

# Assessment of Nutritional and Metabolic Condition in the Field

GENERAL AND CLINICAL ASPECTS

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TECHNICIAN FOURTH GRADE A. RAZOYK AND TECHNICIAN FIFTH  
GRADE M. CASTIGLIONE, ARMY OF THE UNITED STATES

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## ASSESSMENT OF NUTRITIONAL AND METABOLIC CONDITION IN THE FIELD

### GENERAL AND CLINICAL ASPECTS

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In a series of surveys of groups of soldiers living and working in a variety of climates, some of them extremely rigorous, we have been impressed with the manifold and complex possible causes of physical deterioration, which include emotional disturbances in uncomfortable or perilous surroundings, diseases that are not fully incapacitating, the rigors of work, environmental extremes, inadequate or improperly used equipment and combinations of many types of nutritional deficiency. Unless these complexities are emphasized constantly, serious errors of interpretation may arise in nutritional surveys. The present paper deals with our experiences with young men active in the field, and the results and conclusions are not necessarily applicable without reservation to other age groups or other types of population.

The assessment of nutritional status in the field should employ as many various technics as are practical under sometimes difficult and primitive conditions. Too much reliance on any one technic may lead to grossly erroneous conclusions. In our experience a man is adequately nourished if he maintains good physical fitness and morale

From the Harvard Fatigue Laboratory.

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The statements and opinions expressed are those of the authors and are not necessarily in agreement with the official views of any governmental agency.

\* We are indebted to the Quartermaster's Climatic Research Laboratory for the services of Technician Fourth Grade J. Poulin, Technician Fourth Grade A. Razoyk and Technician Fifth Grade M. Castiglione, whose skilled technical assistance has contributed largely to the present work.

in the day's work, if he remains free of clinical symptoms or signs of deficiency and if he avoids chemical desaturation of any of the important nutrients. We have employed in the field a system of diagnosis depending on consideration of: (a) detailed medical history, (b) detailed dietary history, (c) routine medical examination, (d) chemical examination of blood and of urine obtained from the subjects before breakfast, (e) analysis of chemical changes resulting from a standard oral dose of ascorbic acid, thiamine hydrochloride, riboflavin and nicotinamide and (f) performance of both short and prolonged tests of physical fitness for hard muscular work.

Certain practical considerations have to be met in field surveys: (a) Men should be withdrawn from their training schedule for as short a time as possible; (b) all observations should be completed at a single session, since there is frequently difficulty in getting the same men to return on successive days; (c) men should not be asked to forego more than one meal; (d) apparatus should be sturdy, light and portable, and methods should be as nearly as possible independent of local sources of power, which are not always available or dependable; (e) finally, since observations must be made in widely different climates, special precautions for stabilizing and preserving samples must be taken.

#### CLINICAL OBSERVATIONS

We shall now discuss one by one the various technics employed in our system of diagnosis and emphasize some of the peculiarities of active young men:

1. *Medical History*.—This is elicited according to standard medical procedures system by system. In addition, careful inquiry is made into the effects of heat, wet, cold or altitude; of inadequate equipment or clothing; of physical fatigue, and into certain fairly characteristic syndromes, such as intolerance of heat, intolerance of cold, mountain sickness, gross physical unfitness, salt

cramps and inefficiency due to water deficiency. If neuropsychiatric disturbances are present, they are usually detectable in this interview.

2. *Dietary History.*—It must always be borne in mind that even the best field ration is not so satisfactory as a normal diet of fresh food. Intense dislikes of certain important items will always be found among men who have lived on field rations for a considerable period, and different men dislike different things. Caloric deficiency may be common among such men. Hence, likes and dislikes, intolerances and allergies must be searched for. Loss of appetite and loss of weight are important. It is usually possible to make a qualitative estimate of the intake of important nutrients, but field rations may undergo deterioration during transportation and prolonged storage. These changes may vitiate any estimate of intake, unless analyses of the food can be undertaken. Losses may also occur in preparation.

3. *Medical Examination.*—Particular attention is paid to the systems which reveal nutritional deficiencies on simple inspection. Among these the more important are the skin, eyes, nose, lips, gums, teeth, tongue and nervous system. The neurologic examination may well be restricted to eliciting tendon jerks and to testing the senses of light touch, pain and vibration. The abdomen, heart and lungs need not be examined routinely unless the history warrants it.

In examining troops under desert, temperate and subarctic conditions we have found certain physical signs to be extremely common and not necessarily related directly to diet.<sup>1</sup> The commonest are: (a) carious teeth—dental care is commonly poor in many cases because of difficult field conditions; (b) gingivitis—this is commonly seen among men with poor oral hygiene and consists typically of edema of the interdental papillae, redness of the gum margins, bogginess and easy bleeding on pressure. Laceration of the gums is not uncommon from eating hard biscuits. (c) Coated tongue—this is typically a thick fuzzy coating, mainly in the midline, of color ranging from yellow to dark brown; (d) dermatitis—the three commonest forms are miliaria, tending to occur on the abdomen, forearms or upper legs, “leggings” dermatitis, which is a scaling dry dermatitis of the lower legs in the leggings area, and folliculitis, especially over the thighs and buttocks; (e) conjunctivitis—this is usually of the dry type with scleral inflammation in the nasal

1. Almost all the changes discussed are commonly recognized as indicative of certain types of dietary deficiency.

and temporal quadrants (when severe right to the cornea) and appears to be a common effect of undue exposure to light, wind, dust and snow; (f) neurologic changes—alterations in tendon jerks are of common occurrence among the hard working infantry, and we have seen loss of knee jerks during the course of 150 miles (240 kilometers) of cross country marching. Asymmetry of vibratory sense in the legs is likewise of common occurrence among infantrymen.

4. *Chemical Examination of Blood and Urine.*—While the subjects are fasting before breakfast, venous blood is drawn and serum is prepared by standard methods. A timed specimen of urine is collected at the same time. The urine is stored in brown bottles and is acidified with dry oxalic acid, which stabilizes vitamin C as well as or better than does metaphosphoric acid (Ponting<sup>2</sup>). In addition, maximal stability of the vitamins of the B complex is attained at this degree of acidity. As a routine, qualitative tests are performed for urinary albumin, sugar and acetone bodies; quantitative measurements are made of whole blood hemoglobin, serum protein, serum chloride and urinary chloride, ascorbic acid, thiamine, riboflavin and factor F.<sup>2a</sup> If indicated, a wide variety of other measurements such as dextrose, nonprotein nitrogen and gas contents of the blood, can be carried out.<sup>3</sup>

5. *Physical Fitness and Morale.*—These are best tested by actual performance of the daily duties in the field. Line officers and noncommissioned officers are good judges of the condition of their men, provided a whole company has not deteriorated all together. Long forced marches give valuable information. Under most conditions information from these two sources is not always available; hence it is advisable to have some other means of testing the men's capacity for hard work. We customarily use for this purpose a field modification of the laboratory test of Johnson, Brouha and Darling.<sup>4</sup> This is a test of capacity for hard physical work, cardiovascular fitness and will power, and it has

2. Ponting, J. D.: Extraction of Ascorbic Acid from Plant Materials, *Indust. & Engin. Chem. (Analyt. Ed.)* **15**:389-391, 1943.

2a. Factor F<sub>2</sub> is sometimes designated as N<sup>1</sup>-methyl-nicotinamide, although the more accurate name is N-methylpyridinium-2-carboxylic acid amide (a quaternary ammonium compound).

3. We have developed a self-contained field nutritional laboratory for carrying out a wide variety of estimations under field conditions. A full description of it is being published separately.

4. Johnson, R. E.; Brouha, L., and Darling, R. C.: A Test of Physical Fitness for Strenuous Exertion, *Rev. canad. de biol.* **1**:491-503, 1942.

been of great use in dietary studies, e. g. protein studies by Darling and co-workers.<sup>5</sup>

6. *Tolerance Tests.*—The merits of various types of loading tests have been discussed by Youmans and Patton.<sup>6</sup> For practical field use the advantages of administering test doses by mouth in our experience outweigh the disadvantages. The chief arguments against oral administration are that the effects of individual idiosyncrasies of intestinal absorption appear and that the time of collecting specimens of urine is longer than when doses are injected. The chief arguments for administration of test doses by mouth are: first, that vitamin deficiencies caused by improper absorption are important and cannot be detected by injecting the test dose; and, second, that under field conditions it is often difficult to maintain facilities for sterilizing apparatus and solutions, whereas transportation of nonsterile tablets is convenient and saves space. For these reasons we have adopted the oral tolerance test employing 500 mg. of ascorbic acid, 5 mg. of thiamine hydrochloride, 5 mg. of riboflavin and 50 mg. of nicotinamide followed by collection of urine for four hours. This time is chosen for purely practical reasons, since it is highly desirable to miss the subjects in time for lunch. A longer period of collection would be better, but in actual practice the results justify these sorts of tolerance test. In experimental deficiency of vitamin C we have demonstrated the reliability of the short oral tolerance test.<sup>7</sup>

#### ESTABLISHMENT OF DIAGNOSIS

1. *Interpretation of Chemical Results.*—It must be borne in mind that moderate chemical unsaturation is often found in men with unimpaired mental and physical vigor, without other evidences of nutritional disturbance and eating an apparently normal diet. Extended experience with these tests has demonstrated that individual differences in absorption and in renal threshold are rather wide. When plasma levels are measured, as in the determination of chloride and of ascorbic acid, one frequently sees in normal persons high plasma levels with low

5. Darling, R. C.; Johnson, R. E.; Pitts, G. C.; Con-solazio, F. C., and Robinson, P. F.: Effects of Variations in Dietary Protein on the Physical Well Being of Men Doing Manual Work, *J. Nutrition* **28**:273-281, 1944.

6. Youmans, J. B., and Patton, E. W.: Nutritional Deficiencies: Diagnosis and Treatment, Philadelphia, W. B. Lippincott Company, 1942.

7. Johnson, R. E.; Darling, R. C.; Sargent, F., and Robinson, P. F.: Effects of Vitamin C Deficiency on the Physical Well Being of Men Doing Manual Work, *J. Nutrition*, to be published.

urinary levels. Therefore, only a low plasma level with a low urinary level is truly indicative of unsaturation.

In the case of substances measured only in the urine before and after loading (vitamin thiamine, riboflavin and factor F<sub>2</sub>), one can often see both low and high fasting levels<sup>8</sup> with good excretion of the test doses and also with poor excretion. Therefore, only a low fasting level associated with poor excretion of the test dose is considered indicative of unsaturation. These criteria are somewhat different from those of Holt,<sup>9</sup> who has stated that a zero level of thiamine, riboflavin or factor F<sub>2</sub> in the fasting specimen is indicative of unsaturation with respect to thiamine, riboflavin or nicotinic acid respectively.

The accompanying tabulation is used for interpreting<sup>10</sup> chemical data obtained by our field methods:

<i>Evidences of Chemical Inadequacy</i>	
Water	—Serum protein above 7.5 Gm. per hundred cubic centimeters.
Calories	—Sometimes ketosis; sometimes hypoglycemia; nothing is pathognomonic.
Salt	—Fasting serum chloride below 98 milliequivalents per liter and fasting urine chloride less than 0.2 Gm. of sodium chloride per hour.
Ascorbic acid	—Fasting serum ascorbic acid level below 0.3 mg. per hundred cubic centimeters and excretion of test dose less than 3 mg. in four hours.
Thiamine	—Fasting urinary excretion less than 0.6 microgram per hour, and excretion of test dose less than 20 micrograms in four hours.
Riboflavin	—Fasting urinary excretion less than 20 micrograms per hour and excretion of test dose less than 200 micrograms in four hours.
Nicotinic acid	—Fasting urinary excretion less than 0.03 mg. of factor F <sub>2</sub> per hour and excretion after test dose of nicotinamide less than 0.5 mg. of factor F <sub>2</sub> in four hours.

2. *Necessary Conditions for Diagnosis.*—We have adopted a conservative attitude in making a diagnosis of deficiency (for extended discus-

8. Throughout this paper "fasting level" means the hourly excretion in urine passed after emptying the bladder on arising and before any food is eaten.

9. Holt, L. E., Jr.: The B Vitamins and Certain Problems They Present to the Practicing Physician, *Pennsylvania M. J.* **46**:451-458, 1943. Najjar, V. A., and Holt, L. E., Jr.: A Simple Method for the Laboratory Diagnosis of Subclinical Deficiencies of Thiamin, Riboflavin and Nicotinic Acid. *Bull. Johns Hopkins Hosp.* **70**:329-330, 1942.

10. It should be emphasized that the time relations in deficiency are important, but present knowledge of the relation between daily intake of nutrients and the onset of incapacity is so unsatisfactory that the criteria listed are undoubtedly open to question by some investigators.

sions of this controversial field see Youmans and Patton<sup>6</sup> and Jolliffe and Most<sup>11</sup>). If the dietary history, medical history, medical examination, chemical results and tests of physical fitness all point in the same direction, some confidence can be placed in a diagnosis. In our experience, clear evidence of chemical unsaturation is a primary and indispensable requirement, and this must be supported by corroborative evidence from other sources of information. The correlation between chemical and other clinical information is often not so satisfactory as it might be. According to the "saturation theory," the highest health and efficiency are achieved only when loading tests reveal a high level of vitamins in the body. However, experiments in the laboratory and various nutritional surveys have revealed, first, that men in apparently good health can have low stores of vitamins and, second, that supplementing normal diets with vitamins does not lead to significant increases in physical fitness (see the complete review of Keys<sup>12</sup>). In our own surveys, we have frequently seen severe loss of weight without undue caloric deficiency, desiccated skin without demonstrable dehydration, apparently identical neurologic changes in men with and without thiamine unsaturation, identical types of conjunctivitis and cheilosis in men with and without riboflavin unsaturation, similar reddening and atrophy of the tongue in men with low and with high urinary levels of factor F<sub>2</sub>, and identical types of gingivitis in men with no ascorbic acid in the serum and with high levels of ascorbic acid in the serum. We have seen remarkably high physical fitness and morale in groups of men whose chemical stores were by orthodox interpretation low and extremely poor physical fitness in groups of well saturated men. We have seen adequate chemical stores in men subsisting on very unbalanced diets and low levels in men whose diet by analysis was high in water-soluble vitamins. Differential diagnosis may be extremely difficult, and there are complications in the factors of hard physical work, emotional stresses and exposure to climatic extremes. It appears that conservatism is desirable in making a diagnosis of nutritional deficiency.

Certain conditions are common to a great many nutritional deficiencies. Symptoms of lethargy, inefficiency and irritability are often

11. Jolliffe, N., and Most, R. M.: *The Appraisal of Nutritional States*, in Harris, R. S., and Thimann, K. V.: *Vitamins and Hormones*, New York, Academic Press, Inc., 1943, pp. 60-107.

12. Keys, A.: *Physical Performance in Relation to Diet*, *Federation Proc.* **2**:164-187, 1943.

the first symptoms. Poor physical fitness when established by satisfactory tests means one of two things: either the man has never been fit or else he was at one time fit and has deteriorated. Physical deterioration in association with nutritional deficiencies is commonly observed. It should be borne in mind that a man originally in very good physical condition may show physical deterioration and still be by ordinary standards at least in average physical condition. The dietary history may be unreliable for a variety of reasons.

The following considerations<sup>13</sup> lead us to various diagnoses:

#### Water

Dietary history—Inadequate intake, especially during periods of activity.

Medical history—Symptoms of heat exhaustion, particularly falling out of marches; syncope; easy fatigue in the heat; dizziness; headache, and unsatisfied thirst.

Physical examination—Dehydrated lips, tongue or skin; rapid pulse; body temperature may or may not be raised.

Chemistry—Unsaturation as indicated in the tabulation.

Physical fitness—May not be impaired for short bursts of activity, but is usually impaired for prolonged work.

#### Total Calories

Dietary history—Inadequate intake, especially of carbohydrate, in proportion to the daily work output.

Medical history—Progressive loss in weight; progressive increase in fatigue lassitude and decrease in efficiency and morale; hunger variable, being intense during the first few days but often decreased thereafter; bowel habits modified, usually with diminution of bowel movements; frequently nausea, with or without vomiting.

Physical examination—Nothing but evidence of recent loss in weight is usually found. There may be thick furring of the tongue, with foul breath. In case of severe deficiency acetone may be evident on the breath.

Chemistry—There may be little abnormal, but there may be dehydration with high serum protein, acidosis with ketonemia and ketonuria, and hypoglycemia.

Physical fitness—Usually seriously impaired, even for moderate work.

#### Salt

Dietary history—Inadequate intake; dislike of salt and salty foods.

Medical history—Symptoms of heat exhaustion (as outlined under "Water"); symptoms of heat cramps (as outlined by Talbott<sup>14</sup>); craving for salt.

Physical examination—Usually nothing abnormal, occasionally hyperactive tendon reflexes or tenderness of various muscle groups to pressure.

Chemistry—Unsaturation, as indicated in the tabulation.

Physical fitness—Usually impaired for hard work.

13. As will be seen by reference to the case histories, a diagnosis of deficiency is made only when there is clear chemical evidence. We do not always demonstrate positive physical findings, which usually become positive long after the beginning of chemical unsaturation.

14. Talbott, J. H.: *Heat Cramps*, *Medicine* **14**:323-376, 1935.

### Ascorbic Acid \*

- Dietary history—Inadequate intake of fruits, juices and vegetables.
- Medical history—Usually nothing significant; in cases of severe deficiency, lethargy, painful muscles, bleeding gums or ecchymoses on the lower extremities.
- Physical examination—Gingivitis, with red gum margins, edematous interdental papillae and easy bleeding on pressure; occasionally ecchymoses on the lower extremities, and rarely hyperkeratotic follicles, as observed by Crandon, Lund and Dill.<sup>15</sup>
- Chemistry—Unsaturation, as indicated in the tabulation.
- Physical fitness—Impaired only late in deficiency.

### Thiamine

- Dietary history—Inadequate intake of meats, eggs and cereals.
- Medical history—Multiple complaints, including lethargy, irritability, lack of ambition, anorexia, loss of weight; vague gastrointestinal symptoms, including mild nausea, rarely vomiting and irregular bowel habits; loss of strength; vague aches and pains, usually in the legs, joints or back.
- Physical examination—Usually nothing significant, but occasionally depression of tendon jerks, unequal tendon jerks, diminution of vibratory sense or diminution of sense of light touch.
- Chemistry—Unsaturation as indicated in the tabulation.
- Physical fitness—Impaired early in deficiency.

### Riboflavin

- Dietary history—Inadequate intake of milk, eggs and meats.
- Medical history—Usually little except "sore eyes," photophobia or excessive lacrimation.
- Physical examination—Dry conjunctivitis, with scleral injection encroaching on the cornea; rarely circumcorneal injection; cheilosis.
- Chemistry—Unsaturation as indicated in the table.
- Physical fitness—Usually unimpaired.

### Nicotinic Acid

- Dietary history—Inadequate intake of meat.
- Medical history—Sore tongue or mouth; irregular bowel habits, especially diarrhea.
- Physical examination—Typical dermatitis, atrophied papillae of the tongue, red inflamed tip.
- Chemistry—As indicated in the tabulation.
- Physical fitness—Usually impaired for hard work.

In field surveys it is essential to keep constantly in mind the various lengths of time necessary to cause inefficiency and deterioration in different nutritional deficiencies (see Johnson<sup>16</sup>). Deprivation of water can kill a man in hot weather in a day or two if he is sweating profusely, and we have seen cases of exhaustion of dehydration at —20 F. Caloric deficiency can demoralize working men in two or three days (as in case 7). Salt deficiency even in cold weather can lead to serious results in three or four days. Deficiency of the water-soluble vitamins can result in chemical unsaturation in

15. Crandon, J. H.; Lund, C. C., and Dill, D. B.: Experimental Human Scurvy, *New England J. Med.* **223**:353-369, 1940.

16. Johnson, R. E.: Nutritional Standards for Men in Tropical Climates, *Gastroenterology* **1**:832-840, 1943.

from one to two weeks, with physical deterioration in the case of the B complex if conditions are right. Given a previously normal diet, vitamin C deficiency can begin to cause trouble within three months. So far as is known at the present time, diets can be very low in protein, fat and the fat-soluble vitamins for several months without serious effects. Therefore, we place primary emphasis on nutrients lack of which can cause trouble in a short time. We have had no field experience with soldiers isolated for long periods or with civilian populations on poor diets for months or years. The techniques, measurements and interpretation of results under such conditions would doubtless have to be somewhat different from those that we have outlined.

### CASE HISTORIES OF NUTRITIONAL DEFICIENCIES IN MEN IN THE FIELD

This section consists of presentation of case histories illustrative of types of nutritional deficiency<sup>17</sup> met in the field. It should be pointed out at the outset that the percentage of such cases in troops on this continent is very low.

**CASE 1.—Dietary History.**—There had been a generally inadequate intake of all types of food, owing to constant anorexia in the desert.

**Medical History.**—The patient's general health was poor, with loss of 10 pounds (4.5 Kg.) after two months in the desert. He had experienced daily vague pains in the shoulders and legs without cramps, worse when marching; daily precordial pains with feeling of smothering and pains radiating to the left arm, and daily headaches, especially in morning. All symptoms were accentuated by exercise, during which the patient became progressively weaker. He never failed to finish a march, but he usually fell far behind and needed assistance.

**Physical Examination.**—There were severe miliaria, conjunctivitis, severe gingivitis, dirty teeth (many carious), severe malocclusion, diminished vibratory sense and sense of light touch in the legs. The margins of the tongue were atrophied.

**Physical Fitness.**—The patient was so incoordinated that a satisfactory test was impossible, but his fitness was obviously poor.

**Chemistry.**—Tests revealed a high serum protein level, 8.7 Gm. per hundred cubic centimeters. There was poor excretion of test doses of thiamine and riboflavin, but excretion of chloride and of factor F<sub>2</sub> was normal.

**Diagnoses.**—The diagnoses were: (1) congenital physical and mental weakness; (2) water deficiency; (3) thiamine deficiency; (4) riboflavin deficiency, and (5) probable caloric deficiency.

17. Therapy will not be discussed in this paper. The diagnoses in cases 2, 3, 6 and 7 were substantiated by specific therapy.

CASE 2.—*Dietary History*.—There was nothing abnormal in the dietary history.

*Medical History*.—The medical history revealed only a frequently unsatisfied thirst.

*Physical Examination*.—The conditions observed on physical examination were normal.

*Physical Fitness*.—The patient's physical fitness was low average.

*Chemistry*.—The serum protein level was very high, 8.7 per hundred cubic centimeters, and the serum chloride level was also high, 109 milliequivalents per liter. All other measurements were normal.

*Diagnosis*.—The diagnosis was water deficiency.

CASE 3.—*Dietary History*.—The patient's appetite and general intake of food were poor because of anorexia while in the desert.

*Medical History*.—For three days previous to examination the patient had had diarrhea with slight fever. On three separate days in the preceding month he had had epigastric pain with episodes of nausea and vomiting, and during that month six successive canker sores and three successive boils.

*Physical Examination*.—The patient had moderate gingivitis and one carious tooth.

*Physical Fitness*.—The subject was excused from the test because of recent illness, but he and his lieutenant reported that he had deteriorated badly.

*Chemistry*.—The ascorbic acid level of the serum was 0; the serum chloride level was low, 97 milliequivalents per liter. There was no urinary excretion of test doses of ascorbic acid and thiamine, but excretion of riboflavin was normal.

*Diagnoses*.—The diagnoses were: (1) salt deficiency; (2) ascorbic acid deficiency; (3) thiamine deficiency.

CASE 4.—*Dietary History*.—The subject's appetite was poor after one month in the desert.

*Medical History*.—The medical history revealed: chronic fatigue; 15 pound (6.8 Kg.) weight loss in three months; recurrent diarrhea lasting two to three days every two weeks, with vomiting after meals about once a week; chronic productive cough; pains, especially in the back, during exercise, and frequent dizzy spells.

*Physical Examination*.—The chest was clear on percussion, but the breath sounds were harsh, with many squeaks and groans. Many carious teeth were found. Knee jerks were sluggish, even with reinforcement, and ankle jerks could not be elicited. Vibratory sense was diminished on the right.

*Physical Fitness*.—The patient's physical fitness was rated as poor.

*Chemistry*.—Excretion of thiamine in the fasting specimen and excretion of the test dose were low. The serum protein, chloride and ascorbic acid levels were normal. Urinary excretion of ascorbic acid, riboflavin, factor F<sub>2</sub> and chloride was normal.

*Diagnoses*.—The diagnoses were: (1) thiamine deficiency; (2) chronic bronchitis, and (3) probable caloric deficiency.

CASE 5.—*Dietary History*.—This patient's diet in general had been good, but practically no dairy products of any kind had been available for two months.

*Medical History*.—During three months in the desert his "eyes had been weak," with considerable lacrimation and blood-shot conjunctivas.

*Physical Examination*.—A dry conjunctivitis was observed, and the right temporal lower quadrant showed pronounced infiltration, probable corneal invasion. There was no cheilosis.

*Chemistry*.—There was a low fasting urinary riboflavin level, with small excretion of the test dose. Other hematologic and urinary measurements were normal.

*Diagnosis*.—The diagnosis was riboflavin deficiency.

CASE 6.—*Dietary History*.—The diet had been adequate.

*Medical History*.—There was a past history of admission to a clearing station for heat cramps and heat exhaustion, but for the preceding month nothing abnormal had been observed.

*Physical Examination*.—Moderately severe gingivitis, with easy bleeding, conjunctivitis and severe miliaria were revealed on physical examination.

*Chemistry*.—The serum contained no ascorbic acid and there was no excretion of the test dose.

*Physical Fitness*.—The patient's physical fitness was rated as good.

*Diagnosis*.—The diagnosis was vitamin C deficiency.

CASE 7 (17 men).—*Dietary History*.—These men had had an excellent diet until three days previously, when they went on an unacceptable combat ration. The average daily intake for these three days was 1,700 calories, and the work output was about 4,500 calories.

*Medical History*.—This had been an excellent, tough platoon, with no medical abnormalities. After two days of inadequate diet a majority were suffering from a variety of gastrointestinal complaints, especially nausea, occasional vomiting, loss of appetite and complete cessation of bowel movements. Pathologic fatigue was constantly present, and spirits were at an extremely low ebb. They were living outdoors in temperatures down to -30 F. and they felt the cold keenly, in contrast to their usual good adaptation. Abnormal thirst was not present.

*Physical Examination*.—They were a group of listless, dehydrated men, with drawn cheeks and sunken eyeballs and with breath loaded with acetone. Systematic physical examination revealed no further abnormalities.

*Physical Fitness*.—Performance of the short severe test showed gross deterioration from the week previously. This deterioration had also been evidenced in the daily marches. One week previously they had all finished with ease a 46 mile (74 kilometer) forced march in thirty-six hours. After two days of poor diet, exhaustion curtailed at 10 miles (16 kilometers) a proposed 15 mile (24 kilometer) patrol.

*Chemistry*.—Chemical tests revealed severe acetonemia and acetonuria. The serum protein levels were high for subarctic subjects, averaging 7 Gm. per hundred cubic centimeters, and the serum chloride levels were low, averaging 96 milliequivalents per liter. Urinary excretion of chloride was essentially nonexistent and of ascorbic acid was low. Excretion of thiamine, riboflavin and factor F<sub>2</sub> was normal.

*Diagnoses*.—The diagnoses were: (1) acute caloric deficiency; (2) acidosis; (3) dehydration, and (4) chloride deficiency.

#### COMMENT

Our interest has centered on active young men in the field. In our experience with soldiers on the North American continent eating United States Army rations, significant deficiency is rare. When it does appear, the most important cause is rejection of important items of food because of inherent unpalatability, special

Food habits, intolerances, allergies, poor teeth, sore gums or in hot climates the commonly observed anorexia. Reports from combat theaters seem to indicate that deficiencies in some places are relatively common, owing to problems of supply, infectious diseases, emotional disturbances and rejection of unpopular items. It would seem, therefore, that the most useful work by nutritional surveys would be in combat theaters, not in North America.

#### SUMMARY

1. A system for assessing the nutritional status of young men active in the field has been developed. Emphasis is placed on the manifold

and complex possible causes of physical deterioration, which include emotional disturbances, diseases, the rigors of work, environmental extremes, inadequate or improperly used equipment and many types of nutritional deficiency.

2. There are six types of observations that are feasible in the field, namely, medical history, dietary history, routine physical examination, chemical examination of the blood and urine obtained before breakfast, chemical changes resulting from test doses of vitamins and performance in tests of physical fitness.

3. There is sometimes a disturbing lack of correlation among the various types of observation.