Do you have any pain or stiffness in the joints ?	YES/NO
Do you have any skin trouble ?	YES/NO
Do you have any difficulty in getting off to sleep at night ?	YES/NO
Do you wake up early before you have to get up ?	YES/NO

FOR WOMEN ONLY

How many pregnancies have you had ?	
-------------------------------------	-------

If you have had children:	
Did you have any complications during your pregnancy ?	YES/NO
Have you still got your periods ?	YES/NO
If so: How frequently do your periods come on ?	Every.....days
Are your periods regular ?	YES/NO
How long does each period last ?	days
Do you take, or have you taken the contraceptive pill ?	YES/NO

Computers in Medicine

Computer-based Hypertension Clinic Records: A Co-operative Study

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Summary

A computer-based medical record system has been developed to help with research into hypertension and the management of patients with hypertension. Standard medical records are replaced by data collection forms and case notes printed by the computer. A computer-generated document for recording information at follow-up visits contains an up-to-date summary of the important clinical features with warnings of risk factors. A blood-pressure graph and a letter for the general practitioner are produced on request. The system has been used in three clinics for two years and is being tested in general practice. Information on 900 newly-referred patients has been recorded and at present data on 30 to 40 new patients and 160 follow-up visits are added each month.

Introduction

Special clinics have been set up in several centres for the care of hypertensive patients since the introduction in 1950-1 of effective drug treatment for hypertension. Though a few

studies have been made of patients attending hypertension clinics, research and management have suffered from inadequate standard clinical records.

We have developed a new computer-based records system to aid research and management of patients with hypertension by providing an accurate, detailed, and readily retrievable set of "longitudinal" data. The committee responsible was composed of physicians from three hospitals, a medically qualified computer scientist, and two programmers with paramedical training. Preliminary accounts of this work have been given.^{1,2}

Outline of System

At the patient's first visit the clinician records his findings on a special input form (the initial input form) and not in standard case notes. Nevertheless, the form contains a history, details of the examination and investigation, and a decision about treatment and long-term supervision. At the computer centre a case note is printed and returned to the clinic; a subset of data is stored on magnetic tape; a follow-up input form is printed for the doctor; and a blood-pressure graph is printed (fig. 1).

After the patient's next visit the completed follow-up input form is returned to the computer centre where the data are added to the computer file, the clinical case note is brought up to date, and a further follow-up input form is produced together with a new blood-pressure graph and a letter to the general practitioner. The case note printings form the clinical case record.

Method of Recording Data

Information is recorded on the input forms in English in coded boxes, or by encircling code numbers, or by entering simple standard codes. Codes distinguish between a negative observation and one that is missing. When the information is in numerical form—for example, the blood-pressure reading—the number can be written in the appropriate place. But symptoms, diagnoses, and drug names are written and the computer converts them into a numerical code using a dictionary against which it compares the plain language entry.

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FIG. 1—Flow diagram of data through systems. Patient master file is held on magnetic tape and dictionary file on magnetic disc. Completion of follow-up input form (bottom left) continues cycle.

The computer dictionary contains six classes of terms—diagnoses and physical signs, symptoms, sites, drug names, investigations ordered, and investigation results. Each term is classified as a “preferred term” or a “synonym,” and the synonyms cross-refer to the corresponding preferred term. The preferred term for a drug is the official name, but its proprietary name(s) are held as synonyms. If a synonym is used on an input form the computer translates it into the preferred

term. A term that is not in the relevant dictionary is identified by the computer and considered for inclusion at the next steering committee meeting. On the input forms there is room to qualify fixed format statements by comments in plain English, but these comments only appear on the computer-printed case note for clinical use.

Initial Visit and Initial Input Form

The first interview with the patient, when the initial input form is completed, has been shown by an organization and methods consultant to have increased from an average of 31 minutes to 40 minutes. The form consists of 29 printed foolscap pages divided into six sections on different coloured paper. Every page contains headings and a series of printed boxes, the first of which contains the key number for that particular record. The information is inserted in the box or one of the pre-printed alternatives is encircled. For example, to record a diagnosis of hemiparesis (fig. 2), the doctor encircles one of the digits 1, 2, or 3, to indicate the degree of severity. He enters the date of diagnosis, the word hemiparesis, and the side affected. Here “site” is not applicable and is left blank.

Categories of Information in Initial Input Form

Identification.—The patient is identified by a code number, his name and address, date of birth, and National Health Service and hospital numbers.

Free History Entry.—A page for a narrative history enables the doctor to obtain some idea of the patient's problems before he collects more detailed information.

Symptoms.—The severity of the symptom, site, date of onset and cessation, laterality, frequency, and the disability it causes are recorded. Symptoms which are important in hypertension—for example, angina (fig. 3)—are pre-printed in the initial input form and are referred to as the “key symptoms” (see list of symptoms). If a key symptom is not present the severity code “o” is circled. The statement about diagnosis

FIG. 2

PAST DIAGNOSES - May be of three classes: A - Diagnoses related to hypertension e.g. pyelonephritis
B - Diagnoses not related to hypertension e.g. peptic ulcer
C - Local pathology related to A or B e.g. ankle oedema

Severity (if relevant) None Mild Mod Severe	Date Diagnosis Made	Diagnosis	Site	Side (if relevant)			Class of Diagnosis			
				Left	Right	Both	A	B	C	nl
# 2-3-0, 0 1 2 3	6 / 71	Hemiparesis		L	R	B	A	B	C	nl
# 2-3-0, 0 1 2 3	/ /			L	R	B	A	B	C	nl
# 2-3-0, 0 1 2 3	/ /			L	R	B	A	B	C	nl
# 2-3-0, 0 1 2 3	/ /			L	R	B	A	B	C	nl
# 2-3-0, 0 1 2 3	/ /			L	R	B	A	B	C	nl
# 2-3-0, 0 1 2 3	/ /			L	R	B	A	B	C	nl

Comment

# 2-3-0,	Gradual recovery of function. Can now feed and dress herself	nl
# 2-3-0,		nl

FIG. 2—Section of initial input form showing how diagnosis “hemiparesis” may be recorded.

FIG. 3

HISTORY DIRECTLY RELATED TO HYPERTENSION

Please complete either by writing in the box adjacent to each question or by ringing the code letter or number under the correct answer. Add any other information in the comment boxes.

ANGINA

Severity	Date of Onset	Date of Cessation	Number	Duration of Attacks of Secs.	Mins	Hours	Present Frequency of Attacks				
							Number	Per Day	Week	Month	
# 5-1-1, 0 1 2	12 / 72	/ /	2	S	M	H	10	D	W	L	nl

Comment

# 5-1-1,		nl
----------	--	----

FIG. 3—Section of initial input form showing how symptom “angina” may be recorded.

FIG. 4

Date Started		Therapy (dictionary term)	Route Code PO IM IV PR SL O other	Drug Dosage AM MD PM Eve				Units of Dosage 1 = mg 2 = tabs 3 = units 4 = ml	Days/week drug taken	Regularity Drug Taken 1 = reg 2 = irreg	Date Stopped	Principal Reason for Stopping 1 Symptom 2 Sign 3 Ineffective 4 Trial 5 Other	
#3-5-0.	11 / 1 / 73.	<i>methyl dopa</i>	PO	250	250	250		1	7	1	27 / 4 / 73.	1	<i>Drowsiness</i> nl
#3-5-0.	/ / .								7		/ / .		nl
#3-5-0.	/ / .								7		/ / .		nl
#3-5-0.	/ / .								7		/ / .		nl
#3-5-0.	/ / .								7		/ / .		nl
#3-5-0.	/ / .								7		/ / .		nl
Comment	#3-5-0.	nl											

FIG. 4—Section of initial input form showing how therapy may be recorded.

FIG. 5

PERIPHERAL PULSES

Left		Pulse			Bruit		Right		Pulse			Bruit		
		Normal	Weak	Absent	Absent	Present			Normal	Weak	Absent	Absent	Present	
Carotid	#3-7-1.	2	1	0	0	1	Carotid	2	1	0	0	1	nl	
Femoral	#3-7-2.	2	1	0	0	1	Femoral	2	1	0	0	1	nl	
Posterior Tibial	#3-7-3.	2	1	0			Post. Tib.	2	1	0			nl	
Dorsalis Pedis	#3-7-4.	2	1	0			Dors. Pedis	2	1	0			nl	
Renal	#3-7-5.				0	1	Renal				0	1	nl	
Comment	#3-7-5.	<i>Cold left foot</i> nl												

FIG. 5—Section of initial input form showing how details of peripheral pulses may be recorded.

includes its severity, the date the diagnosis was made, the diagnostic term, site, the laterality, and the "class" of diagnosis (fig. 2). These "classes" distinguish between major diagnoses such as myocardial infarction or carcinoma of stomach and descriptions of local lesions—for example, pleural effusion—and determine whether the diagnosis is printed at the head of the follow-up input form.

Treatment.—The statement about treatment includes the date, route, dose, unit of dosage (tablets, milligrams, etc.), regularity with which the drug is taken, when and why the treatment stopped (fig. 4).

Blood Pressure.—Blood-pressure readings in various body positions are recorded with the date, time, arm used, and an indication of whether the patient is receiving hypotensive treatment. The point of muffling of sounds is taken as the diastolic pressure.

Physical Examination.—This section begins with a general description of the patient. Most of the rest of the pre-printed area is devoted to a cardiovascular examination with tables for the peripheral pulses (fig. 5) and retinal features. Other features are pre-printed to ensure the recording of ankle oedema, basal lung crepitations, or an enlarged kidney. Physical signs are not usually set out, but the appropriate diagnosis is recorded. For example, if a pleural effusion was detected clinically, "pleural effusion" would be recorded as a local diagnosis, and though signs such as stony dullness to percussion could be commented on they would not be coded for analysis.

Investigations.—A check list is used to show when a particular investigation is ordered, and to enable boxes with the appropriate terms for results to be printed on the next follow-up input form. Numerical-investigation results are written in the appropriate boxes; non-numerical results—for example, E.C.G. diagnosis of atrial fibrillation—are written in as diagnoses. For important investigations related to hypertension, such as the E.C.G., chest x-ray examination, intravenous pyelogram and urine culture, special formats are printed which enable the doctor to answer specific questions concerning the results. For example, when a chest x-ray examination has been ordered there must be space to record the size of the heart and thoracic diameter and diagnostic terms for ventricular

hypertrophy, atrial hypertrophy, pulmonary oedema, and unfolded aorta.

Follow-up Visits and Document

At each follow-up visit the doctor has the cumulative clinical record consisting of the case note print-out from the first visit, case note print-outs from follow-up visits, a blood-pressure graph, and the follow-up input document for use at the current visit. Any doctor who sees the patient thus has a legible organized supply of information. The doctor uses the follow-up input form to remind him of the salient features and current problems and to record new information. The use of the follow-up input form does not alter the length of the consultation which on average lasts for nine minutes.

The follow-up input document is unique for each patient's visit. The printed information identifies the patient and includes the latest body weight, blood pressure at the last two visits, and, if present, papilloedema cotton-wool spots, and retinal haemorrhages. Risk factors are listed and include the pretreatment blood pressure, smoking habits, the serum potassium (if below 3.6 mEq/l.), blood urea level (if above 38 mg/100 ml), and the serum cholesterol. There are boxes for the date, examining doctor's name, and the patient's weight, pulse rate, and blood-pressure readings. A treatment section

THERAPY STOPPED LAST VISIT PROPRANOLOL, REASON STOPPED=SYMPTOMS, DEPRESSION				
CURRENT THERAPY				
NITRAZEPAM	AM	MD	PM	EVE
STARTED-03/11/72,				5.00 MG
HYDROCHLOROTHIAZIDE	50.00		50.00	MG
STARTED-16/02/73,				
SLOW-K	1.00		1.00	TABS
STARTED-25/05/73,				
CHANGED-17/08/73,				
OXPRENOLOL	40.00	40.00	40.00	MG
STARTED-17/08/73,				

FIG. 6—Section of follow up case note printed by the computer concerning current drug therapy.

lists present treatment (fig. 6) and provides boxes for recording changes. All current symptoms and diagnoses are listed and there are boxes for entering new symptoms and diagnoses. An investigation section includes boxes for entering results of investigations ordered at an earlier visit and spaces for indicating those requested at the current visit. The final section provides space for freehand comment, the date of the next visit, and for an indication of whether a letter should be sent to the family doctor.

At the end of the clinic a case note, blood-pressure graph, general practitioner's letter, and new follow-up input document are produced at the computer centre and sent to the hospital for the patient's next visit.

Documentation

The case note printed after each visit contains all positive information recorded on the input forms. Negative information—for example, absence of dyspnoea on exertion—is stored on the main computer file but is not printed out. The case note printed after the first visit consists of two to three pages compared with about half a page for a follow-up visit. The doctor's letter gives the blood pressure readings, treatment, and investigation results. The blood-pressure graph produced on the line printer shows monthly averages of readings over the previous nine years (fig. 7).

FIG. 7—Computer-printed graph of average monthly pressures (in mm Hg) with patient lying. + = Systolic value. o = Diastolic value. U below time axis indicates that the patient was then untreated. Similar graphs are produced on request for sitting, standing, and post-exercise pressures.

The data are processed at the Medical Research Council Computer Centre at Northwick Park using an I.C.L. 190 3A computer, and the system can cope with patients attending at a minimum of weekly intervals. The programmers carry out the preliminary editing of individual documents, such as interpretation of handwriting, spelling, and incorrect entry of data, while the doctor who saw the patient checks all print-out documents and reports errors to the computer centre.

CONFIDENTIALITY

Everyone working in the computer department undertakes not to disclose information concerning patients. Clinical documents are locked in a filing cabinet at night and access to the computer file is limited to those working on the project. Paper tapes, containing identifiable clinical information which is not sent to the clinic, are burnt. In the hospitals documents are treated with the same confidentiality as other medical records.

Discussion

The system described has been successfully implemented and is proving capable of achieving the research objectives outlined in the introduction.

Some form of automatic data processing was necessary to make routine clinical data about hypertensive patients easily available for selective extraction and analysis. The computer system described was designed to provide a number of facilities; information can be recorded merely by using simple codes or English terms which are translated by the computer, codes held in the file can be translated into English terms for printing, a variable number of items can be stored for each patient, information can be extracted selectively for feedback of relevant data at follow up attendances, and the files can be searched quickly for other specified items of information.

Alternative techniques by which the research and management objectives could be achieved were considered to be less satisfactory. For example, relatively little progress has been made in programming computers to interpret narrative entries.³ If all of the terms for describing clinical conditions were permitted then the computer would require a vast dictionary⁴ and when it came to retrieval and analysis it would be necessary to consider terms whose meaning is imprecise. In our system it was decided that there should be one preferred term for each symptom, diagnosis or drug, although a limited number of synonyms are recognized by the computer programme.

Conversational or "on-line" computer systems have solved some of the problems of categorizing data by the computer program "interrogating" the patient⁵ or the doctor.^{6,7} Nevertheless, for outpatients attending not more than once a week, these methods are expensive compared with batch processing which achieves the required turn round of information.

To fulfil management and research requirements the system had to be comprehensive in terms of data collection, restrictive in the sense that data recorded by different physicians should be comparable, and yet sufficiently flexible to cope with the vagaries of clinical practice.

A major problem with computer based medical records has been their lack of acceptability to busy clinicians,^{7,8} and therefore it was essential that benefits in terms of ease of patient management should compensate for any constraints imposed. The design of the input forms and case notes were critical in this respect for they influence well-established patterns of communication between doctor and patient and doctor and doctor. Extensive discussion and some re-programming were necessary to overcome these problems and most doctors now adapt to the system after the first half dozen or so patients.

The system has been working successfully for two years and has been used by over 20 doctors for the regular management of some 900 patients, with data on 30 to 40 new patients being added a month and currently 160 follow up visits a month. The feasibility of extracting data is implicit in the use of the follow up input document, the blood-pressure graph, and the general practitioner's letter, all of which contain data extracted from an individual patient's computer file.

The system is currently being evaluated by a randomized controlled trial of computer system records versus standard hospital records in respect of efficiency in recording and retrieval of information, the time it takes to use the system, the administrative effort, and the cost.

Patients attending hypertension clinics are highly selected, the group hopes to develop a modified version of the system for use in general practice, with a view to aiding management and study of hypertensive patients in the population at large.

Requests for reprints should be sent to Dr. L. J. Beilin.

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Key Symptoms Pre-printed on Initial Input Form

Angina	True vertigo	Migraine
Intermittent claudication	Transient loss of consciousness	Headache
Dyspnoea on exertion	Transient loss of vision	Depressive illness
Paroxysmal nocturnal dyspnoea	Transient paresis (less than 24 hours)	Nocturia
Ankle oedema	Cerebrovascular accident (more than 24 hours)	Dysuria
		Haematuria

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For Debate

Referees and Research Administrators: Barriers to Scientific Research?

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To a considerable extent the course of medical research in this or any other country is determined by the policies of the major grant-giving councils, trusts, and foundations. In theory this policy is publicly expressed in annual reports. In practice the only way of knowing whether the policy is actually being followed is to examine the detailed processes by which grant applications are accepted or rejected. In most cases the procedures of the major grant-giving bodies make such examination impossible. This paper presents evidence that such secrecy can seriously distort the true picture of potential research activity.

Secrecy

Almost invariably grant applications are sent out to referees, whose identities are not disclosed. This process offers the first opportunity for secret policy making. There are wide and legitimate differences of opinion about the value of a piece of research work. The greater the potential significance

of the work the more spectacular may be the differences. History has repeatedly shown that new research which is genuinely important is often initially vehemently rejected by established scientific opinion. It is therefore possible to destroy an application by deliberately sending it to eminent referees who are known to be opposed to the work. This enables administrators to claim that while it is the firm policy of the council or trust to support research in the area execution of the policy has proved impossible because of an absence of work of sufficient calibre.

The expert referees' reports are normally considered in conjunction with the application by a committee of eminent medical men who may or may not have expertise in the area. The applicant is given no chance to comment on referees' reports which, as will be shown later, may be wrong in factual detail, based on misunderstanding, or very occasionally even frankly malicious. The prosecution therefore has the last word, a situation unheard of in any procedure whose aim is to get at the truth.

Finally the applicant is informed either that the grant is to be given or that the application has failed. Usually in neither case are the referees' reports shown to the applicant. It is hard to see how this secrecy can further scientific progress. The successful applicant is denied access to the comments of supposedly serious and experienced referees; these comments should be helpful to him in carrying out his project. The unsuccessful scientist is unable to know whether the application was rejected for valid reasons or not. He cannot find out