Laboratory tests in health screening

Their feasibility and usefulness in a general practice

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MUCH has been written in recent years on the rôle of laboratory investigations in routine health screening. Those in favour of such screening point to the economic and social advantages of early detection and better diagnosis of disease to the individual and the community. The opponents of this type of blanket screening point to the dubious diagnostic value of many of the abnormal results found and the impracticability of making laboratory screening generally available even if it was shown to be of definite value. The present study was carried out to check (1) if it was feasible to carry out a large battery of laboratory tests as part of a health screening operation in a rural area where extensive laboratory facilities were not close at hand, and (2) to assess the usefulness of the information provided from the laboratory tests to the doctors involved.

Materials and methods

During the week of the health screening 1,838 people presented themselves for a health check: Of these, 1,457 (655 males and 802 females) volunteered to have a blood profile carried out. The exercise was confined to the evening enabling people to attend after work. A breakdown by age decade for both sexes is shown in table I. Details of

TABLE I
BREAKDOWN BY AGE DECADE FOR BOTH SEXES

	Total No.	0–19	20–29	30–39	40–49	50–59	60–69	70–79	<80
Males	655	6	78	126	176	131	92	39	7
Percentage of total		0·41	5·35	8·65	12·08	8·99	6·31	2·68	0·48
Females	802	14	104	191	215	144	93	33	8
Percentage of total		0·96	7·14	13·11	14·76	9·88	6·38	2·26	0·55

the patients' age, sex, whether they were currently attending the doctor or not, and what medicines if any they were taking were recorded. Ten other screening tests were performed, details or results of which will not be dealt with here. 20 ml of blood was then taken from each subject. 2·5 ml was placed in a sequestrene tube for haematology, 2 ml

into a fluoride oxalate tube for sugar and the remainder into two lithium heparin tubes. The plasma from one of the latter was separated in the doctor's surgery for routine biochemistry and the other was sent to the laboratory unseparated. Samples were analysed on a Technicon SMA 12/60, Technicon 7A Haematology Analyser, Technicon Protein Bound Iodine Analyser and a single channel Technicon Analyser.

TABLE II

THE ACCEPTED NORMAL RANGE OF THE LIMITS CHOSEN FOR THE STUDY OF THE TESTS PERFORMED

Assay	Accepted normal range	Arbitrary definition of normal range in present study
Calcium (mg per cent)	9·0–11·0	8·5–11.0
Phosphorus (mg per cent)	2·5–4·5	2·0–5·0
Sugar (mg per cent)	65–100	65–200
Urea nitrogen (mg per cent)	10–20	10–25
Uric acid (mg per cent)	2·5–7·5	2·5–8·0
Cholesterol (mg per cent)	150–250	130–300
Total protein (g per cent)	6–8	5·5–8·5
Albumin (g per cent)	3·5–5·0	3·3–5·2
Total bilirubin (mg per cent)	0–1·0	0–1·5
Alkaline phosphatase (mU/ml)	42–85	35–100
Aspartate amino-transferase (mU/ml)	10–50	10–70
Creatinine (mg per cent)	0·5–1·5	0·3–1·8
Protein bound iodine (ug per cent)	4–8	3·5–8·5
Packed cell volume (PCV) (per cent)	Females: 38–47	30–55
	Males: 40–54	35–60
Red cell count (RBC) (cmm)	Females: 4·2–5·4	3·5–6·0
	Males: 4·6–6·2	4·0–6·5
White cell count (WBC) (cmm)	5–10	4–15
Haemoglobin (Hb) (g per cent)	Females: 12–16	11–17
	Males: 14–18	12–18
Erythrocyte sedimentation rate (ESR) (mm/hr) ..	0–7	0–7

TABLE III

THE NUMBER OF ABNORMALITIES FOUND FOR EACH TEST

Assay	No. of estimations	No. of abnormals found	Judged clinically useful	Judged not clinically useful	New diagnoses	Not evaluated clinically
Cholesterol ..	1,263	207	207	0	5	0
E.S.R.	1,368	248	67	101	1	80
Uric acid ..	1,236	32	26	0	14	6
Haemoglobin ..	1,388	34	34	0	18	0
Alk. phos. ..	1,368	24	9	7	1	8
Albumin ..	1,396	12	8	2	0	2
Sugar	1,457	13	8	3	2	2
Total protein ..	1,391	14	5	7	0	2
W.B.C.	1,392	16	4	6	0	6
Urea	1,457	8	4	3	0	1
Aspartate amino.	1,281	41	4	23	0	14
Creatinine ..	1,386	6	3	2	0	1
P.C.V.	1,388	6	3	2	0	1
P.B.I.	1,378	23	2	16	1	5
R.B.C.	1,293	3	2	0	0	1
Bilirubin ..	1,364	8	1	3	0	4
Calcium ..	1,401	2	1	1	0	0
Phosphorus ..	1,398	3	0	2	0	1
TOTAL	24,615	700	388	178	42	134

In all 18 tests, including the erythrocyte sedimentation rate which was done manually, were carried out on each subject. It was appreciated that in a study such as this a sizeable proportion of results would fall marginally outside the usual normal limits, thus arbitrary wider limits were set in an effort to confine the study to significant abnormalities. In table II the tests performed are listed, the accepted normal range and the limits chosen in this study. Printing of the reports and analysis of the results was carried out on an IBM computer following the transfer of the data to punch cards. Individual reports for each person were then sent back to the doctors involved indicating the abnormalities found. In the light of these findings the patient's own doctor reviewed the abnormalities and classified the findings in one of the following groups:

(1) Leading to a new diagnosis, (2) supporting existing diagnosis, (3) identified subject in a high risk group, eg, association between high cholesterol and ischaemic heart disease, (4) could be explained by current medication, eg, raised protein bound iodine in women on oral contraceptives, and (5) unexplained finding. All those values falling in the first three groups were classified as being clinically useful while those in the remaining two were classified as being of no use clinically. Many of those who attended came from other practices over a wide area and it was not feasible to classify all the abnormalities found in these subjects.

Results

Of those studied 398 (27 per cent) were attending a doctor at the time of the study while 1,059 ⟨73 per cent) were not.

A complete breakdown of the abnormalities found for each test is shown in table III. Of the 700 abnormal results found (2·8 per cent of all results), 566 were judged as to their their clinical usefulness but it was not possible to do so in the remaining 134. Three-hundred-and-eighty-six (69 per cent) were judged as being of use and 178 (31 per cent) were considered of no clinical value. Forty-two of the abnormal results led to a new diagnosis but this could be an underestimate as there were 13 low haemoglobins in which it was not established if these were known anaemias or not. Further analysis of the abnormal values showed that 52 per cent were found in subjects who were currently attending the doctor while 48 per cent were in subjects who had not attended a doctor in the month prior to the study. Eighteen of the new diagnoses were in the former group while the remaining 24 were in the latter. This represents an incidence of 4·5 per cent of the subjects attending a doctor and 2·3 per cent of those who were not.

Discussion

Over 70 per cent of the subjects who presented themselves for a health check in this study were not attending a doctor indicating that apparently-well people are eager to make use of health screening facilities when these are easily available. Examination of the distribution between the sexes of those attending revealed that the breakdown was identical to that in a previous study involving 1,711 subjects in the same community (Cope and Smith 1967), where 45 per cent of those attending were males and 55 per cent females. A more detailed breakdown showed that in those under 40 years of age females constituted 21 per cent of the total while males represented only 14 per cent. The distribution in those over 40 years was very similar in both sexes being 31 per cent males and 34 per cent females.

The higher attendance of women over men in the under-40-year age group could be interpreted as indicating a greater interest in health screening though it may merely be a reflection of inability of males to attend due to job commitments. The latter seems unlikely however as the exercise was carried out outside of normal working hours and one would have expected a similar pattern at all age levels, yet in those over 40 years the attendance by both males and females was very similar.

The present study demonstrated conclusively that it is feasible to offer a wide range

of laboratory investigations as part of a health screen in a rural practice, even when laboratory facilities are not close at hand. The exercise revealed how essential a computer system is in any laboratory handling a work-load of this nature and attempting to get results back quickly. While the analysers coped well with the load it would have required an army of people to handle manually the data and prepare reports in order to get the results back within 24 hours of collecting the specimen.

It is difficult to compare the results obtained here with other screening studies because of differences in the groups studied, the tests carried out and the normal ranges employed. One noticeable difference is the low incidence of anaemia, being only 2·5 per cent when compared with an incidence of 10 to 20 per cent in other studies (Fry 1962, Cochrane and Elwood 1968, Carmalt, Freeman, Stephens and Whitehead 1970). When this population was screened previously the incidence of anaemia was 7·7 per cent (Cope and Smith 1967) and the improvement in the position in the present study could be attributed to a beneficial effect of the original screening exercise. The incidence of diabetes at 0·75 per cent compares well with the level of 0·67 per cent found in the study of Walker and Kerridge (1961) and 0·69 per cent in the study by the College of General Practitioners (1962). Scott and Robertson (1968) found raised cholesterol levels (>260 mg per cent) in 19·4 per cent of their subjects, a figure which agrees well with the 16·0 per cent incidence found in this study, though the upper limit of normal in this study was set a little higher.

The question arises as to the need for separating the plasma before sending to the laboratory for biochemical analyses. The results of an independently carried out experiment suggest that this is not necessary for the parameters measured if the specimen

TABLE IV

A COMPARISON BETWEEN SEPARATED AND UNSEPARATED PLASMA READINGS

| | Subject I | | | | | | Subject II | | | | | |
| | Separated | | | Unseparated | | | Separated | | | Unseparated | | |
Assay	I	II	III	I	II	III	I	II	III	I	II	III
Cholesterol (mg per cent)	225	220	230	225	220	220	215	210	215	208	215	215
Sugar (mg per cent)	65	66	65	67	66	66	69	67	67	70	67	69
Aspartate aminotransferase (m I.U./ml)	40	40	42	45	45	45	25	22	22	25	30	30
Urea (mg per cent)	39	38	38	38	38	38	33	32	32	34	34	34
Calcium (mg per cent)	9·6	9·6	9·7	9·7	9·6	9·7	9·6	9·6	9·6	9·8	9·6	9·8
Phosphorus (mg per cent)	2·2	2·3	2·6	3·0	2·9	2·9	3·0	3·0	3·0	3·6	3·3	3·6
Alkaline phosphatase (K.A. Units/100ml)	7·8	7·8	7·8	8·0	7·8	7·8	7·0	7·0	7·0	7·2	7·2	7·0
Total protein (g per cent)	7·1	7·0	7·0	7·0	7·0	7·0	6·8	6·8	6·8	6·8	6·7	6·7
Albumin (g per cent)	4·0	4·0	3·9	4·0	4·0	4·0	4·2	4·1	4·1	4·2	4·2	4·3
Uric acid (mg per cent)	5·8	5·8	5·6	5·4	5·4	5·5	5·9	5·8	5·8	5·2	5·8	5·4
Creatinine (mg per cent)	1·4	1·2	1·2	1·3	1·2	1·4	1·0	1·0	1·0	1·2	1·0	1·2
Bilirubin (mg per cent)	0·5	0·4	0·4	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·6	0·6

reaches the laboratory within 24 hours. In this study six plasma samples individually labelled were handed into the laboratory having been separated at the time of collection. A further six unseparated specimens were received in lithium heparin containers and bearing different numbers through the post on the following day. All samples were analysed for 12 constituents and the results returned. It was subsequently revealed that there were just two subjects involved with three separated aliquots and three unseparated aliquots from each subject. The results are presented in table IV. Except for a slight increase in the aspartate aminotransferase levels in the unseparated specimens which would not invalidate its usefulness in a screening operation, the values obtained in the separated and unseparated specimens were virtually identical.

One disadvantage of the present type of study is that it defines as abnormal everything which falls outside a predetermined range called the normal range and ignores all values within this range. Many of these ranges are extremely wide and do not take into account possible differences due to sex, age, different ethnic backgrounds, diurnal rhythms and so forth. By the very nature of the method by which the normal range is calculated five per cent of all results in supposedly normal subjects fall outside it and broadening of the range in this study was done in an attempt to concentrate on significant abnormalities only. This reduced the number of abnormal values from 2,791 when compared with a narrower range to 700 which were classified as significant. It must be appreciated that many test results which are now classified as abnormal may be normal. Similarly results which are regarded as normal may be abnormal for the individual concerned when all influencing factors are considered. What is probably much more important than comparison with the normal range is the establishment of trends in each individual. This necessitates the establishment of a baseline value for each test and examining the pattern of change from this value with time. For example, a cholesterol value of 240 mg per cent in a man of 35 is within the normal range and could be considered of no clinical significance. If it was known however that the value 12 months previously was 170 mg per cent, this would point to a rapid upward trend in this blood constituent, information which could considerably alter the interpretation and management. It is felt that repeated screening at yearly intervals and observing changes with time may be much more rewarding in the detection and prevention of disease than the present tendency to do one-off checks and relate results to a dubious normal range. Unfortunately we have little experience in this area and much research is needed.

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