

## A BASIC POLYPHASIC SCREENING PROGRAMME IN PREVENTIVE MEDICINE

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**P**REVENTIVE medicine has, until the present time, been the sole prerogative of the public health authorities. They have tackled the problem in two ways: by primary and by secondary prevention.

*Primary prevention* is directed to the control of food and water supplies and sanitation. This type of prevention is community oriented and does not involve the individual directly. It has provided legislation insisting on a high standard of food handling both at the source and by the retailers. As a result of these measures we no longer have the epidemic outbreaks of food and water-borne infections so common in the last centuries.

*Secondary prevention* is directed towards the individual with direct benefits to the community. Specific immunological techniques are used to give protection to the individual against specific diseases, such as poliomyelitis, diphtheria and pertussis, as well as other less common diseases. Resulting from this there are fewer carriers of these diseases, and there are no longer the large and distressing epidemics so frequent 50 years ago.

*Tertiary prevention* is directed to the individual with little or no direct benefit to the community, except perhaps by reducing the burden of the chronically ill. Tertiary prevention relies upon the early recognition of the changes in the health and habits of the individual as well as the environmental and hereditary risks to which he may be subject, thus allowing for a diagnosis to be reached before irreparable damage has taken place, and at a time when the condition may be cured or at least have its natural history so altered that the effects of the disease may be minimized.

This paper is concerned with the techniques which are available in tertiary prevention, and the diseases which are amenable to this type of preventive programme. Screening programmes using

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similar techniques have been used frequently in various fields in preventive medicine, albeit they have been used largely to detect one disease in each programme and have been very successful in doing so. There are three main fields so far utilizing screening methods in large programmes. In the United Kingdom large scale diagnosis of pulmonary tuberculosis was undertaken using mass miniature radiographic techniques. Almost every community in the country was visited by one of these units, and treatment was offered to all those who were found to have the disease. Over the years this has resulted in a marked fall in the notification of new cases and in the death rate from pulmonary tubercle (table I). It can be seen that

TABLE I\*  
NOTIFICATION OF NEW CASES AND DEATH RATE—PULMONARY TUBERCULOSIS  
1950–1964

<i>Year</i>	<i>Pulmonary T.B. notified</i>	<i>Death rate from pulmonary T.B. (per 100,000)</i>	<i>Year</i>	<i>Pulmonary T.B. notified</i>	<i>Death rate from pulmonary T.B. (per 100,000)</i>
1950	157	47	1958	100	12
1951	152	37	1959	72	10
1952	144	28	1960	64	9
1953	147	23	1961	59	8
1954	138	20	1962	54	8
1955	127	17	1963	49	10
1956	115	14	1964	45	7
1957	153	13			

\*Scottish Home and Health Department Statistics<sup>1</sup>

since 1960 casefinding and mortality have levelled off. It is perhaps reasonable to suppose that there is a pool of infection that cannot be totally eradicated, only contained. There are two possible, indeed likely, sources of this pool of infection. First, it has been found that those people within the community who are most at risk, such as those living in sub-standard housing, and with a low level of health education, are the very people who are most unwilling to have chest x-rays and are irregular at taking medication. The second likely source of infection is from immigrants to this country from areas of high tuberculosis prevalence such as Hong Kong, India and Pakistan. Until there is some control which is effective both in its concept and its application, there will be a constant reintroduction of infection from these areas. Gunn<sup>2</sup> has shown that there is a shift in the age group to the younger ages in the new notifications, and he suggests that a more rigorous follow-up of contacts is needed to contain the disease. Citron<sup>3</sup> bears this out and maintains that up to five per cent of contacts will develop the disease in an active pulmonary form.

Both Gunn and Citron strongly urge more activity in the school tuberculin testing with the use of BCG vaccination when needed.

**Antenatal screening**

The second field in which screening techniques have been extensively used is in antenatal care, resulting in a marked decline in the stillbirth rate and both maternal and foetal mortality. While a considerable part of this improvement can be attributed to the use of antibiotics and such specialized techniques as washout transfusions in haemolytic disease of the newborn, by far the greatest improvement is the result of the high standard of antenatal care now normally given to the expectant mother. Throughout her pregnancy a constant check is kept on her blood pressure; regular urinalyses are performed; the position of the foetus and the general physical status of the mother are kept under regular surveillance. Table II shows the steady improvement in the stillbirth, maternal and neonatal death rates over the past 15 years.

**TABLE II\***  
**MATERNAL DEATHS, DEATHS UNDER ONE MONTH, STILLBIRTH RATE (PER 1,000 DELIVERIES), 1950-1964**

<i>Year</i>	<i>Maternal deaths</i>	<i>Stillbirth rate</i>	<i>Deaths under 1 month</i>	<i>Perinatal deaths</i>
1950	1.11	26.9	23.0	—
1951	1.06	26.6	22.3	—
1952	0.99	26.2	21.7	—
1953	0.92	24.8	19.3	—
1954	0.74	25.3	20.6	—
1955	0.45	24.6	19.7	—
1956	0.52	23.9	19.1	—
1957	0.46	23.7	19.6	—
1958	0.52	22.8	18.7	—
1959	0.35	22.2	19.4	—
1960	0.30	21.7	18.2	—
1961	0.40	20.8	17.9	36.0
1962	0.40	19.9	17.9	34.8
1963	0.40	19.1	16.8	33.4
1964	0.20	17.9	16.4	32.1

\*Scottish Home and Health Department Statistics<sup>1</sup>

**Diabetes**

The third and most recent field in which screening methods have been applied is in the detection of diabetes. A large number of surveys of this type have been carried out in the country in the recent past. They have revealed the extent of unsuspected diabetes within the community. As a result of these people being diagnosed and

treated, they are no longer in indifferent health and are now able to lead fuller and more active lives than before. Surveys (table III)

TABLE III  
NEW DIABETICS ELICITED BY SURVEY 1960-1962

<i>Diabetic surveys</i>	<i>Population</i>	<i>Glycosuria per cent</i>	<i>New diabetics per cent</i>
Halstead 1960 <sup>4</sup> .. .. .	3,843	3.3	0.57
Walker and Kerridge 1961 <sup>5</sup>	4,105	4.8	0.67
Coll. of Gen. Practit. 1962 <sup>6</sup>	19,412	2.6	0.69
Arbroath, 1962 <sup>7</sup> .. .. .	17,958	2.4	1.10
Forfar, 1962 <sup>8</sup> .. .. .	10,758	3.6	0.37

have shown that the incidence of unknown diabetes is in the region of 0.5 to 1.0 per cent, depending on how strict a criterion of diagnosis is used.

It can be seen from these three examples that a different technique for diagnosis is needed for each, a chest x-ray, a physical examination or a laboratory test. It is not an easy matter or a simple procedure to make a diagnosis at a presymptomatic stage of any disease, and it is necessary to utilize every scientific and statistical aid available.

#### **Diseases amenable to screening and some screening methods**

In planning a programme designed to elicit disease at a pre-symptomatic stage which will be used in a given community, it is essential to ascertain beforehand the types of disease most prevalent within that community. On the basis of this one must select the diseases serious enough to warrant detection, which are most likely to be detected with the techniques available and which can be treated

TABLE IV\*  
PREVALENCE CHRONIC CONDITIONS IN 1,503 EXECUTIVES, PHILADELPHIA, 1960

<i>Disease</i>	<i>Total number</i>	<i>Percentage</i>
Obesity .. .. .	137	9.0
Hypertension .. .. .	124	8.1
Ano-rectal lesions .. .. .	94	6.2
Rectal polypi .. .. .	87	5.6
Prostatic pathology .. .. .	47	3.1
Hernia .. .. .	35	2.3
Diabetes .. .. .	28	1.8
Coronary heart disease .. .. .	14	0.9
Peptic ulcer .. .. .	11	0.7

\*Elsom: Periodic health examination: 1,503 executives

or modified to the benefit of the patient.

*Diseases of the circulatory system and obesity.* Morbidity studies are available for many parts of the world, and in some areas more in-depth studies have been undertaken. Elsom<sup>9</sup> studied 1,513 executives in the Diagnostic Clinic at Philadelphia, finding obesity to be the disease of highest prevalence, at 9 per cent; hypertension was close behind at 8.2 per cent (table IV). Of the people examined at this clinic new diagnoses were made in 58 per cent of cases, and the same group examined 16 months later exhibited an additional 47 per cent of new diagnoses, a classical example of the value of continuing surveillance. Ashworth<sup>10</sup>, in a much smaller survey, offered a screening programme to all his patients between the ages of 45 and 54 years, and 225 people took advantage of his offer. New diagnoses were made in 19 per cent of the participants, and the two most common diseases were hypertension and obesity (table V).

Obesity often leads to a lack of well-being in itself; worse than that, however, the obese patient frequently develops hypertension with a raised blood cholesterol which in the future may cause coronary arterial disease. The obese person, also, is frequently incapacitated by an impaired pulmonary function and in old age will usually develop the senility-related diseases earlier than usual.

If all these complications of obesity cannot be entirely prevented, at least their onset can be delayed and the effects minimized, by simple dietary procedures at an early stage. The diagnosis of obesity in its gross state presents no problems, while earlier the simple measurement of height and weight will indicate the diagnosis.

*Hypertension.* The diagnosis of this condition at an early stage is often of considerable importance. While in some cases the disease cannot be effectively controlled, even with the most potent of modern drugs, the vast majority of patients are responsive, and at times the underlying cause of the hypertension can be corrected. The diagnosis of this condition is a simple enough procedure provided that adequate care is taken to minimize the patient's emotional response thus giving rise to false positive results.

TABLE V  
PREVALENCE CHRONIC DISORDERS, 225  
PATIENTS, DARBYSHIRE HOUSE  
HEALTH CENTRE, 1963\*

<i>Disease or symptom</i>	<i>Total</i>	<i>Per-centage</i>
Obesity .. ..	3	1.3
Hypertension ..	22	9.8
Angina of effort ..	2	0.9
Proteinuria ..	3	1.3
Anaemia .. ..	3	1.3
Gynaecological pathology ..	8	3.5
Glycosuria ..	1	0.4

\*Ashworth, H. L. Survey of 225 patients, Darbyshire House Health Centre.

*Anaemia.* This is a very common disease in this country. Ashworth<sup>11</sup> suggests that the incidence is about 15 per cent in the Manchester area, and Donaldson, in his Multiple Screening Programme at Rotherham in 1964<sup>12</sup>, found 6 per cent. The screening methods available for detecting anaemia are many, ranging from the Van Slyke method to colorimetry. Johnston<sup>13</sup> found the Van Slyke technique was quite satisfactory as a screening method, although for those who fell below the average normal limits more extensive blood examination was indicated before initiating simple iron therapy.

*Diabetes.* Much more information in regard to diabetes is now available in this country than for almost any other disease, with the possible exception of pulmonary tubercle. A large number of surveys which have been carried out in the past decade, all indicate that the incidence of undetected disease lies in the region of between 0.5 and 1.0 per cent depending on the strictness of diagnostic criteria used (*see* table III). There is some disagreement as to whether or not these surveys have been worthwhile, as the type of disease found has been in the main, of the senile variety. However, mild ill health can be caused by this form of diabetes, and opinion that to find the diabetics is desirable is hardening, since, as a group, diabetics are more liable to other pathological processes which are largely preventable. The diabetic is also more susceptible to infections, particularly of the Koch variety, so that surveillance of these people would appear to be appropriate.

*Cytology.* At the present time a great deal of pressure is being built up by the lay press to make this procedure available to a larger number of people than it currently is. MacGregor and Baird<sup>14</sup> showed the incidence of preinvasive carcinoma of the cervix to be in the region of one per cent, this figure being confirmed later by Grant<sup>15</sup>, who also found the highest incidence to be in the 20–44 age group. More recent information from the United States indicates that there is a relationship between frequency of sexual intercourse and cervical cancer. There is little doubt that this is an essential screening procedure which should be available to every married woman on a regular basis, as well as to any other woman who wishes it.

*Chronic urinary infection.* A large amount of material is available regarding the incidence of this condition. Kunin *et al.*<sup>16</sup> carried out an extensive survey of American school children and found evidence of chronic urinary infection in 1.14 per cent of all those surveyed. Further investigation of these people by cystoscopy showed that 44 per cent had some demonstrable abnormality, the most common being ureteric reflux; on IVP, 22 per cent had findings

indicative of renal disease. Eastwood *et al.*<sup>17</sup>, using purely clinical criteria for the diagnosis, suggested the incidence of chronic infection to be over 6 per cent. Allen<sup>18</sup> confirms the high incidence of ureterovesicular reflux in association with chronic urinary infection and suggests that this is the cause in as many as 66 per cent of chronic infections. At present, the screening methods for this are neither easy nor cheap, although the use of the Uroscreen (Pfizer) is of value in the detection of *Escherichia coli* in large numbers. Percival and Bromfitt<sup>19</sup> suggest that there may be a relationship between a high antibody titre to *E. coli* and the amount of renal tissue damage. If this were so then the need for elaborate radiological investigations would be considerably reduced.

*Glaucoma.* At the present time it is a very vexing question as to whether or not this is a suitable disease for screening; many ophthalmologists believe that simple tonometry is grossly inaccurate and as such is more of a hindrance than a help as a screening method in this disease. Graham and Hollows<sup>20 21</sup>, have shown that tonometry will give normal readings when glaucoma can be shown to be present by slit lamp examination. They went on to show that tonometry missed about half the cases, and that over 6 per cent of those with a raised intraocular tension did not in fact have glaucoma. Other methods of screening were found to be equally inaccurate, and it would seem that at the present time there is no suitable, high-accuracy screening test available. However, since tonometry will detect some of these cases, there is a fairly strong argument for doing this, provided its limitations are taken into account.

*Chronic bronchitis.* This condition is one of the major scourges of the male population of this country, and the early detection of the disease would prevent suffering and save many thousands of work days. Although the disease itself is not entirely preventable, it is possible, with the use of antibiotics, to reduce the duration and the severity of the repeated acute bronchitic episodes which lead to the permanent changes of the chronic disease, and so minimize the permanent tissue damage. Once the disease has become established its detection is not a problem, but effort should be directed to making the diagnosis before this stage has been reached. Those in peak risk groups are fairly easy to screen out if one takes into account the geographical, environmental and occupational aetiological factors in this disease, adding to this evaluation of lung function, a diagnosis at a preclinical stage becomes a possibility. Gregg<sup>22</sup> has shown that one of the earliest signs was a decreasing peak flow rate, as measured with a Wright Peak Flowmeter, and he was also able to demonstrate that this was apparent long before the patient would admit to any

symptomatology related to chronic lung disease.

### **Personal and family history**

The value of a medical biography is constantly overlooked as a screening technique and is infrequently used in conjunction with laboratory procedures, thereby reducing the value of the biochemical results. A history is certainly the cheapest and one of the simplest techniques. It will produce a mass of very valuable data limited only by its lack of definitive ability. It will, however, yield information of diagnoses already made, although these may well have to be verified. The other obvious disadvantage is the time involved in eliciting a worthwhile history. Traditionally the physician will sit with the patient and conduct an interview; this is very wasteful of the physician's time, and the information will be biased quite unconsciously by the physician's own special medical interests. Also, it may be that the doctor-patient relationship may never be established to the extent of providing a good quality history. The solution to this may be the use of questionnaires dealing with medical areas which are of value in the context of the screening programme. These questionnaires are designed to yield high density information only on specific subjects and questions may be misinterpreted by the patient. Recently a new approach to this problem has been tried, using a small digital computer (LINC)<sup>23</sup>. With the computer, questions appear on a cathode ray tube, and the patient answers by depressing one of four keys. The response is then stored for future use, and the computer selects the next question on the basis of the original response. It was found, over a series of 50 patients, that the computer's analysis was more accurate than a team of physicians using traditional methods of history taking.

The value of verbal history-taking is closely related to the physician's background knowledge of the patient. Crombie<sup>24</sup> states that the doctor who knows the background of his patient intimately will be able to make a diagnosis on history alone in two out of 16 cases, adding that a physical examination improved the diagnostic rate only minimally, but that one was able to exclude the probability of serious illness in almost all cases. With the addition of laboratory procedures, i.e. biochemical, bacteriological and radiological, a firm diagnosis was made in one third of the patients. This would seem to indicate that a full history, local system examination and eclectic laboratory procedures comprise the most efficient way of making a diagnosis. In many ways it seems that the physical examination is of value in a negative, rather than a positive way.

### **Peak-risk selection**

This has gained favour as a screening method in this country



recently. Peak-risk selection means that some people, by reason of the environment or a history of certain diseases in either their own past or in their blood relatives', are more liable, at least statistically, to develop some conditions than other people within the community. A typical example of this would be the mother of the newly-born baby which weighs over ten pounds and whose own mother is a diabetic. In the opinion of many physicians this person is as good as being a diabetic herself, and many times this would be correct. Also on this basis, a person living in close contact with active tuberculosis is more liable to develop tuberculosis than the rest of the community who have not been in such close contact.

Further use of peak-risk selection can be made on a purely geographical basis. This was recently demonstrated by Anderson<sup>25</sup> using the existing records of vital statistics relating to maternal and child health to demonstrate an accurate localization of the peak-risk area of the city of Buffalo. It was shown that by itemizing the statistical data under review within the high-risk locality, quite definite subgroups of high-risk characteristics existed side by side. Here is another potent method, as yet rarely used in this country, of demonstrating the existence of high-risk groups, to what they are at risk and of showing with a fair degree of accuracy where they may be found in any given community.

### Urinalysis

Many tests have been devised to be used on urine for screening purposes, some are of value and others less so.

*Glycosuria.* This can be tested using either Clinistix or Clintest (Ames Company). As a screening test for diabetes it is inaccurate. This has been shown by two surveys, that of the Royal College of General Practitioners at Birmingham<sup>6</sup> and the other at Arbroath<sup>7</sup>. In both these surveys over 9 per cent of the controls, i.e. those who were nonglycosuric at the time of testing, were in fact, shown to have a glucose tolerance curve of a diabetic type.

*Proteinuria.* The validity of screening techniques for proteinuria is also in considerable doubt. Kunin<sup>16</sup> found that only 7 per cent of those with chronic urinary infection had proteinuria. Clark and Morgan<sup>26</sup> found the test to be too non-specific to be of diagnostic value, however in the presence of other pathology it had an adverse prognostic significance.

*Bilirubinuria.* Shutkin and Caine<sup>27</sup> used Ictotest (Ames Company) on 1,000 consecutive hospital admissions and found that 2.2 per cent had bilirubin present in their urine. Of these 55 per cent had no clinical icterus, and various diagnoses were made in these cases. The commonest cause was infective hepatitis, but a few early hepatic

neoplasms were found. Without doubt the incidence in the general population would not approach the 2.2 per cent of this study. It is likely that a number of subclinical and nonicteric hepatitides would be discovered.

*Phenylketonuria.* This is easily detected with the use of a paper Dipstick, and if found early enough in infancy, the condition will respond to treatment. Although the incidence is very low (in the region of one in 20,000) in this country, the test is routinely carried out by most public health authorities with great success.

*Bacteruria.* Certain bacteria can be screened in urine using the Uroscreen Test (Pfizer). This test is most accurate in the *E. coli* group of organisms, and, since they are by far the most common urinary pathogens, can be of considerable value in screening programmes. Many cases of asymptomatic urinary tract infections will be detected by Uroscreen.

### Conclusion

In the design and planning of a screening programme various factors must be taken into consideration. Programmes designed for school children and old or retired people will differ considerably, although the basic criteria will be the same. Firstly, a knowledge of the predominant morbidity in that community is essential. Secondly, diseases amenable to screening detection and to treatment, cure, or prevention will be selected as the main targets for the programme. Thirdly, areas of research can be delineated and fitted into the programme.

In order to save time and cost it is essential to plan the programme so that as much of the routine work can be done by paramedical personnel. It is rarely necessary to involve a physician as an active participant. His value is in assessment and advice to the patients who have positive findings. He will also be responsible for the initiation of further investigations which may be required to reach a diagnosis in any individual case.

A typical screening programme would include a history questionnaire with a competent nurse or secretary available to clarify any points the patients may wish to raise. The physical examination would include height and weight measurements, peak flow or spirometry tracings, cervical smear cytology, blood pressure measurements, urinalysis and two postprandial blood glucose estimations. Chest x-ray, haemoglobin, and breast examination would also be included. All these investigations would be done by either nurses or laboratory staff. Trained personnel would be available to carry out audiometry and visual acuity assessment. Thus, when the patient is seen by the physician, all the material he requires is available for him to reach a diagnosis and initiate treat-

ment if indicated. He is also in a position to advise on further investigations as appropriate.

### Summary

A brief history of the development of preventive medicine is outlined. Examples of already existing screening programmes are given with their results both to the individual and to the community. The diseases which are suitable for screening are discussed, and a suggested basic screening programme is illustrated.

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