth only, where patients are listed one per line.
- (b) *Registration data* – As above but including sex and occupation.
- (c) *Long form* – All data for each patient is printed. It is listed under the major headings – registration and medical. The medical section is subdivided according to the four classifications given previously.

The default is short form.

6. *The diabetes clinic* – This program, called from the main menu, deals with data recording and display during consultation. A detailed description of the clinic screen and data presentation is given in a later section.

The diabetes program may call other programs depending upon options chosen by the user. A different program will be run if the user chooses to:-

- print details of the current patient. Details will be printed in long form.
- show clinical data in graphical form.
- ask for help.
- open the education package.
- update patient details.
- remove a patient from the database.

All these programs call the diabetes program when they finish. In the case of the education package, the diabetes program, when re-run, rewrites patient details to the screen where they were overwritten, and starts with the cursor on the closed education package. In the case of patient details being updated or a patient being removed, the diabetes program starts anew with a blank clinic screen. In the case of printing, graphical data and help screens, the diabetes program re starts from wherever it was when the other program was called. To allow it to do this, global variables are set before the new program is called, to show which screens were expanded, where the cursor was and what data, if any, was being read at the time.

7. *Print current patient details* – This program prints, in full form, the data held on the patient currently being dealt with. This program can be called from anywhere within the diabetes program when patient details are on the screen.

²Ten was chosen because it was the number of searches which could be written to a single screen – name of search plus a short description. To date, this number has proved more than adequate but it could be increased with little difficulty.

8. *The graph facility* – All data recorded chronologically can be graphed. The form of the graphs was discussed in the previous chapter. When the program is called, the data graphed is that corresponding to the current position of the cursor on the screen.
9. *The help facility* – All fields on the clinical screen, which can be accessed by the user, have two associated help screens. The first describes the data which can be recorded in that field. The second lists the keys which may be used. Because the set of valid keys will vary, the conventional system of help files is not used. A set of current keys is maintained and used to determine which data should be written to the help screen. For example, whether or not keys to access past and/or future data are active depends upon how much data is stored in a particular field, and which item is currently on the screen. The structure of the code to draw the help screen is as follows:-

- Write the help screen heading.
- Initialise the set of keys to contain the file key and cancel key, which will be active for all fields, and the current keys.

```
keys := currentkeys + [filekey, cancelkey];
key:=filekey; (* filekey is the first in the set *)
```

- Go through the full set of keys one by one. If the key is active print the appropriate message to the help screen.

```
WHILE NOT (keys=[]) DO BEGIN

    WHILE NOT (key IN keys) DO
        key := SUCC (key);

    CASE key OF
        filekey, cancelkey :
            Write appropriate message to screen
            keydone := [filekey, cancelkey]

        randomkey, treatmentkey :
            ...

    END CASE

    keys := keys - keydone

END { while };
```

- A problem occurs for certain keys, because of lack of room in the help window. Particular pairs of keys must be written differently if they are both present in the set. This occurs for the previous and next data keys and the print and graph keys. For example, if the previous date key and next date key are both active, they will be written together

```
F7/F8 Previous/Next
```

- Detecting the presence of particular key combinations is done using Pascal's set operations. For example, for the date keys:-

```

datekeys := [prevdatekey, nextdatekey] * currentkeys;

IF datekeys = [prevdatekey, nextdatekey] THEN
  ReverseVideo; Write (' F7/F8 '); NormalVideo;
  Write (' (cycle through data chronologically) Previous/Next')
ELSE IF prevdatekey IN datekeys THEN
  ReverseVideo; Write(' F7 '); NormalVideo;
  Write ('      See data from previous clinics')
ELSE
  ReverseVideo; Write(' F8 '); NormalVideo;
  Write ('      See data from more recent clinics');
END;

keysdone := [prevdatekey, nextdatekey]

```

10. *The education package* – This is still under development. The structure will be a list of items about which the patient must be told. The nurse will be able to record patient response to particular subjects – the date will be recorded automatically, so that it will be possible to see what subjects have been discussed and when.

The items listed for a patient will depend upon the type of diabetes. If there is nothing recorded in the current treatment field, the user will be asked to specify type of diabetes when the education package is first accessed – this information would then be written to the current treatment field.

11. *Updating patient records* – While the diabetes program is running, all new, or amended data, is held in memory, in a 'screen record'. The screen record differs from the file records in various ways. For example, the screen record holds a patient's age, whereas the file records hold date of birth. Basically, the screen record holds data in the form in which it is displayed on the screen. Chronological data is held in arrays for fast access. In the main file record for a patient, chronological data is not held at all. The record just holds 'pointers' to positions of records in other files.

No patient data is written to file until the user specifically requests that it be written. This is done by exit from the diabetes program using the file key. This will call the update program which will update the files as appropriate. This program also deals with file housekeeping – keeping track of how much room there is left in particular files and checking the pointer system. The search vectors are also updated as necessary.

12. *Removing patients* – There are two occasions on which this program is called. One is where it is called by the user. Patient registration details are written to the screen and the user is asked to confirm removal of the patient record. To guard against accidental removal of a record, two separate double key presses are required.

The possibility of requiring all medical data to be removed from the record before the patient could be removed from the database was discussed. This would have mimicked the general package. However, removing medical data on the general package involved navigation around half a screen, whereas the diabetes clinic involves expanding screens and chronological data. Thus, the idea was not adopted. This program updates the search vectors.

The remove program is also called if inconsistencies are found between miniclinic data and data on the general package. If a patient's date of birth or sex appear to have changed, the most likely explanation is that the patient has been removed from the general package for some reason and the registration number has been re-allocated to another patient. If the patient is no longer registered with the practice, their record should be removed from the miniclinic also. However, the record is not removed automatically. The user is given the option of leaving the record in the database but will not be allowed to update this record until the discrepancy is removed. This is to cater for the situation of a discrepancy caused by a software bug³.

6.3.2 The supporting software

The framework

MINICLINIC is run within a menu driven framework. This outer menu structure is controlled by batch files. The options on the outer menu are:-

1. Run MINICLINIC
2. Hard disk backup – This copies the data files to a backup directory.
3. Floppy disk backup – This runs a program which copies the data files to floppy disks. File copy is done by program, not batch file, to cater for files which are too big to fit on a single disk. The data file names are read from a file and each is copied in turn to the floppy drive. In outline, the program structure is as follows:-

REPEAT

```
IF disk_wanted THEN
  Get_New_Disk (disknumber);
  disk_wanted := false;
```

```
IF file_wanted THEN
  Get_New_File (file_found);
  file_wanted := false;
```

```
IF filefound THEN
  Transfer_Files;
```

UNTIL all_files_copied;

4. Reinstate from backup data – This gives a further menu giving a choice between reinstating from hard disk or from floppy disk. This also warns that data added since the previous backup will be lost and gives the option of aborting the process.

Reinstating from floppy disks is done by a program, identical in structure to the backup program but transferring data from, and not to, the floppy drive.

³In 1991 the surgery was struck by lightning. The MINICLINIC software was unaffected but the general package responded by altering all its patient records.

5. Software update – This program asks for a disk to be put into the floppy drive. It checks for the presence of a specific batch file on this disk and if present, runs it.
6. Return to main system menu – This returns control from the miniclinic system.

MINICLINIC support software

Programs were developed to support various aspects of MINICLINIC:-

Initial file creation – The size of the data files is static. Nominally, they will hold five years data for each patient. The files are structured according to a 'pointer' system linking records according to particular criteria. For example, records belonging to a particular patient will be linked; some data is linked in specific order, alphabetically or numerically, for easy access.

'Empty' records are linked and a record is kept of how many records are free in a particular file, and which is the first free record. These lists and pointers are updated as data is added, removed or amended.

A program was developed to create the initial empty file store. This program asks how many patients should be catered for and then creates appropriately sized data files, links all the free records together and creates the files containing the housekeeping information.

Installation – Software was developed to install a complete system from scratch. Two versions have been developed.

The first was a series of batch and Pascal programs. The batch programs dealt with the creation of the directory structure and much of the file copying. The Pascal programs, called from the main batch file, copied the data using the reinstate program and set up the initial configuration – particular default values can be set up by the practice. The system can be re-configured at any time.

The second version, which carried out the same operations, was written entirely in Modula. This allowed for extra validity checks. For example, checks could be made that the correct disks were in the floppy drive before attempting to copy files; space on the hard disk could be checked. The entire process was made more secure. However, there are two major disadvantages to this second option:-

1. People are reluctant to set up systems from programs they cannot read and check beforehand – and quite rightly, as this is a means of spreading viruses.
2. An unforeseen problem. Some of the Modula system calls clashed with the network software being used by the practice. The effect was that the program would not run⁴.

Consistency checking – The clinical database relied upon its pointer system for linking records within, and across, files. A program was developed to go through all the records and check the pointer system for consistency.

Maintenance of pointer structure – Even if the software could be relied upon to maintain a consistent pointer structure, problems could still occur⁵.

⁴There is a trend towards more reliable network software in general practice. It is becoming apparent that the advantages of reliable software outweigh the increased costs

⁵Problems such as the aforementioned lightning strike.

As this structure was fundamental to the reliable running of the system, a program was developed which would track all pointer lists and allow pointers to be changed. This, used in conjunction with the previous program, could repair the database if necessary. The programs have been tested on an artificially damaged database, but have never actually been needed.

Programming tools

The Turbo Pascal system used was restrictive in terms of memory capacities. Source code had to be split into many different files and procedures within programs had to be overlaid. There were no tools provided with the system for maintenance of large programs and no checking on such things as procedures wrongly overlaid.

It was vital, for efficient and reliable program development, to be able to locate procedures easily and to check overlay areas. To this end, a program was developed which would go through the source code of a program and extract the required information. 'Include' files would be taken in order and procedure and function headings listed. Nesting would be represented by indentation.

All procedure headings could be kept in a single text file. Thus, procedures could be located by simple text string searching. The extent, and contents, of overlay areas could be seen easily.

The following example shows procedure headings from a part of the logo program. The file from which they have been read is given at the top. The list shows four procedures at the top level, one of which has a procedure nested within it.

logo.cln

```
PROGRAM Logo;
  PROCEDURE Set_Date (date :daterecords)
  PROCEDURE Get_Password (VAR pwd : stringrecords)
    PROCEDURE Read_Length (VAR pwdf : text; VAR length : stringsizes)
  PROCEDURE Change_Password;
  PROCEDURE Read_Password (VAR pwd : stringrecords; VAR pwdok :boolean)
```

The next example shows an overlay area within a program.

comprocs.cln

```
PROCEDURE ReverseVideo;
PROCEDURE NormalVideo;
PROCEDURE Move_To (row : rows; col : cols)
OVERLAY PROCEDURE Beep;
OVERLAY PROCEDURE Pause (no : posints)
OVERLAY PROCEDURE ClearLine (row : rows)
OVERLAY PROCEDURE ClearScreen;
OVERLAY PROCEDURE SaveGlobalBooleans (VAR copies : booleanarrays)
OVERLAY PROCEDURE RestoreGlobalBooleans (copies : booleanarrays)
PROCEDURE ClearMiddleOfScreen;
```

The other area in which the programming environment was particularly lacking was in the compiling of large programs – and, specifically, systems which consisted of several interlinked programs.

The compiler was relatively slow when compiling overlaid code. It would also stop at the first error; thus, 9,000 lines of code would need a complete re-compilation because an error had been found, and there would be no guarantee that further errors did not exist. Compiling a suite of programs was a lengthy business. A program was developed which would automatically compile a number of programs, and store the results in a file. This program could be left to run unattended and thus saved a great deal of time.

The basis of the program was fairly simple. The commands to the programming environment were input from a file instead of from the keyboard. This, in itself, required only the command

```
turbo < fred
```

The file *fred* may contain a sequence such as “nm diabetesocqc”. This would mean (n) do not load the error file, (m) load a main file, (diabetes) name of file to be loaded, (o) compiler options, (c) compile as a com file, (q) quit compiler options, (c) compile.

This would compile the single file but the environment would then ‘hang up’ as there would be no more data in file *fred* and keyboard input would be ignored. Putting further data into file *fred*, the obvious solution, generated other problems. The further data was read in immediately and this caused compilation to be suspended.

Solving this problem, still left the problem of loading the next file to be compiled. If the previous file compiled correctly, the next file could be loaded directly. If a mistake was found, the environment automatically loaded the appropriate file and entered the editor at the point where the error was found.

Once this problem was solved, the basic program was complete. The results were written to a file. Because of the nature of the program, the result file was enormous and contained much irrelevant data. A further program was written to extract only the relevant data⁶.

The system was run from a batch file. The program which created the input file could either read from the keyboard or from a suitably formatted text file. The program details were kept in a text file and the entire system could be compiled by calling the batch file and giving the name of the text file containing the information. The batch file contained the following:-

```
@echo off
turbobat          : program to create input file
if not exist check goto end : check that file has been
                        : properly created
del check
turbo < amy > fred : call Turbo environment
                        : to read from file, amy,
```

⁶An irritating problem here was that the number of lines which had been compiled for each program could not easily be extracted from the result file. Solving this could not be given a high priority, and so time was never found to investigate fully.

```

                                : and output to file, fred.

if exist fred sortfred      : program to sort the output file
:end
echo on

```

6.4 Screen Design

6.4.1 The consultation screen

The system was designed specifically for use during consultation. Thus screen design was very important. The main aims were to achieve clarity and uniformity.

The system was built around a menu driven and form filling model as has previously been described. This section describes, in detail, the consultation screen. This is the screen used in the presence of the patient, and around which discussion during consultation will be based.

In order that users would accustom themselves to the screen layout quickly, the consultation model was built around a single screen. Specific data groups appeared in specific sections of the screen and were separated from other data groups so that they could be distinguished easily.

The screen was divided into three parts. The largest section, in the middle of the screen, was for the clinical data. The top five lines of the screen were reserved for the registration data and the smallest section, the bottom two lines were used for help and warning messages. The three sections were separated by borders.

The registration screen This gives registration and administrative information. The middle line of the registration screen gives the patient's registration number, name, age and sex. Underneath this, is given their occupation.

Above this, and separated from it by a single blank line are the date of the patient's last visit, the date of the next booked appointment and the current date and time.

When a patient record is first accessed, this registration data is written to the screen and the user asked to confirm that the correct record has been chosen. Only after this confirmation is given, is medical data written.

This registration data remains on the screen throughout the consultation. The only registration data that the user is able to alter is the patient's occupation. The other data are entered via the general medical package.

The medical screen This occupies the middle sixteen lines of the screen. Not all data will fit into this space in full at the same time. However, the initial screen lists all data groups and all data fields, some only as headings.

If the user navigates the screen using only the Enter and Tab keys, or the shortcut keys for jumping to particular fields, all main fields will be accessed but not all sub-fields. This allows for faster screen traversal. To access all sub-fields requires use of function or arrow keys to expand the fields or access the less frequently used boxes.

There are twenty medical fields divided into four groups:-

1. Basic data – This occupies the top of the medical screen and stays on the screen in full throughout the consultation. There are four basic data fields; current treatment is a single box, weight is recorded in kilograms and grams and comprises two boxes, height is recorded in metres and centimetres and comprises two boxes and blood pressure also comprises two boxes, recording systolic and diastolic pressures.
2. Test results – These occupy the left side of the medical screen and are overwritten by expansion of other fields or opening of graph and help windows. There are six test result fields; urine and protein are each single boxes; blood sugar and glycosylated haemoglobin are recorded as real numbers and each comprise two boxes; MSU expands to six sub-fields – five text and one numeric and U&E expands to ten sub-fields, all numeric – four comprise single boxes and six double.

On the initial screen, the six tests are listed, one per line, under the test results heading. The MSU and U&E fields have an asterisk in their input boxes to signify that they may be expanded.

Each test has four other values associated with it – repeat interval, repeat due, test done and result due. The two of these that the user may access are repeat interval and test done. The user may specify a repeat interval in weeks. The system will then prompt, in repeat due, when a repeat test becomes due. Test done is used to signify that a sample has been sent for analysis but the results are not yet available. The system will prompt, in result due, that the result is expected. These boxes may be accessed for MSU and U&E without the fields being expanded.

Because these reminder boxes are not accessed regularly, the use of Enter and Tab to traverse the screen will miss them out – otherwise, navigating this part of the screen would become slow and tedious. They are accessed by using the left and right arrow keys.

The top of the test results group may be accessed from anywhere on the screen by use of the down arrow key.

3. New events – These occupy the bottom of the medical screen and are overwritten by expansion of other fields or opening of graph and help windows. There are four sub-fields; specific diagnosis comprises two free text boxes, hospitalisation comprises two dates, hypoglycaemia comprises a single free text box and therapy changes also comprises a single free text box.

The initial screen shows the new events heading and the first of the new events fields. The user may cycle through these using the Enter and Tab keys and the fields will appear one at a time under the new events heading. Alternatively, the group may be expanded. In this case, all four fields are shown in full, overwriting the test and other results.

If a user exits the first line of the specific diagnosis field without entering any data, it is assumed that they wish to skip the entire field. The second, or treatment, line may be accessed by using a function key.

4. Other tests – These occupy the right side of the medical screen and are overwritten by expansion of other fields or opening of graph and help windows. There are six sub-fields. Each must be expanded in order to input data. On the initial screen, the tests appear only as headings with asterisks in the input boxes.

The eyes field expands to three sub-fields, each a single free text line; the feet field expands to two sub-fields, each a free text line. The teeth, skin, reflexes and other symptoms fields each expand to two free text lines. For these last four fields, if the user exits the first line without entering any data, it is assumed they wish to skip the entire field.

The group expands in two sections – all the expanded data will not fit on the screen at once. Eyes and feet expand together to form the first section and the other four fields expand together to form the second. Moving forwards from an expanded first section will put the cursor into the first field of an expanded second section. Similarly, moving backwards out of an expanded second section will move into the last field of the expanded first section.

The top of the other results group may be accessed from anywhere on the screen by use of the up arrow key.

Other than moving between the expanded sections of the other tests group, moving out of an expanded field or group will always restore the initial screen.

The patient record may be closed or filed from any point on the screen. If the record is updated, the user is given the option of setting a next appointment date. Initially, the user gives either a number of weeks or a number of months. The system specifies a date which is nearest to that time interval and falling on the same day of the week. The user may confirm the suggested date or alter it.

The help and messages screen This part of the screen holds a summary of the information on active keys and warning messages, which can be seen in full on the associated help window. The set of active keys will vary as the user moves about the screen.

More detailed messages, for example the sequence for deleting patient records, are also written to this part of the screen.

The help and messages screen is separated from the medical screen above it by a border. This border remains throughout the consultation.

6.4.2 Graphical display

All chronological data can be graphed. The graph facility is accessed by use of the appropriate function key from the field for which the graph is required. The form of the graphs was described in the previous chapter.

The graph is written to a window which overwrites part of the medical screen. The registration screen remains unchanged, but only the basic data remains on the medical screen.

The graph is drawn in a box, with an appropriate heading. Dates of readings are given along the x-axis. In some cases, a scale is given on the y-axis; in others, the actual values are written on the graph.

The graph window holds nine readings. If more readings are available, the graph may be moved using the arrow keys. The initial position of the graph will mirror the data currently on the screen.

The “graphing” of text fields is simply a listing of the data in the graph window, with the appropriate date listed beside the data on the ‘y-axis’. It is a convenient means of reading through the data.

Closing the graph, done by pressing the Enter key, restores the medical screen to the state it was in prior to the graph being drawn.

6.4.3 The education package

It is intended that this will be accessed through the medical screen. It will probably be a separate heading under 'other tests' – with a shortcut key for direct access. From the user's point of view, accessing the education package will be akin to expanding part of the screen. It will, in fact, be a separate program.

A proposed form for the data has been described. The exact items to be recorded are still under discussion. The aim is to produce a comprehensive list in which points of particular interest are emphasised. Various options are possible. For example, the list could be re-ordered to put the items needing most attention to the top, or specific items could be highlighted.

The previous study demonstrated potential advantage in encouraging patients to read information from the computer screen. The vast majority would ask for more information about anything they did not fully understand. This could be particularly advantageous as regards education and compliance.

6.5 Interfacing with the General Medical Software

Interfacing of MINICLINIC with the general medical package was a balance between sufficient interaction to ensure consistency of data across systems and the minimum possible interaction to avoid compatibility problems with changes in the general medical package.

When a patient is first registered on MINICLINIC, the patient record is accessed on the general database. Information is extracted on the patient's name, date of birth and sex. This information is held in memory and will only be added to the MINICLINIC database if explicitly filed by the user.

When a patient is accessed from the MINICLINIC database, the corresponding record is read from the general database and the name, date of birth and sex compared. If the date of birth or sex do not match, the user is told that the patient has been removed from the general database and may not, therefore, be accessed by MINICLINIC. The user is given the option to remove the patient's record from the MINICLINIC database. The record is not removed automatically, in case the discrepancy is due to a mistake having been made on the general database⁷. However, the user will not be allowed to access the record while the discrepancy remains.

If the patient names do not match, the MINICLINIC will inform the user that the names do not match, and will update the name from the name on the general database. This update will only be done to the screen record in memory and will not be amended on the MINICLINIC database until the user explicitly files the record.

Compatibility problems will occur when the general medical package is updated. Because the interface has been kept to a minimum, the vast majority of updates – all but one – have caused no problems at all. The only compatibility problem occurred when the general package was rewritten in a different Pascal dialect. The data file structures were altered at the same time. The major problem was that integers in the new dialect were of a different length. In practice, the technical side of the problem was solved very quickly. The system itself

⁷Or a sex change operation – although this is not expected to be a problem while the scope of operation of the system remains in the industrial North of England!

could not be updated for a long time for non technical reasons⁸.

Sharing of data between systems is a problem which must be addressed. The type of interface described here is far from ideal and a more general approach to the whole problem is discussed in the final chapter.

6.6 Summary

The software system developed has proved its value in the test site practice and will continue to be developed. Probably more significant, in general terms, are the lessons learned about the development of miniclinic systems. These have been discussed in the previous chapter.

MINICLINIC has not only been useful as a general practice software system, but is also a useful research tool for research into software maintenance as well as medical software systems.

6.6.1 Future development

Because MINICLINIC has developed into a valuable medical system, resources are now being sought for further development; particularly to develop the system within a larger framework of comprehensive medical records, as discussed in the final chapter, and to develop further the idea of automated protocols and generic software for miniclinics.

On a smaller scale, plans are underway for a rewrite of the system into Ada or Modula. This would create more efficient software, greatly facilitate system enhancement and modification and provide an excellent vehicle for the study of software maintenance issues.

⁸The full story does not belong here, but continues the theme of 'Suppliers of software to the medical profession think they can get away with anything.'

Chapter 7

Summary and Conclusions

7.1 An Overview

The original aim of the study was to investigate the use of information technology in the NHS with a view to identifying means by which standards of health care could be improved. The scope of the project was general practice with particular emphasis on the care of chronic illness. Although, the investigations carried out did concentrate on specific areas, the inter-related nature of health services widened the scope of these investigations.

Computerisation can greatly increase efficiency by its effective use in an administrative and managerial role. This use of computers in the NHS is basically no different from such use in other fields. Effective computerisation of the organisational side depends upon a full understanding of how that organisation works. In the NHS, many management and administrative procedures have developed without being fully understood. However, the problems and solutions are well documented. Solutions to the problems exist and, what is required, is for the correct solutions to be applied across the NHS. Although NHS computing lags behind computerisation in other fields, many areas within the NHS are experiencing increased efficiency from the effective use of computers. In essence, the administrative and management side of NHS computing is 'coming together', despite the continued lack of any properly orchestrated planning.

An interesting aspect of computerisation, is the way in which information about NHS procedures is emerging. Audit and evaluation are becoming more accurate and very much easier. In the general practice environment, this has meant being able to produce far more accurate pictures of the work being carried out. Practices who did not have the staff to carry out detailed manual audit reported dramatic increases in income as a result of computerisation. Analysis of clinical data allows for evaluation of medical protocols. For example, the analysis of glycosylated haemoglobin results in a diabetic clinic or the pattern of weight loss in a diet clinic. The basis upon which clinical procedures and protocols are developed is becoming a less subjective process.

Finance has played a large part in holding back computerisation in many areas, particularly on the clinical side. In very many areas it has been impossible to predict cost saving or advantage in terms of health care until a system is in use and can produce the results to allow accurate audit.

The neglected side of NHS computing is the clinical. In many cases, the need has been seen for computerisation and systems have been developed. Without central organisation, this has resulted in the development of many isolated systems. Many of these systems are very good at doing the job for which they were

developed. The problems lie in their isolation. Systems which are good in some respects and bad in others often needed only a sharing of experience and expertise to overcome their worst problems. Isolated development is a more costly business than it need be because of the elements of 're-inventing the wheel' and 're-finding the pitfalls'.

Health care systems cover a very wide range of data, procedures and disciplines. Computerised systems across the health service will, therefore, be very different. It is essential that they *are* very different in order to do the tasks for which they have been developed. However, the provision of the best in health care relies a great deal upon interaction between different areas of the health service. Thus, to use information technology to the full, information systems must interact as well.

There have been moves towards defining minimum data sets within certain clinical areas. This would help towards standardising systems within a particular discipline, but not towards facilitating communication across disciplines. This study suggests that a more fruitful move would be towards creating a comprehensive clinical base to encompass all disciplines and upon which clinical systems could be built.

The need for flexibility in clinical systems is paramount. Because of the nature of health care there is no such thing as a *best* system – only a best system to suit a particular task in a particular area. The production of *best* systems requires a complete understanding and specification of the area to be computerised. People's medical problems will not fit to computer models the way their tax problems will. The reason being that such things as income tax can be fully specified and understood. We are still a long way from a full understanding of what makes the human being tick.

A comprehensive base, therefore, would be a definition of all that any information system would need to store to encompass all clinical areas of health care. A particular area, or discipline, would only require a small proportion of this base. The base would impose no structure upon clinical procedures and no restrictions upon how data was used. It would allow for complete flexibility in the development of systems. What it would provide would be a common base across which any system could interact with any other. It would be a means by which new systems could be developed with an inbuilt ability to communicate with other systems and also an interface through which existing systems could communicate. It would provide an underlying link without imposing restrictions upon the way in which systems operate.

This is simply an overview of a solution to one of the largest problems in health care computing. There are very many important issues, such as confidentiality and data transfer security, which would need to be addressed if this idea was to be explored further. Many of the problems would be technical ones to which technical solutions already exist. The underlying idea – the comprehensive clinical base for information systems – would need to be tackled by the medical community at a national or international level.

7.2 In a Nutshell . . .

- There is evidence that the care of chronic illness may be improved by effective computerisation.
- The computerisation of clinical procedures cannot effectively be tackled in the same way as the computerisation of administrative procedures.

- Much valuable information is lost between incompatible information systems, to the detriment of health care.
- The potential for improved health care through computerisation is far from realised.

7.3 The Catch 22

The effective computerisation of health care relies, amongst other things, upon a full understanding of health care organisation. The best way to understand health care organisation is by effective computerisation.

Appendix A

Patient questionnaires

The questionnaires were structured into four sections:-

Section 1 The purpose of this section was to provide a means of re-identifying the patient groups should a follow up survey ever be carried out. It asked for the patient's name and identified the questionnaire by number. When the questionnaires were returned, this section was removed and stored separately from the main questionnaire because it contained information which identified individual patients. This information was not stored electronically.

Section 2 This section also identified the questionnaire by number and asked for the patient's date of birth and the length of time they had been attending this surgery. This information was used to classify the results according to age.

Section 3 This section asked specific questions about the computer system. As the patients' experience of the system depended upon how and where it was used within the practice, the questions in this section varied according to whether or not the computer was used during consultation.

If the computer was not used during consultation, the following questions were asked:-

1. This surgery uses a computer to help with various tasks; for example, to store medical records and print repeat prescriptions. Tick one box which most closely describes your opinion of the computer system:-
 - The computer system has had a good effect upon the surgery.
 - The computer system has had a bad effect upon the surgery.
 - The computer system has made no difference to the surgery.
 - I was not aware that the surgery used a computer.
2. If the doctor used a computer during consultation, do you feel that this would:-
 - Make it easier for you to discuss your condition with the doctor.
 - Make it harder for you to discuss your condition with the doctor.
 - Make no difference.
3. Would you like to be able to see the information which is recorded about you on the computer?

4. If yes, would you particularly like to see information about your own condition on the computer screen while you were with the doctor or nurse?

If the computer was used during consultation, the following questions were asked:-

1. When you are with the doctor or nurse, do you feel that the computer plays a large part in the proceedings?
2. If yes, tick the box or boxes which most closely describe the way in which the computer is used:-
 - Information on the screen is talked about.
 - The computer is asked for information e.g. previous test results.
 - The doctor puts information onto the computer e.g. results of tests.
 - Other
3. What information do you see on the computer screen?
 - Information about yourself.
 - Information about other patients.
 - None.
 - Other
4. Do you (or would you) like to be able to see information about your own condition on the computer screen?
5. Have you ever learned anything about your treatment or condition from information you have seen on the screen?
6. If yes, is this information that you would not otherwise have known?
7. Does the computer screen show information in different ways e.g. in the form of graphs?
8. Does this make (or do you feel that this would make) :-
 - Information easier to understand.
 - Information harder to understand.
 - No difference.

The computer system under investigation did not, in fact, show information in the form of graphs. However, there were a number of different screen displays which patients would see depending upon the way in which the doctor was using the system.

The results from this question were used as a simple measure of the correlation between the system itself and the patients' perception of it.

Section 4 This section asked for the patients response to three hypothetical situations.

A computer can give "advice" and information in various ways. For each of the following situations, please tick the one box which most closely describes your probable reaction to the situation.

Three messages were given and the questionnaire asked for a choice between a range of responses should such a message appear on the computer screen.

As the system itself was not designed to give advice in this way, none of these messages would have actually been seen by the patients.

The messages could be loosely defined as 'polite message', 'rude message' and 'informative message'.

Example messages

polite message – 'Your diet should contain less sugar.'

rude message – 'STOP SMOKING!'

informative message – 'High blood pressure.'

For the first two, the patient was asked to choose between five alternative responses; the extremes being that they would definitely follow the given advice and that they would definitely not follow the given advice.

For each of these two messages, the patient was also asked to assess how their response would differ if the advice had come from the doctor or nurse. Here there were three choices of response:-

1. They would be more likely to follow the advice.
2. They would be less likely to follow the advice.
3. It would make no difference.

For the informative message, the patient was asked to choose between three alternatives.

1. They would ask the doctor or nurse about it.
2. They would take mental note of it but not ask.
3. They would ignore it.

Appendix B

A summary of the results

The computer IS used during consultation

1. What difference has the computer made to the surgery?

Answer	Total	Under 40	40 – 65	Over 65
Great improvement	41%	47%	46%	30%
Some improvement	28%	25%	27%	32%
No difference	12%	3%	16%	15%
Some loss of standards	1%	0%	0%	2%
Great loss of standards	1%	0%	0%	2%
No response	17%	25%	11%	19%

2. Does the computer play a large part in the proceedings when you are with the doctor or nurse?

Answer	Total	Under 40	40 – 65	Over 65
Yes	55%	62%	56%	47%
No	39%	38%	40%	40%
No response	6%	0%	4%	13%

3. How is information on the computer used during consultation?

Answer	Total	Under 40	40 – 65	Over 65
Discussed	14%	19%	10%	17%
Asked for	28%	24%	32%	26%
Entered	17%	22%	14%	17%
Other	3%	3%	3%	3%
No response	38%	32%	41%	37%

4. What information do you see on the computer screen when you are with the doctor or nurse?

Answer	Total	Under 40	40 – 65	Over 65
About yourself	55%	70%	56%	38%
About others	0%			
None	27%	22%	26%	35%
Other	3%	0%	4%	5%
No response	15%	8%	14%	22%

5. Would you like (do you like) to be able to see information about yourself on the screen?

Answer	Total	Under 40	40 – 65	Over 65
Yes	75%	86%	79%	58%
No	16%	11%	11%	27%
No response	9%	3%	10%	15%

6. Have you ever learned anything about your condition or treatment from information on the screen?

Answer	Total	Under 40	40 – 65	Over 65
Yes	8%	8%	11%	3%
No	81%	84%	80%	80%
No response	11%	8%	9%	17%

7. Have you ever learned anything from the computer screen that you would not otherwise have known?

Answer	Total	Under 40	40 – 65	Over 65
Yes	3%	3%	1%	5%
No	9%	5%	13%	7%
No response	88%	92%	86%	88%

8. Does the computer screen show the information in different forms (eg graphs)?

Answer	Total	Under 40	40 – 65	Over 65
Yes	17%	19%	19%	13%
No	43%	57%	40%	35%
No response	40%	24%	41%	52%

9. If information was presented in different forms, would you find it easier or harder to understand?

Answer	Total	Under 40	40 – 65	Over 65
Easier	40%	49%	42%	30%
Harder	6%	3%	4%	10%
No difference	25%	24%	23%	30%
No response	29%	24%	31%	30%

The computer is NOT used during consultation

1. This surgery uses a computer for various tasks ... What is your opinion of the computer system?

Answer	Total	Under 40	40 – 65	Over 65
Good effect overall	49%	47%	56%	45%
Bad effect overall	0%			
No difference	10%	26%	5%	10%
Didn't know about it	41%	27%	39%	45%
No response	0%			

2. If the doctor used the computer during consultation, do you feel that this would make it easier or harder to discuss your condition?

Answer	Total	Under 40	40 – 65	Over 65
Easier	34%	13%	38%	45%
Harder	8%	13%	5%	9%
No difference	52%	67%	52%	37%
No response	6%	7%	5%	9%

3. Would you like to be able to see the information which is recorded about you on the computer?

Answer	Total	Under 40	40 – 65	Over 65
Yes	89%	93%	89%	81%
No	11%	7%	11%	19%
No response	0%			

4. Would you particularly like to see information about your condition while you are with the doctor or nurse?

Answer	Total	Under 40	40 – 65	Over 65
Yes	87%	93%	85%	73%
No	10%	7%	8%	27%
No response	3%	0%	7%	0%

Responses to computer given 'advice'

- “Polite message” - Would you follow this advice?

Answer	Total	Under 40	40 – 65	Over 65
Definitely	56%	31%	68%	56%
Probably	35%	63%	27%	25%
Ignore	3%	2%	2%	6%
Probably not	1%	0%	1%	0%
Definitely not	1%	2%	0%	0%
No response	4%	2%	2%	13%

- Would you be more or less likely to follow this advice if it was given by a doctor or nurse?

Answer	Total	Under 40	40 – 65	Over 65
More likely	52%	47%	51%	60%
Less likely	1%	0%	1%	0%
No difference	42%	51%	45%	27%
No response	5%	2%	3%	13%

- “Rude message” - Would you follow this advice?

Answer	Total	Under 40	40 – 65	Over 65
Definitely	45%	43%	45%	46%
Probably	34%	39%	37%	21%
Ignore	6%	8%	5%	4%
Probably not	1%	0%	2%	2%
Definitely not	1%	2%	2%	0%
No response	13%	8%	9%	27%

- Would you be more or less likely to follow this advice if it was given by a doctor or nurse?

Answer	Total	Under 40	40 – 65	Over 65
More likely	51%	47%	52%	50%
Less likely	1%	0%	3%	0%
No difference	37%	45%	38%	29%
No response	11%	8%	7%	21%

- “Informative message” - How would you react?

Answer	Total	Under 40	40 – 65	Over 65
Ask	90%	96%	88%	88%
Take note	6%	4%	8%	2%
Ignore	1%	0%	1%	2%
No response	3%	0%	3%	8%

Appendix C

The World Health Organisation Criteria for the Diagnosis of Diabetes Mellitus

If symptoms, such as severe thirst, increased urine and glycosuria and rapid weight loss, are present then diagnosis is confirmed either by random plasma glucose concentrations greater than 11 mmol per litre, or by the presence of specific macrovascular disease, usually retinopathy.

In the absence of such symptoms, measurements of plasma glucose made under standard conditions may be necessary. A fasting value of 8 mmol per litre or greater is diagnostic. A random value of less than 8 mmol per litre and fasting levels less than 6 mmol per litre exclude the diagnosis.

For doubtful results, the oral glucose tolerance test may be used. A value of 11 mmol per litre two hours after the glucose load would be considered abnormal.

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