

A COMPUTER PROGRAM TO STORE AND ANALYSE AMBULATORY BLOOD PRESSURE DATA FOR THE REMLER M2000 RECORDER

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Ambulatory blood pressure measurement may have an important place not only in the diagnosis and management of hypertension (1), but also in the evaluation of new blood pressure lowering drugs (2). The duration of drug action, the effect on peak blood pressure with exercise, on blood pressure variability, on circadian rhythm, and on blood pressure after abrupt withdrawal can be demonstrated.

Ambulatory measurements give a profile of blood pressure behaviour that is more informative than conventional measurements, but there are problems with data analysis not least of which is the time required. Computerization of data should minimise this problem.

Direct intra-arterial ambulatory recording produces the largest amount of data, each hourly mean being derived from up to 5400 systolic and diastolic pressures (3), and computer facilities are essential for data analysis. Of the two commonly used devices for non-invasive measurement of ambulatory blood pressure, the Del Mar Avionics Pressurometer and the Remler M2000, the former can produce up to 200 blood pressure recordings in 24 hours, and the Apple IIe has been used for data analysis (4). The Remler M2000, using a manually operated recorder produces 24 to 30 measurements of systolic and diastolic blood pressure together with heart rate in a 12 to 15 hour period of recording during waking hours, and this data has to be manually analysed and presented. In this paper we describe the use of a BBC microcomputer for the statistical analysis, plotting and storage of ambulatory data obtained with the Remler 2000.

ISAM 1985

*Proceedings of the Fifth International Symposium
on Ambulatory Monitoring*

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METHODS

The Remler 2000 consists of a standard pressure cuff, a microphone, and amplifier, a transducer, a pneumatic switch assembly and a leakoff valve (5). The patient inflates the cuff using a standard inflation bulb at 30 minute intervals. At a pre-set level above the patient's systolic pressure, the equipment is energized. Pressure leaks off as calibrating pulses and the arterial Korotkov sounds are recorded on a tape over about 30 seconds. The tape recorded information is fed to a decoder comprising a frequency to DC convertor, amplifier, calibration device and chart recorder. The arterial sounds are amplified and the technician may listen to the recorded sounds with earphones. The calibrating pulses and arterial sounds are converted to DC signals which drive the chart recorder pen, and systolic and diastolic pressures, and heart rate can be read. It is our practice to plot heart rate and blood pressure against time and to calculate the mean, peak, trough, standard deviation and coefficient of variation for systolic and diastolic blood pressure and heart rate. The average time spent by our technician on one Remler ambulatory measurement is 45 minutes, which is calculated as follows - attachment of equipment and instruction of patient 12 minutes; decoding of tape 21 minutes; plotting of graph 10 minutes; statistical calculations 5 minutes. One of the main purposes of using a computer was to reduce the costly expenditure on technician time in plotting the graph and making the statistical analysis.

The physician ordering a Remler completes a form documenting the personal details as listed in Table 1. Following Remler decoding approximately 24 systolic and diastolic pressures and heart rates are obtained (Table 2). A Basic program, compacted for speed of execution, was written for a BBC Microcomputer with 32K memory and a twin 800K disk drive. The program disk with a second floppy disk for data storage are inserted in the disk drives. The program Main Menu (Table 3) lists the options available to the operator. To enter a new record the edit option is chosen. Table 1 appears on the screen and a record number and the personal details are keyed in. Table 2 is

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NON-REMIER DETAILS

NUMBER: 1000	CHART NUMBER X15432
NAME O'GRADY ROSIE	DATE OF BIRTH 10 - 01 - 1934
SEX F	WEIGHT 70 .2 kgs. HEIGHT 168 cms.
GP BP 190 / 98	4 years 0 months
CL1 BP 184 / 92	FUNDT Normal
PWT 1.1 SWT 1.5 (Mean) 120	ECG 27.2 / 24.8 STUDIES NO
OTHER ILLNESSES I.H.D.	
Metoprolol	
2000	
REMIER DATE 20 - 10 - 1984	TIME 10.30 INTERVAL 30 min.

Table 1. Personal Details

- GP BP - Blood pressure recorded by general practitioner.
- CL1 BP - First clinic recorded blood pressure.
- Echo - PWT - posterior wall thickness.
SWT - septal wall thickness.
- ECG - SV1 + RV5/SV1 + RV6

called up and ambulatory data is entered. The statistical parameters and data plots generated by the Basic program are shown in Tables 4 and 5. If any one interval reading is missing the plot records a blank and the statistical analysis ignores that interval. Printouts of a record consisting of the patient details, systolic and diastolic pressures and heart rates, statistics and graphs are obtained with a high speed screen dump facility with a dot matrix printer. (Epson MX-100 III)

Records can be accessed using the patients name or the computer number of the record assigned at the time ordered. The date of each ambulatory measurement is displayed with the per-

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TABLE OF REMLER DATA

X15432			DATE 20 - 10 - 1984			NAME O'GRADY ROSIE		
	SBP / DBP	H.R.		SBP / DBP	H.R.		SBP / DBP	H.R.
10.30	143 / 92	98	10.30	158 / 95	112	02.30	/	
11.00	140 / 90	107	19.00	153 / 104	100	03.00	/	
11.30	173 / 107	107	19.30	160 / 90	104	03.30	/	
12.00	138 / 109	107	20.00	179 / 102	95	04.00	/	
12.30	173 / 105	95	20.30	165 / 98	95	04.30	/	
13.00	155 / 98	104	21.00	195 / 112	120	05.00	/	
13.30	155 / 103	110	21.30	190 / 130	96	05.30	/	
14.00	152 / 99	110	22.00	168 / 104	96	06.00	/	
14.30	173 / 101	110	22.30	150 / 97	88	06.30	/	
15.00	163 / 104	110	23.00	/		07.00	/	
15.30	162 / 100	110	23.30	/		07.30	/	
16.00	160 / 100	96	00.00	/		08.00	/	
16.30	160 / 103	89	00.30	/		08.30	/	
17.00	163 / 102	112	01.00	/		09.00	/	
17.30	199 / 111	142	01.30	/		09.30	/	
18.00	180 / 103	116	02.00	/		10.00	/	

Table 2. Rember Data

Systolic, diastolic blood pressures and heart rate.

PROGRAM MAIN MENU	
1.	Edit a record
2.	Print a sequence of records
3.	Create a Name Index File of sorted names
4.	Print list of sorted names
5.	Search for a particular name
6.	Prepare disc to hold Rember records
7.	Quit

Table 3. Main menu

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REMLER STATISTICS

X15432	DATE 20 - 10 - 1984	NAME O'GRADY ROSIE			
	SBP	DBP	H.R.		
OVERALL MEAN	164	102	185		
STANDARD DEVIATION	15.5	7.94	11.16		
STANDARD ERROR	3.1	1.59	2.23		
COEFFICIENT OF VARIATION	9.45	7.78	10.63		
MEAN OF TOP FIVE	189	114	120		
STANDARD DEVIATION	7.97	8.28	11.21		
COEFFICIENT OF VARIATION	4.22	7.26	9.34		
MEAN OF BOTTOM FIVE	145	93	92		
STANDARD DEVIATION	5.51	2.79	3.22		
COEFFICIENT OF VARIATION	3.8	3	3.5		
PEAK	199	130	142		
TROUGH	138	90	88		

M.A.P.
122.6

Table 4. Remler Statistics

SBP - systolic blood pressure.

DBP - diastolic blood pressure.

HR - heart rate. M.A.P. - mean arterial pressure.

sonal details to identify which of a number of recordings for a particular patient is being shown, a useful facility if the computer number is unavailable. Using the BBC microcomputer we have been able to reduce technician time for data analysis and presentation from 15 to 5 minutes, and in addition the program provides us with considerably more statistical data as well as the facility for data retrieval.

DISCUSSION

The Remler M2000 has been used in our Blood Pressure Clinic for indirect non-invasive measurement of ambulatory blood

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GRAPH OF REMLER DATA

PATIENT NO. X15432

DATE 20 - 10 - 1984

NAME O'GRADY ROSIE

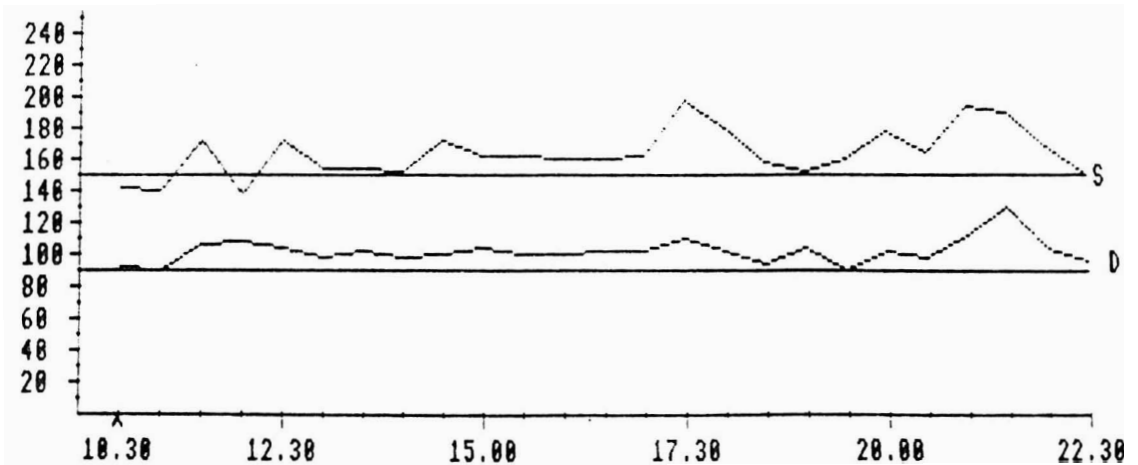


Table 5. Graph of Rember Data

Vertical axis - blood pressure. Horizontal axis - time. S - systolic blood pressure. D - diastolic blood pressure.

pressure in over 1700 patients. We find the system satisfactory because it is accurate (6) and reproducible (7), has good patient acceptance (8), and because it provides a permanent tape record of Korotkov sounds which permits the verification of recorded measurements. However, to obtain satisfactory results with the Rember M2000, considerable attention must be directed to applying the recorder to the patient, instructing the patient in its use, decoding the tape, maintaining the equipment and recognising (and if possible correcting) the 'wear and tear' faults that develop in the recorder, the microphone and the decoder. To achieve optimal results from the system we have found it expedient to employ a full-time technician. This

has resulted in a worthwhile improvement in the quality of recordings (Table 6) but it adds considerably to the cost of ambulatory measurement.

The use of a microcomputer is the first of two projects the purpose of which is to reduce the estimated 45 minutes of technician time. It has permitted the saving of 10 minutes, and in addition provides extra statistical calculations, as well as providing a facility for correlations on different parameters of our patient population. The ease of providing a copy for the referring doctor and for the patients notes is a further advantage. In the second project we are attempting to reduce technician time further by linking the Remler decoder directly to the microcomputer so that it will not be necessary to key in the decoded measurements to the computer.

Table 6.

Year	Total recordings	Overall failure rate	Failure Rate Equipment / Patient	
1981	271	20.7%	58.9%	/ 41.1%
1982	309	9.1%	64.3%	/ 35.7%
1983	482	6.6%	65.6%	/ 34.4%
1984	589	4.8%	96.4%	/ 3.6%

Table 6. Annual Remler Failure Rate

Equipment - Failures due to equipment malfunction.

Patient - Failures due to patient error.

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ACKNOWLEDGEMENT

A grant from the Royal College of Surgeons in Ireland is gratefully acknowledged.