A COMPUTERISED OUT-PATIENT MEDICAL RECORDS PROGRAMME BASED ON THE SUMMARY TIME-ORIENTED RECORD (STOR) SYSTEM

P Y Cheong, L G Goh, R Ong, P K Wong

ABSTRACT

Advances in microcomputer hardware and software technology have made computerised outpatient medical records practical. We have developed a programme based on the Summary Time-Oriented Record (STOR) system which complements existing paper-based record keeping. The elements of the Problem Oriented Medical Record (POMR) System are displayed in two windows within one screen, namely, the SOAP (Subjective information, Objective information, Assessments and Plans) elements in the Reason For Encounter (RFE) window and the problem list with outcomes in the Problem List (PL) window. Context sensitive child windows display details of plans of management in the RFE window and clinical notes in the PL window. The benefits of such innovations to clinical decision making and practice based research and its medico-legal implications are discussed.

Keywords: Medical records, computerised, Summary Time-Oriented Record, Problem Oriented Medical Record, windows, pick-lists

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INTRODUCTION

Microcomputer systems are increasingly used in clinics for administration and practice management. Its use in medical record keeping however has not been widely adopted[1]. In the United States, Woodlander and Himmelstein noted that the problems posed by paper-based records were contributing to their nation's costs of healthcare delivery[2]. The Institute of Medicine of The Academy of Sciences, United States saw the emerging capabilities and widespread implementation of computerised medical records (CMR) as a solution to control costs[3]. The lack of awareness by physicians of the recent exponential increase in power of microcomputer systems, their perception that CMR will necessarily impose a total change to a paperless system, as well as their fear that data entry and retrieval in the consulting room would interfere with the consulting process help to explain the relative lack of interest in the use of computers for medical records (MR) keeping. Until recently, the cost of hardware and the lack of appropriately designed software also contributed to the slow adoption of CMR systems.

The development of a CMR system that complements (but does not replace) the detailed traditional paper-based records, is prudent and more likely to be accepted at this juncture compared to a completely paperless MR system. One way of achieving this is to use a computerised Summary Time-Oriented Record (STOR) System. Such a system was described in 1985 by Whiting-O'Keefe et al who found that STOR provided more information than the traditional paper-based MR[4]. Our strategy was to integrate the strengths of the Problem Oriented Medical Record (POMR) pioneered by Weed in 1968[5] with the STOR concept as the basis of our design. This paper describes the development of a STOR programme, discusses its benefits to clinical decision making and practice-based research[6]. It also highlights the medico-legal implications of information capture, storage, validity and security in CMR systems[7].

MATERIALS AND METHODS

The computerised outpatient STOR programme to be described is a module that is integrated into an existing clinic practice management programme, the Clinic Practice Manager (CPM). The STOR module, like the CPM is written in Clipper 5.0, an XBASE database language for DOS-based micro-computers. It can run as a stand-alone programme under DOS or in a Local Area Network (LAN) such as Novell Netware.

In developing the STOR module, we defined five requirements that the module should meet, namely:

1. horizontal integration with an existing clinic management system to achieve a 'critical mass of capabilities' to ensure its acceptance by physicians and clinic staff[8];
2. an easy access by a single keystroke into the STOR screen from other points-of-care in the CPM without having to navigate through a maze of menus;
3. the display of key clinical information that is important for decision making by applying the concepts of the Problem Oriented Medical Record (POMR) system;
4. the exploitation of user-interface techniques that facilitate data entry and retrieval, namely, window display and pick-lists; and
5. the use of a time-oriented MR system to provide a 'longitudinal, continuing record'[3].

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RESULTS

The five requirements of the STOR module were all met. The salient features of the STOR module are described around the five requirements.

1. Horizontal Integration into an Existing Clinic Management System

The STOR module integrates horizontally with the CPM which has comprehensive functions of patient registration, appointment scheduling, automated generation of medical certificates and letters, dispensing and inventory keeping, accounting capabilities as well as 'pop-up' productivity tools. The integration of the STOR module into the existing clinic management programme, used in managing the daily operations of the clinics, extends the usefulness of the existing software and facilitates the acceptance of CMR.

2. Single Keystroke Access to the STOR Module

The CPM is designed around the queue manager. This is a display of current patients in the clinic waiting to see the physician. A patient is listed in the queue on registration when he presents at the clinic.(Fig 1). The time of registration and the times of beginning of subsequent events of consultation, dispensing and payment are all recorded. These timed events provide a management overview of the patients' movements through the various points-of-care in the clinic.

By highlighting the patient's name in this queue screen and hitting a single key (the letter <N> for notes or the function key <F8>), the STOR screen pops up immediately (Fig 2). Previously registered patients not in the clinic (and therefore not in the queue screen) can be accessed through the main menu by keying in their names or unique registration numbers in the Notes module.

3. Overview Display of Key Clinical Information

The design of the STOR screen provides an overview of key items of information necessary for patient management (Fig 2). These consist of:

- a display of patient's biodata: the patient's name, sex, age and allergies are displayed in two lines at the top of the STOR screen.
- a Reason For Encounter (RFE) window in the top two-thirds of the remaining space of the screen. The RFE window is divided into three columns, one each for the date, the RFE and Remarks (if any). A date context sensitive child window drops down from the Remarks display to show items like medicines, laboratory tests, etc which were entered in the dispensing module. The RFE screen captures the "SOAP" components (Subjective information, Objective information, Assessment and Plans of a patient encounter) of the POMR. The subjective, objective keywords are recorded in the RFE column and the assessment and plans under the Remarks column.
- a Problem List window in the bottom one-third of the screen. This is similarly divided into three columns for recording the date, problem list and outcome; more than one clinical problem can be entered. A context sensitive child window explodes above this Problem List window as each problem is highlighted on moving the cursor (Fig 3). This child window allows free-form text entry of information related to each problem.

The child windows of the RFE and Problem List windows can be optionally deactivated to allow unhindered display of all the keyword fields.

For children, the availability of an up-to-date record of all immunisations given is useful for decision making on what other immunisations need to be given. The necessary information is stored electronically in a separate file on immunisations. Similarly, for adults there may be a need for keeping a record of immunisations given, particularly in relation to occupations like food catering, construction and travel. This facility is available from the medical certificates module accessed through the main menu of CPM.

4. User Friendly Interface

A user friendly interface has to be developed for data entry using the keyboard. This is achieved by:

- automatic insertion of present date when adding entries; and
- activating pop-up windows of pick-list of keywords

Fig 1 - A patient is listed in the queue on registration

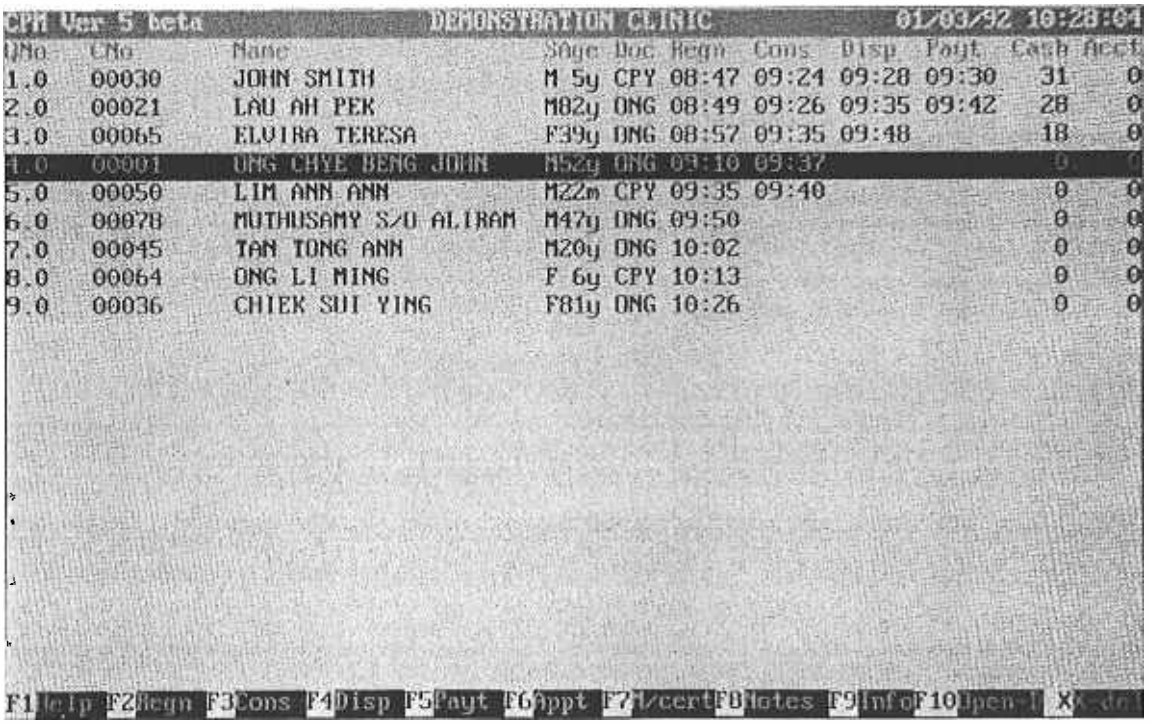


Fig 2 - The Summary Time-Oriented Record screen with the highlight on 14/12/91 and the child window showing the medications given.

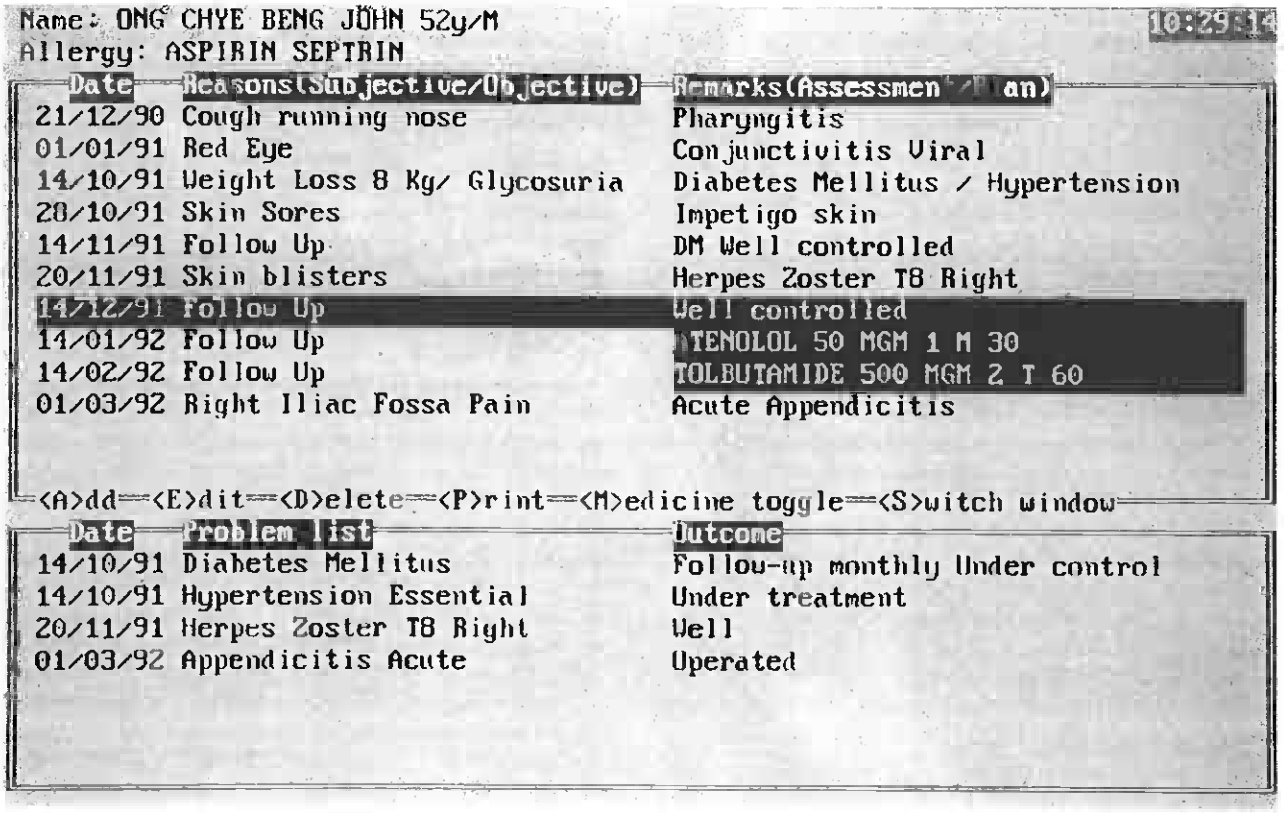
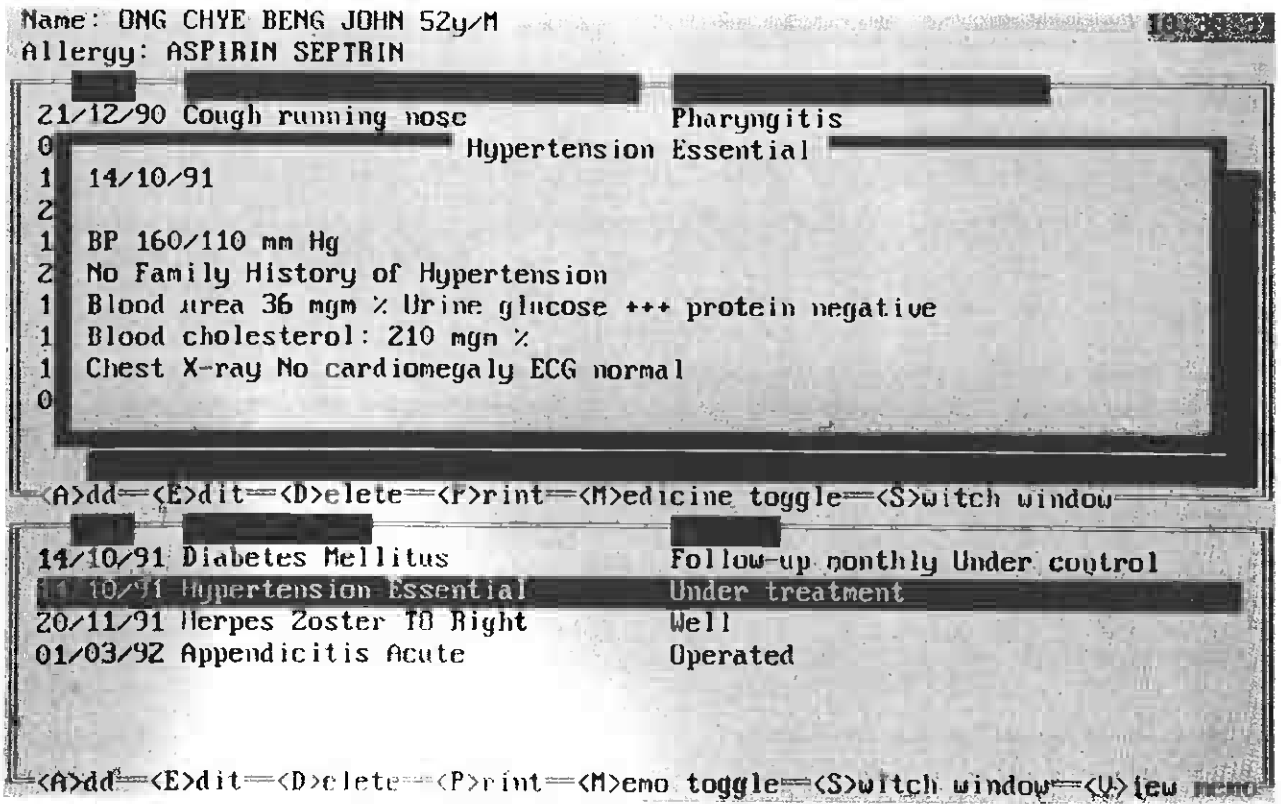


Fig 3- A context sensitive child window above the Problem List Window showing free text entry on a visit for hypertension



when the function key <F2> is pressed when in the respective data field. Keywords are labels used to describe the reasons of encounter, remarks, problems and outcomes relating to the consultation. The pick-list that pops up is context sensitive to the data field that the user is in. The required item can be selected by moving the highlight with the arrow keys or hitting the first letter of the item. If more than one items begin with the same letter, then hitting the same letter repeatedly moves the highlight around the group. Hitting the enter key inputs the keyword(s) into the data field (Fig 4).

The four pick-lists of keywords are user definable under the Notes Module accessed through the main menu of CPM. When in this module, the user can enter new keywords and the associated numeric codes. The associated numeric codes are transparent to the user when the keywords are accessed. They are nevertheless stored and can be retrieved for audit and research analyses. The use of codes in this context has been well described by Bishop[9].

Data retrieval is also easy. Pressing the <S> key from the STOR screen switches the cursor between the RFE and the Problem List screen with options therefore of displaying their respective context sensitive child windows viz items dispensed for RFE and the free-text window for the problem list. The information in both the windows can be printed on paper and filed for reference or included as part of medical correspondence.

5. Time-Oriented Record System

Since very little typing is involved, the physician can enter the information himself immediately after the consultation if he has a computer workstation in his consultation room. Alternatively, the keywords written by the physician in traditional paper-based records can be keyed in by the nurses or clinic clerks when medicine or payment details are keyed in. As the information is all automatically dated and displayed chronologically, it provides in one screen a quick clinical overview of the patient which is available at any time. Since the key information are recorded in structured database fields, the data can be displayed in various formats, be used for clinical decision making such as physician authored reminder systems[10,11], for practice-based research and for medical audit.

Hitherto, we have described how historic information from patients can be stored and retrieved rapidly to aid clinical decision making. Clinical decision making also depends on clinical knowledge. The STOR module we have developed has two enhancements that allow for the capture, storage and retrieval of clinical knowledge. They are:

i. The electronic link with an information manager module that is accessed from the main menu. This allows for rapid entry and retrieval of patient education materials, diagnostic and treatment guidelines (Fig 5).

ii. A single keystroke <alternate-F10> access from any part of the CPM brings the user out of the programme (the so-called exit gateway). On exit, one can run programmes used for clinical decision making and remote access communication (such as PCAnywhere) to access Medline for literature search. One is able to get back to the clinic management programme when one has completed the tasks outside the CPM, to where one has left CPM on exit through the gateway.

iii. A fringe benefit of the gateway is to allow the physician to send information on immunisations and notifications effortlessly to Health Authorities through modem link. A protocol can be written for the despatch of such notifications electronically and automatically at a pre-determined time each day freeing the physician or his staff from having to remember to send the notifications.

DISCUSSION

In decision making, the physician draws upon both clinical knowledge and specific information regarding the patient. The patient information includes current information obtained directly from the patient, as well as historical information derived largely from the medical record (MR)[12].

The MR as a source of information is a subject of considerable interest. One key concern is how to store it, such that it can be retrieved when required, to help in clinical decision making. The frustration encountered with missing paper-based records or when information is lost amongst heaps of papers underscores the important contributions that the MR makes to clinical decision making. The MR assumes its maximum usefulness in chronic medical problems and complicated cases where decisions on investigations, choice of treatment, and posology depend on past experience. On the other hand, records of minor infections and self-limiting problems are not so important once these are resolved. The interest in them is only while they are not resolved or for historical assessment. Of course, what appears as minor problems may collectively assume some importance with the passage of time. For example, the number of episodes of tonsillitis (with consequent incapacity) in a year will tip the decision whether tonsillectomy is indicated.

Since pieces of medical information may have different values for clinical decision, data capture in a flexible MR keeping system is necessary. One way of achieving this is to have discrete electronic files for different parts of the MR. A system that has the MR in a single electronic file can only provide a rigid framework for data entry. It will result in large empty spaces and make wading through such spaces tedious. The STOR module described in this paper captures the data items of date of visit, reasons for encounter and remarks in one electronic file. Such information may be all that is required to document a visit permanently. The medicines prescribed and laboratory tests ordered are captured in a separate file and tagged to the Reason For Encounter (RFE) file so that as each entry in the RFE window is highlighted, the items in the treatment plan will show up in the child window.

Some visits may be for problems that are of importance for clinical decision making, either immediately or at a later date. Examples are injuries resulting from accidents, assaults or self-injury. Detailed clinical notes need to be kept as such conditions are potentially of medico-legal importance. Similarly, medical conditions like diabetes mellitus and hypertension deserve a place in the problem list and clinical details on follow-up parameters like blood sugar levels, investigations and notes on complications need to be kept. Space for entering the clinical details is provided for in a separate memo text file and tagged to the problem list file. Tagging the memo text to each problem in the Problem List allows the memo text window to pop up as each problem is highlighted as the cursor runs down the list.

The STOR module that has been developed allows the user to bring to the same screen the important items of information for decision making. The value of the module lies in the ability of the information to change as the items are highlighted, and all in one screen. This is akin to flipping through a paper-based MR.

There is no doubt there are potential benefits to be derived from CMR systems[13]. Thus, the computer can help (a) to solve logistic difficulties of finding, organising, and reporting patient information that occur with paper-based systems, (b) to identify clinical events that need attention, including cancer surveillance, and (c) to analyse accumulated information to guide management decisions on future policies and practices. The advances in screen display capabilities of windowing and pick-lists offer solutions to the problems of having to wade

Fig 4- A pick-list on reasons for encounter activated by pressing <F2> while the cursor is on the reasons for encounter field.

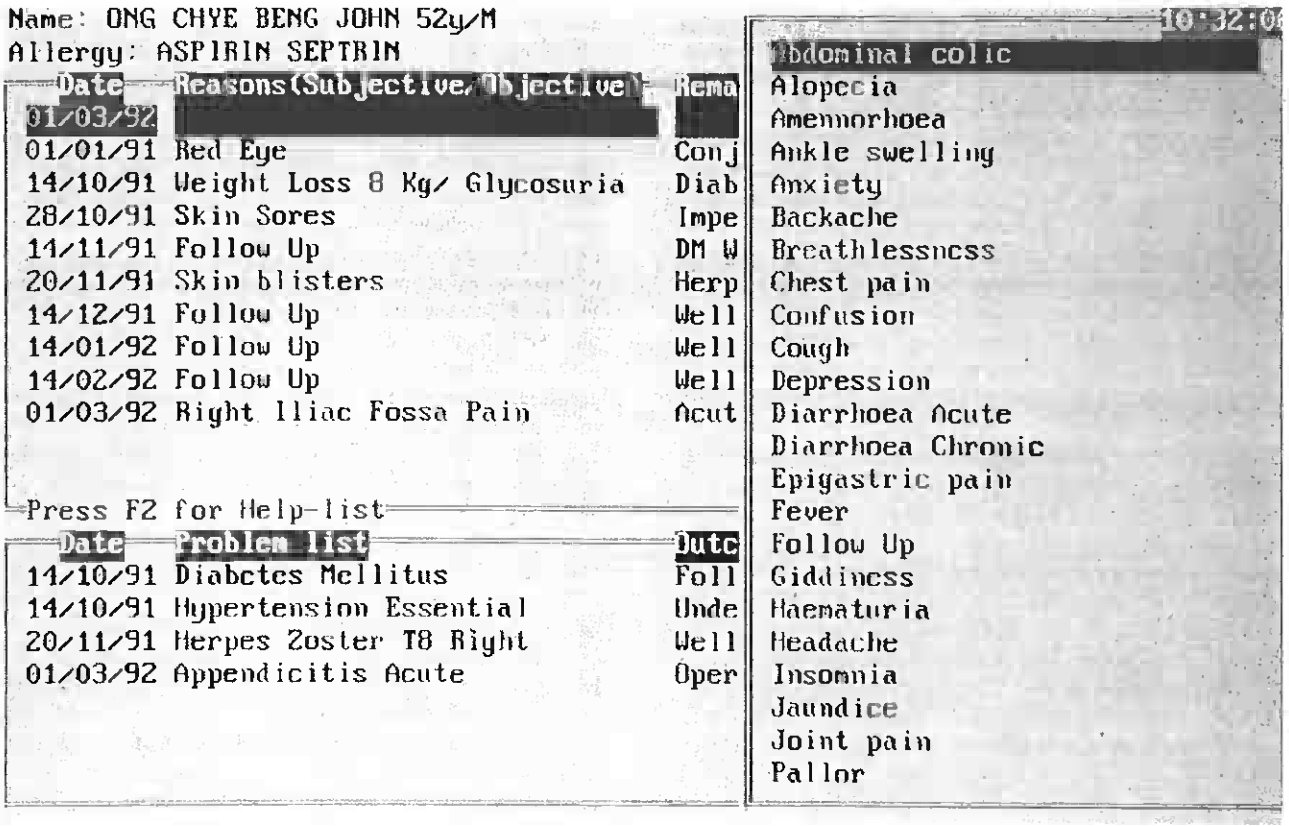
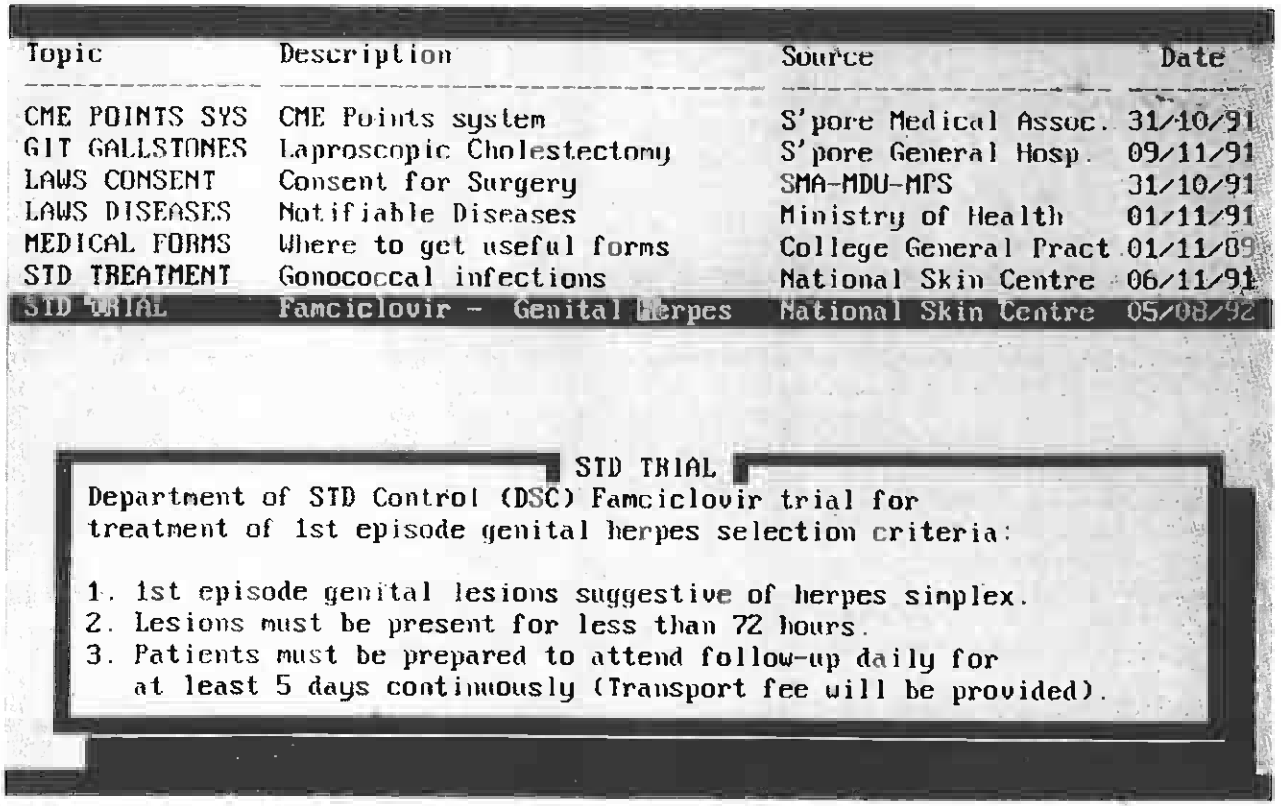


Fig 5 - The child window at the bottom $^{1}/_{3}$ screen displays abstract of the topic highlighted.



through screenfuls of data reminiscent of older CMR systems. The availability of high capacity and fast harddisks have removed two limitations of CMR keeping on the micro-computer: firstly, the limitation of response time is no longer a problem. It has been observed that the response time of any on-line enquiry should not exceed 2 seconds[14]. With the advent of microcomputer chips like the Intel 80486 and data programming languages like Clipper 5.0, such response times are possible. Secondly, the huge volumes of data that need to be stored can now be easily accommodated on local micro-computer harddisks which usually have capacities of between 80 to 200 megabytes. On the basis that a clinic could have a base of 10,000 patients with 3 problems each, who may make 4 visits each per year and require 3 items to be dispensed during each visit, we estimate that a CMR based on the system described would occupy only 77 megabytes of harddisk space over 10 years.

The technical aspects of pick-lists deserve comment. They allow the selection and keying in of items of information required with minimum keystrokes instead of having to type in the whole phrase or diagnostic label or remark. The pick-list items can also be linked transparently to medical classification codes such as International Classification of Health Problems in Primary Care (ICHPPC), International Classification of Diseases (ICD) or even the Read Codes and be stored as such[9].

A major spin-off of the computerised STOR is that the data elements are analysable because they are stored in database format. Captured transparently therefore is a huge database of practice-based information that can be subjected to quantitative research methods. Herein lies a huge resource for research without having to actively collect data.

Another area that deserves discussion is the use of computer programmes to support clinical decision making. Conceptually, a decision-support system is any computer program designed to help healthcare professionals make clinical decisions. Shortliffe[15] describes three types of decision-support functions, ranging from generic to patient specific: (a) tools for information management, such as Medline; (b) tools for focussing attention, such as clinical laboratory systems that flag abnormal values or that provide lists of possible explanations for those abnormalities and systems that alert providers to possible drug interactions or that give reminders for preventive medicine work; and (c) tools for patient-specific consultation, such as Internist-1[16] and its successor QMR[17] which attempt to suggest a single best explanation for a patient's symptoms; still others are oriented toward providing therapy advice rather than diagnostic assistance. Such functions are now available in microcomputer programmes that can be easily integrated with our system through the exit gateway described above.

In the implementation of CMR, the medico-legal implications of information capture, storage, validity and security must be addressed[18,19]. As for information capture, Borst et al [20] have shown that it is feasible for the physician to key in detailed notes during the encounter to achieve a paperless MR system. The STOR system we described however aims to capture only summary data to complement the existing paper-based records. The physician with a computer workstation in his consultation office can refer to the STOR screen at every encounter for an overview of the patient's medical records, key in the summary data himself using the friendly interface described and optionally print the information so captured on paper stickers for pasting onto the paper-based record (if he chooses not to write the same information on paper). This should not take much time once the physician is familiar with the system. Alternatively, the summary information written by the physician as keywords on paper can be keyed in during or soon after the encounter by the clinic staff during dispensing or payment collection. The detailed medical records are still maintained on paper and hence medico-legal questions should not arise.

Though there are many benefits of storing medical records electronically, questions are often posed as to their validity for medico-legal purposes as electronic data can be altered without leaving any trace. The technology of ensuring data integrity is available[7]. These involve authentication of sources of information, security measures to police utility and maintain audit trails through hardware devices like Write-Once-Read-Many (WORM) optical disks or through third party custodian of the captured information. The onerous responsibility of keeping paper-based records for lengthy periods for medico-legal purpose[21] (8 years after the last patient encounter for most patients, 20 years for obstetric patients, for the period until paediatric patients reached the age of 25 and indefinitely for potential medico-legal cases) makes electronic storage of data attractive as the storage devices are compact and the information easily archived. Despite the fact that technology can now ensure data integrity, legislations and legal precedence in most countries still do not permit the use of CMR in medico-legal situations. In Canada though, the state of Ontario has recently (1990) passed legislations to permit medical documents like birth certificates to be stored as computerised data in optical disks and has deemed as admissable evidence in court, the hard-copy reproduction from these data to be equivalent to the original documents[7]. With widespread implementation of CMR and the development of better computer security systems, legislations could be revised and legal principles established to make CMR acceptable for medico-legal purposes.

While awaiting clarification of the legal status, some physician groups have defined minimum standards on data security and protection[22]. Unlike paper-based records where physical custody of the documents enable access to the information to be controlled, computerised data can be easily copied, transmitted and presented in many ways and hence pose problems of data security and privacy. The flexible ways of data manipulation and use however also enable public health authorities, policy makers and medical researchers to use the information for public interest in ways not possible with paper-based MR. Systems are now being developed to accommodate public interest and at the same time protect patients' confidentiality. One such system use 'Smart Cards' or unique 'Personal Identification Numbers' (PIN) with data encryption technology to achieve this[23]. These systems have to be in place before healthcare providers can store and share information in central health database like that of MediNet, a nation-wide computer network set up for healthcare providers in Singapore.

What has been achieved is only the beginning. Flat screen technology and pen-based computing interfaces now available will make the present computer programme even more intuitive[13]. The consultation room is the last area for the benefits of the computer to be realised. The slow migration to CMR keeping and the use of the computer in the consultation room may well accelerate in the coming years with innovations such as those described in this paper.

Computerising medical records is not an end in itself and not the only way to improve clinical decision making. As Stanley[24] has pointed out in 1991, a properly managed paper-based record system may serve present needs. However, CMR despite present limitations, is more than efficient record keeping. It opens up a whole vista of clinical decision-support systems, research and communication capabilities.

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