THE subject of malnutrition is one which has achieved considerable prominence in the past few years and which merits the attention that is being given to it in this and other countries.

It is a matter of great importance in military as well as civil life, especially in its application to the younger generation, and should receive our very serious consideration.

The study of malnutrition is unfortunately hampered owing to difficulties of accurate definition and assessment, but these are being overcome to a material extent, and much additional knowledge of the subject has resulted from the investigations carried out in recent years.

Some authorities make a distinction between undernourishment due to sheer lack of calorie value in the diet and malnutrition which is so often due to the lack of a sufficiency of protective elements in the food ingested. Such a distinction appears illogical and it is difficult to find any valid reason for not regarding such undernourishment as a form of malnutrition.

It must be borne in mind, however, that though dietetic factors are of great moment in the causation of malnutrition, this condition may be due to other causes such as lack of sleep and of recreation and fresh air, unhappiness, malabsorption of food-stuffs, inadequate blood oxygenation and other circumstances, all of which, severally or in combination, may have to be taken into account in different cases.
It is advisable to make a distinction between primary and secondary malnutrition, the former being an original condition of which the development has not been due to any previous disease or disability, and the latter comprising a manifestation which is secondary to some definite and primary disease.

Primary malnutrition is undoubtedly a half-way house to frank disease. The child who suffers from it is more liable to infection, and, whether he escapes this contingency or not, will be adversely affected as regards his development, both mental and physical, and will often fail to attain that fullness of life which should be his heritage, and that degree of ability and capacity for work and play which he should possess.

The early recognition therefore of malnutrition and its treatment are likely to be of the highest importance in the prevention of disease and in assisting the maximum development of the child. Moreover, assuming the excessive prevalence of the condition, such early recognition and treatment will be of material help in raising the standard of health of the nation in the present and future generations.

The detection and, still more, the accurate assessment of a condition in the individual the nature of which is, to say the least of it, indefinite, is bound to be difficult, but we have available one method which, pending the discovery of a more satisfactory substitute, takes us some way along the road, and this is known as the method of clinical assessment. It was prescribed by the Board of Education in a circular of 1934 for use in connexion with the school medical services, and recommends that in the examination of a child for the presence or absence of malnutrition his general appearance should be noted.

Attention should be given to the facies, carriage, posture, and to the condition of the mucous membranes, while the muscular tone and the amount of subcutaneous fat must be observed. It is the dull listless child with a muddy complexion which is the typically malnourished individual in contradistinction to the alert, cheerful child with bright eyes and a good colour.

Carious teeth and other local defects may be signs of malnutrition, but should not alone be taken as evidence of its presence as any single sign may lead to error. It is essentially the general impression that decides the issue.

A method of this kind dependent upon the mental impressions of different persons with different views and experiences and not upon measurable standards cannot be perfect, but it affords the best means of assessment open to us at present, and after examination in the way referred to the child is classified in one of the following groups:

A.—Excellent.
B.—Normal.
It should be noted that this classification is incorporated in Army Form C. 319, the form of medical examination which has to be completed at the ages of 5, 8, 11, and 13 years in the case of all Army school children.

A simple test which may be looked upon as subsidiary to the clinical method is known as the sign of the dorsal median furrow. Here, with the child's arms held straight above the head, the median dorsal furrow is noted together with the posture. A broken or sinuous furrow is a sign of malnutrition, but is difficult to assess mathematically. Certain observers consider this sign to be of definite value, and this opinion has been to some extent confirmed by observations made at the Recruits Physical Development Depot at Canterbury by the Officer in Medical Charge of this establishment for the conditioning of sub-standard recruits.

The essential features of the clinical method of assessment having been described, we will turn our attention to a small number of additional tests out of a very large number which have been made the subject of investigation by numerous workers.

These tests are selected as being those most likely to be of practical value, since considered in conjunction with the clinical test, they will aid the detection of cases of malnutrition, especially of the slight and borderline type which might otherwise escape recognition.

These methods of assessment may be categorized in a simple manner as follows [1]:—

(1) Somatometric.
(2) Physiological: (a) Specific; (b) Non-specific.

As regards somatometric tests, investigations have been carried out by various observers on lines of this nature, and numerous formulae which take into account height, weight, chest and other measurements have been evolved, some simple and some complicated.

No combination of measurements, however, has emerged or is likely to emerge as an infallible means of nutritional assessment, but on the other hand certain measurements may be stated to be of definite assistance in this direction when studied in conjunction with the clinical method.

The height/weight ratio is a simple and comparatively useful index, but recent investigations by Huws Jones [2] appear to have established Tuxford's index as even more valuable, and it is claimed that the application of this formula allows of the picking out of 75 per cent of children assessed as subnormal by two or more doctors, whereas the average school medical officer would only be able to recognize some 66 per cent. This is tantamount to the index referred to being considerably more effective in
Malnutrition—A Survey

assessment than some doctors, and no doctor being materially superior to the index.

The formula referred to is as follows:—

Boys— \[
\frac{\text{Weight (in grammes)}}{\text{Height (in centimetres)}} \times \frac{(381-\text{age in months})}{54}
\]

Girls— \[
\frac{\text{Weight (in grammes)}}{\text{Height (in centimetres)}} \times \frac{(354-\text{age in months})}{48}
\]

and for average children the index is found to be about 1,000. It is suggested that any child with an index below 970 should be looked upon with suspicion.

Some points of a general nature are of moment in connexion with somatometric tests and should receive consideration.

In the first place in contradistinction to certain of the physiological tests to be mentioned later, they are comparatively easy of application to children in bulk and they are of particular value in studying the trend of the mean weight and height of children and adults in the same social group from year to year or in comparing the figures obtained in the same period in different social groups.

In the second place whatever somatometric formulæ are used, the taking of single readings at comparatively long intervals is of little assistance and the greatest value from them is to be obtained by regular measurements at six-monthly intervals or less. In this connexion it is suggested that, as is the practice with the L.C.C. school children, each child should have a chart on which his or her index value is graphed at each six-monthly measurement, and in addition the minimum allowable index value is also shown.

This arrangement allows of the visual detection of a drop in the child’s index value towards the minimum line, and permits the taking of any necessary steps to prevent a further fall.

As regards specific physiological tests it is probable that the estimation of hæmoglobin is as useful as any and is applicable within reason to the examination of children in bulk.

The rationale of the test is that some degree of anæmia is a common accompaniment of vitamin deficiencies in the diet.

It is, of course, essential to exclude any morbid cause for the anæmia and it should be noted also that in certain children with a definitely anæmic appearance a hæmoglobin figure of more than 100 may be discovered.

It might be well also to mention that the Hellige Neoplan hæmoglobinometer probably allows of more accurate and rapid readings than do other types of apparatus of this nature.

It is not contended that the estimation of hæmoglobin is a means on its own of establishing the existence of malnutrition in a child, but it will
in a proportion of cases afford confirmatory evidence of such a condition, and it is possible that with further investigations its value may prove even greater than appears at present.

Other specific physiological tests to be mentioned are used for detecting the existence of what are described as vitamin predeficiencies. They have on the whole the disadvantage that they are not applicable to bulk examinations of children, and are likely to prove of greater worth in connexion with special cases in which it is particularly desirable that the presence of early stages of vitamin deficiencies should be established.

These tests, moreover, are largely still in the experimental stage. They are, however, referred to as, apart from the interesting field of investigation they represent, they may be found useful.

Predeficiency in vitamin C is as important as many other factors in the causation of malnutrition and for its detection certain methods are open to us. Of these, tests for vascular fragility are reasonably easy to apply.

The arterioles, venules and capillaries in certain pathological states (haemophilic and scorbutic syndromes) become comparatively fragile with the formation of petechiae, but in the case of a latent deficiency of vitamin C in order to produce petechiae some moderate distension is necessary.

This is the principle of Hess's technique in which by a pneumatic sleeve compression is maintained at 100 mm. of mercury for three minutes. If in that part of the arm subjected to stasis there are not less than ten petechial spots, it may be considered that abnormal fragility exists.

Hecht's modification [3] with certain recent improvements [4] is an advance on the foregoing test and in this a specific degree of depression is produced for thirty seconds by means of a cupping glass pressed on wet skin at the bend of the elbow. The maximum depression which can be used without producing petechiae and the minimum depression which causes them to appear can be ascertained.

The resistance of vessels is normal if they can stand suction for thirty minutes at a barometric pressure of 175 to 350 mm. of mercury. This test is a useful one when considered in conjunction with others, and if it is realized that causes other than dietetic may at times produce the sign which is the basis of the test. It is also simple, painless, rapid and accurate.

The vitamin-C content of the blood may be estimated in the laboratory. In this connexion it is stated [5] that when the organism is saturated with this vitamin, the concentration in the blood varies between 14 and 18 mg. per litre and some passes in the urine. This corresponds to the utilization of 50 mg. of ascorbic acid in a 70-kilogram subject (0.7 mg. per kilo).
In predeficiency the figure may be 0·1 mg. per kilo, and the proportion in the blood 0 to 4 mg. per litre. The minimum should be 12 mg. per litre.

The numerical results obtained vary somewhat with the methods employed, but with a standard procedure useful information is obtainable in regard to the existence or not of vitamin-C deficiency.

An indication of such deficiency may also be ascertained by examination of the urine.

The subject ingests 250 mg. of ascorbic acid per day and a daily analysis of the urine is carried out. If the reducing properties of the urine on 2:6 dichlorphenol-indophenol increase on the first day, then the body is saturated—the most satisfactory condition. It may, however, take one to five days, and if it takes longer than this definite predeficiency exists.

The test is satisfactory, but errors are liable to occur unless it is carried out under strictly scientific conditions owing to difficulties in connexion with the instability of ascorbic acid in urine even when it is acid, and with the presence of salts, urea, uric acid, etc.

An additional test recently introduced[6] and the subject of experiment is the intradermal injection of 0·01 c.c. of 2:6 dichlorphenol-indophenol under the epithelium of the forearm in an area free from hair and small superficial veins, since the latter may cause confusion as they are the same colour as the dye.

The times of injection and complete disappearance of the dye are noted. In order to minimize any error which may arise in the size of the wheal, four wheals are raised and the average time for decolorization is taken in each patient.

In a group of some thirty-five cases subjected to this test it was found that on the average 16·9 minutes were required for decolorization in cases unsaturated with the vitamin, 7·5 minutes in cases partially saturated, and 2·3 minutes in those fully saturated. Reducing the matter to simple terms it may be assumed that a decolorization time of less than five minutes indicates tissue saturation with vitamin C, and of ten minutes or longer a deficiency in this vitamin.

This test, it will be realized, is not difficult of application in bulk examinations, and should further investigations confirm its accuracy, it is likely that it will prove to be of extreme value to us in the determination of latent deficiencies of vitamin C.

Turning now to a consideration of vitamin A apart from the well-known effects of deficiencies in this vitamin, typified by diminished resistance to disease and the like, certain abnormal conditions of the eyes may occur, such as keratomalacia and xerophthalmia. The former is common in ill-nourished human beings, children being specially prone to suffer,
while the latter or "dry eye" is less serious and is particularly common in children in Southern India.

Of special moment in the assessment of vitamin-A deficiencies is hemeralopia or "night blindness."

This is characterized by an inability to see in any but a good light due to lack of power in the eye to form sufficiently quickly the visual purple which is essential in the adaptation of the eye to dim conditions of light [7]. The cause of this is lack of vitamin A.

In order to carry out tests in this connexion it is necessary to ascertain quantitatively the minimum intensity of light in which visual acuity can be determined by some particular ophthalmological test, first when the eye has been moderately dazzled beforehand by a given source of light and secondly after a certain time has been allowed to elapse for adaptation to complete darkness.

Edmund's [8] and the Birch and Hirschfield's photometer methods are probably the most satisfactory means of carrying out this test.

In order to estimate latent deficiencies in vitamin D X-ray examination of the wrist has been employed, but the method does not give as early an indication of these as the determination of phosphatase in the blood. An increase in this enzyme occurs in the blood in the presence of bone and certain other diseases, and is not specific for rickets.

The sign is, however, of practical importance in children suffering from incipient rickets, but otherwise clinically normal, and it appears before the clinical, radiographic, and other biochemical indications in the blood.

In the normal child of 1 to 10 years it is stated [10] that phosphatase varies from 100 to 250 units. In rickety children between 6 months and 2 years it is 300 to 700 units.

As regards vitamin B there is a definite relationship between dietetic intake and urinary output [11] in the individual, and measurement of the B content of the urine is consequently of value in the estimation of the extent of B deficiency if any in the diet. Harris and Leong state that a daily excretion of less than 12 international units in the urine is indicative of a dietary deficiency of this nature.

Methods of estimation of B in the urine are being investigated by various workers. Of these the most important from our point of view appears to be

a chemical test which depends on the fact that the vitamin can be easily oxidized to thiochrome which possesses a strong fluorescence. The degree of fluorescence produced varies with the amount of the vitamin present [12].

This completes a consideration of those specific physiological tests which it is suggested are the most important of those that have emerged
from investigations carried out up to the present by various workers, and we will now turn to those of a non-specific type.

These are to all intents and purposes equivalent to tests of physical efficiency, and it will be agreed that trials of this nature should be included in any series of tests having as their object the assessment of nutrition.

The dynamometer test is one of strength and of the functional efficiency of the voluntary neuromuscular system.

The pulling power of the child is measured and the results of the $P_{(ull)} / W_{(eight)}$ ratio are compared.

A number of investigations are being carried out with this method of assessment of physical efficiency and with a modification of the test in which the time in seconds the child can keep the dynamometer at a figure equal to half the maximum pull is recorded.

The hanging bar test is an index of physical endurance and consists merely in ascertaining the number of seconds for which a child can remain hanging on a horizontal bar.

Although the last two tests mentioned cannot be looked upon as infallible guides to nutrition, yet they may be employed, within reason, as pointers in one direction or the other.

Finally, Romberg's test is popular with some observers and is a measure of equilibrium and muscular co-ordination.

The child is made to stand at attention with eyes closed, and instability and discomfort are watched for for some fifteen to twenty minutes. It is stated that most unfit children break down in ten minutes.

The various methods, mentioned above, having for their object the detection and estimation of nutrition, are of a direct nature and involve examination of the individual of various descriptions.

It should be pointed out, however, that indirect means of investigation exist of which the most important is that of the dietary survey. This is of particular value when applied to communities, institutions, and the like, and if properly carried out will indicate shortage of protective foods, etc., in the diet.

It will not discover malnutrition in the individual but will assess the corporate liability to it of a community as far as dietetic causes are concerned.

Certain quantitative dietary surveys of this kind have been and are being made under the aegis of the Advisory Committee on Nutrition, and valuable information is likely to be forthcoming. The family budgetary aspect of the question is also being considered in these investigations.

Finally, the beneficial effects of extra milk on school children and others, whose diets otherwise have sufficient energy value, afford sure evidence of prior malnutrition in those in whom these results are observed.
Considering now the question of the prevalence in this country of malnutrition, some light is thrown on the matter by the reports of school medical officers, in which the findings as regards the incidence of malnutrition, as assessed by the clinical method, are given.

Summarizing these findings: In 1,696,527 school children assessed as regards their nutrition in 1937:—

- 15 per cent were classified as excellent.
- 73·8 per cent as normal.
- 10·6 per cent slightly subnormal.
- 0·6 per cent bad.

These findings were very similar to those of previous years and it may be assumed that some 11 per cent of school children in this country on the average are below the normal in nutrition.

In certain districts though, such as the Special Areas, the figures are very different, and in 1935, in Jarrow, some 22·9 per cent and 6·7 per cent of school children were slightly subnormal and markedly subnormal respectively.

In Pontypridd the figures were 19·75 per cent and 4·76 per cent.

Additional evidence is available from the recruiting figures which testify to the large proportion of those men offering themselves for enlistment who are below the comparatively low standards of physique required. In 1935 it is stated some 62 per cent were rejected, and there is still a comparatively large medical rejection rate. It seems reasonable to assume that an examination of the poorer classes would disclose a similar if not more adverse state of affairs.

The evidence of our own eyes when we glance at the large numbers of obviously substandard individuals who crowd the pavements of our towns and cities is incontrovertible, and this lack of physical fitness is in a majority of cases due not to frank disease but to malnutrition. This may have been induced in numerous cases by defective feeding, but such factors as overwork, lack of sleep and recreation, insufficient fresh air and so on have an important bearing on the matter, and must not be forgotten—nor must we lose sight of these “other factors” in forming our opinions as to what preventive measures should be undertaken.

In the Political and Economic Planning Report on the Health of the Nation it is mentioned that Spence and Friend compared children of the middle and working classes in Newcastle and found that of the latter some 47 per cent were below average height and some 55·2 per cent below average weight. In the middle class children 25 per cent were over the average height and 48·4 per cent above the average weight.

It is interesting in this connexion to note that the boys at the Duke of York’s School, Dover, and Queen Victoria School, Dunblane, are on entry below the average for their class; and it would appear that it
Malnutrition—A Survey

is some two years before they attain this average as the result of good feeding and environment. Subsequently they achieve even higher standards, but never reach, as far as average measurements are concerned, those of the public schoolboy.

From observations of Christ’s Hospital schoolboys emerged the interesting fact that at 13 years of age they are on the average 2.4 inches taller than the Council schoolboys, and at 17 years 3.8 inches taller than employed males. Although environmental and hereditary factors play a part there is evidence to show that diet is a most important element in the situation.

For instance in a well-known experiment at an Industrial School, boys fed on an “adequate” diet grew at the rate of 1.84 inches a year, whereas those on extra milk as well grew 2.6 inches a year.

An experiment in Scotland showed a 20 per cent increase in weight in 1,500 school children given additional milk compared with children not so treated.

Sir John Orr came to the conclusion that about half of the population of the United Kingdom have a diet deficient in vitamins A and C, and that a similar proportion of the people do not obtain sufficient quantities of phosphorus and iron.

Professor A. L. Bowley criticized these findings on various grounds but states “there is abundant medical evidence that malnutrition slight or serious is widespread and that there are classes of the population here and abroad whose unaided resources are too small for adequate expenditure on food.”

In conclusion, it may be accepted that while ideas may differ as to the extent to which malnutrition is prevalent in this country, a consensus of opinion considers that it is an adverse factor in the health of the nation which affects its people to a material degree.

The subject is one which is of peculiar interest to those in the Service in its special relation to the health of children and others in tropical and semi-tropical climates.

Unfortunately statistics are not available at present which throw any great light on the matter, but in many cases the experience of those to whose lot it has fallen to be responsible for the supervision of the health of families in India and other countries undoubtedly is that malnutrition is prevalent among them to a considerably greater degree than is the case in this country. It would seem also the reasons for this are to be found mainly in dietary defects of which lack of vitamins is probably the chief, coupled with adverse climatic conditions.

It will be agreed that this subject of malnutrition in military families at home and abroad is one which is deserving of our special study as Army medical officers and that we should play our part with the civilian medical
services in eliminating as far as we can malnourishment in the child and in helping to build up the national health.

It will be realized also that a wide field of investigation into the matter is open to us.

In the prevention of malnutrition it is clear that the importance of doing all that is possible to increase milk consumption, particularly in children, is paramount.

Under the milk-in-schools scheme, in which Army school children in this country participate, one-third of a pint of milk at the cost of 3d. is available for the ordinary child but for malnourished children free milk is obtainable.

It is estimated that about half of the 7,000,000 school children in this country between the ages of 5 and 18 years are taking milk in school, and in England and Wales in the year ending March 31, 1937, 22,750,000 gallons were consumed in this connexion. It will, however, be agreed that though one-third of a pint a day for a child is better than none at all, much benefit from this amount cannot be expected unless the home as distinct from school consumption of milk of the individual child is greater than is usually the case, and that the amount per head authorized in schools at present at the cheap rate should be increased.

Schemes for increasing the milk consumption by the industrial population of our factories also exist and at the end of 1937 covered more than 5,000 factories containing 1½ million work-people who consumed about 600,000 gallons a month.

The installation of milk bars is being encouraged and these are increasing in numbers, though they do not in all probability account for more than about 4,000,000 gallons a year.

In many areas too, facilities exist for the provision of milk for nursing mothers and young children from welfare centres.

These and other schemes are doing much to augment the drinking of milk, and the necessity for this is indicated by the conclusion come to by the Advisory Committee on Nutrition that the national consumption of milk including that of the dried and condensed type is only some 60 per cent of what is considered necessary by the Technical Commission of the League of Nations Health Committee.

In other directions and from the dietetic point of view, much is being done.

Arrangements exist in a majority of areas for the provision of school meals, which in necessitous cases are free. In a number of areas three meals a day are available both during term and in the holidays. In other cases midday meals or "milk" meals are provided while some Local Authorities supply cod-liver oil and malt extract.

Propaganda and instruction are of the greatest moment, and it is
impossible to emphasize unduly the importance of adequate instruction in nutrition and cookery in schools, and of propaganda work in maternity and child welfare centres and the like.

The Central Council for Health Education and the National Milk Publicity Council do valuable work in this connexion, while the British Medical Association with the publication of "Family Meals and Catering" has done much to help. It should be mentioned, moreover, that those interested in this matter may obtain advice and assistance from either of the two national councils referred to.

Finally, it has already been stressed that dietetic factors are not the only consideration in the production of malnutrition and consequently in its causation other possible factors in the situation must be considered.

Their ascertainment may involve careful inquiry in each case into environment at home, at school, or at work, as the case may be, and the taking of all practicable steps to rectify any conditions found which are reacting adversely on the health of the individual. Space, however, does not allow of further consideration of factors of the nature referred to, which may include within their scope circumstances adverse to the individual of many and varied descriptions.

In conclusion the writer would mention that his article is intended primarily to stress the need for further investigation and is little more than a summary of the important points which arise in connexion with this much discussed subject of nutrition. He would invite the attention of those interested to certain reports and publications the majority of which are included in the references given below.

In particular a study of the Bulletin of the Health Organization of the League of Nations, Volume VI, No. 2 of April, 1937, which contains a report on the work of a group of experts appointed to study methods of assessing the state of nutrition in infants and adolescents, and of the section of the recent P.E.P. (Political and Economic Planning) Report on the Health Services of the Nation which deals with nutrition, will afford more detailed enlightenment to those who are interested in this important question.

REFERENCES.

A. E. Richmond


