NUTRITIONAL FAILURES: THEIR CAUSES AND PREVENTION[1]

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NUTRITIONAL failure[2] begins when adequate amounts of essential nutrients are not provided to the "milieu interne." From this point the successive stages are represented by tissue depletion, biochemical "lesions," impaired function, and finally by anatomical lesions.

The anatomical lesions which occur in such clinical states as hunger edema, rickets, osteomalacia, scurvy, beriberi, and pellagra have long been recognized. There are a number of anatomical lesions, however, which are only beginning to be recognized as due to nutritional failure. Among these are cheilosis, fissures in the angles of the mouth, filiform dermatosis in the nasolabial folds, and invasion of the cornea by capillary blood vessels, all commonly attributed to nutritional failure related to deficiency of riboflavin. Quite recently Kruse (1) pointed out that xerosis conjunctivæ is probably the earliest anatomical lesion of nutritional failure related to deficiency of vitamin A.

Evidence has accumulated during the past five years which indicates that the diagnosis of nutritional failure cannot be limited to clinically manifest anatomical lesions. The preclinical states, as represented by tissue depletion, biochemical "lesions," and altered physiology, hold greater import because they precede and are more common than the anatomical lesions. These preanatomic lesions cause inefficiency, impair well-being, and constitute potent sources of poor health.

[1] This paper is taken from the chapter, "Nutrition and the Deficiency Diseases" by Dr. Jolliffe in the book PREVENTIVE MEDICINE IN MODERN PRACTICE, edited by the Committee on Public Health Relations of The New York Academy of Medicine, to be published shortly by Paul B. Hoeber, Inc., 49 East 33rd Street, New York.

[2] For the purpose of this discussion, nutritional failure is limited to deficiencies of protein, minerals, and vitamins.

Causes Contributing to Nutritional Failure

The circumstances mainly responsible for nutritional failure in this country can be classified under four headings: Poor food habits, highly-milled grain and refined sugar, price rationing, and intercurrent illness. None of these factors stands alone but each is inextricably interwoven with the others.

Poor Food Habits. Poor food habits develop in part out of the economic factors which are expressed by the term "price rationing"; they also foster and are a part of the wide use of highly-milled grain products and refined sugar. While ignorance of the rules of good nutrition is fundamental in the causation of poor food habits, they are dependent in considerable degree on popular taste and social custom, factors which weigh heavily in accounting for the consumption of significant quantities of nutritionally inferior foods.

Poor food habits may be either negative or positive. The negative poor food habits include nonconsumption of adequate amounts of the protective foods. This is often due to failure to promote the taste for the protective foods during childhood, to local food customs, racial antipathies, and economic restrictions. In many instances it is due to faulty social conditioning, as when the adolescent boy stops drinking milk as soon as he dons long trousers. The positive poor food habits include excessive use of candy, sweet carbonated beverages, and alcohol. The amount of candy sold in this country in 1939 was sufficient to furnish 90 calories per capita per day. The amount of alcohol consumed in the United States in 1938 was sufficient to furnish about 86 calories per capita per day, and probably exceeded 200 calories per person of alcohol-consuming age (2). Data on the amount of calories furnished by sweetened carbonated beverages to our thirsty population are not available at the present time. It must be very considerable, however, and it may exceed the calories furnished per capita by alcohol and candy combined. It is especially pertinent to note that, except for the small portion which is consumed in the home, these three sources of calories were not taken

into consideration in the Bureau of Home Economics surveys (3). In the case of alcoholic beverages even the amount consumed at home was not counted (4). Yet these vitamin-free calories, constituting possibly from 10 to 15 per cent of the total caloric intake, play an important part by lowering the vitamin-calorie ratio in depressing the quality of our dietary. This fact can be illustrated by adding 250 vitamin-free calories to Sherman's average American diet, which contains 2,500 calories and 342 International units of thiamin and has been calculated (5) to provide a 20 per cent margin of safety in vitamin B_1 above the level where clinical signs of deficiency may appear. With 250 vitamin-free calories added, the safety margin is reduced to only 10 per cent. Since this is an average diet, a 20 per cent safety margin means that considerable numbers have little or no margin of safety. This is actually the case when the safety margins of the city diets studied by Stiebeling and Phipard (3) are calculated (5). The effect of reducing this tenuous figure by half can be readily appreciated.

Vitamin-Free or Poor Calories. The factor of highly-milled grain products and refined sugar (white flour; white bread; highly-milled cereals; granulated, cane, and beet sugar) has contributed enormously to the present poor nutritional milieu in our country. It has already been indicated how this is bound up with food habits, white bread and sugar being widely considered as social refinements, besides appealing to popular taste. Economic necessity, however, is also involved in promoting the use of these products, for they are the cheapest sources of calories.

As pointed out by R. M. Wilder (6), undernutrition is now more serious than at any time in our history. It is worse today mainly because detrimental changes in our dietary habits which started sixty years ago have progressed almost uninterruptedly up to the present time, so that there is a cumulative as well as a more inclusive effect.

Some real improvements have occurred in the American dietary since 1880, notably the greater and more widespread distribution of

fresh vegetables, milk, and meats. This began with the development of the railroads, permitting stable foods indigenous to one section of the country to be distributed in other sections. Then came the railroad refrigeration car and express freight, which made possible the rapid transportation and hence wide distribution of perishable foods, such as meat, fresh vegetables, and milk. Next, the development of the canning industry has resulted in the preservation of fruits, vegetables, and meats at the season of the year when they are most abundant and cheapest, and their shipment and distribution all over the country throughout the year. A final factor in the improvement of our dietary has been the development of the motor truck. While commercial fresh fruits and vegetables were at one time available only in the fairly good-sized towns and cities, there is now hardly a hamlet in our entire country that cannot have these foods delivered to it by motor truck.

Other far-reaching changes in the American dietary, however, which have been called "improvements" have actually been detrimental. The first of these is the patent milling process. Prior to 1880 our grain was milled almost entirely in local communities, by methods which retained most of the vitamins and minerals. Since the introduction of the patent process from Hungary by way of England, grain has come to be milled more and more in the region around Minneapolis, and then transported to all sections of the country. The patent milling process, by removing most of the germ and the bran shorts from the flour, renders it much less susceptible to spoilage. This feature recommended the patent process to the millers and food distributors. The American people, at the same time, preferred the resulting white, cleaner, more uniform, and better baking flour. This process has caused the removal of about 90 per cent of the vitamin B_1 from flour, and 70 to 85 per cent of other fractions of the vitamin B-complex, and of iron.

The second major "improvement" in the American diet which has had a detrimental effect has been a marked increase in the con-

sumption of sugar. About one hundred years ago our annual per capita consumption of sugar was not more than ten pounds. Since the Civil War, and especially since 1910, this has progressively increased so that by 1939 our consumption of sugar amounted to more than one hundred pounds per capita per year. These two sources of calories, white flour and refined sugar, make up about 55 per cent of the calories consumed by the American people, and this total source of calories does not provide more than 50 International units of vitamin B_1. Thus, "a 55 per cent fraction of the calories in the American diet of 1840 containing a minimum of 600 I.U. of vitamin B_1 has been replaced in the contemporaneous American diet by a like fraction containing only about 50 I.U." (5) and has been correspondingly reduced in the other B vitamins and iron. These two factors, white flour and white sugar, must bear much of the blame for the present nutritional inadequacies in our country. The reduction of vitamins and minerals in our dietary brought about by the substitution of white flour for whole wheat is illustrated in Table 1. It will be noted that only 11 per cent of the thiamin originally present in whole wheat survives in flour made by the patent milling process, whereas stone grinding preserved nearly 80 per cent of this vitamin, and proportionate amounts of the other nutritive essen-

Table 1. Vitamin and mineral content of flour.

	Whole Wheat[1]	White Flour[1]	Reduction	Enriched Flour[2]	
			Per Cent	Min.	Max.
Thiamin (mg. per lb.)	2.04	0.23	89	1.66	2.5
Riboflavin[3] (mg. per lb.)	1.13	0.18	85	1.2	1.8
Nicotinic Acid (mg. per lb.)	12.3	3.7	70	6.0	9.0
Iron (mg. per lb.)	18	4.5	75	6.0	24
Calcium[4] (mg. per lb.)	240	72	70	500	2,000
Phosphorus (mg. per lb.)	1,700	460	73	—	—
Vitamin D[4] (I.U.)	—	—	—	250	1,000

[1] Council on Foods and Nutrition, American Medical Association (7).
[2] Food and Nutrition Board, National Research Council; and U. S. Food and Drug Administration (8).
[3] Inclusion in "enriched" flour and bread will not be required, but is optional until July 1, 1942.
[4] Inclusion in "enriched" flour and bread is optional.

tials. The effect of widespread use of patent flour, plus the tenfold rise in consumption of sugar, has been offset only slightly by increased consumption of vegetables, fruits, and dairy products; very slightly, if at all, in the low-income groups who do not purchase these relatively more expensive sources of calories. It has been calculated (5) that it would require the daily consumption of 625 gm. of fruit, 600 gm. of potatoes, 880 gm. of other vegetables, and 1,260 cc. of milk to make up the difference—a combination impossible because of its bulk.

Price Rationing. The third factor responsible for our nutritional depression, price rationing, is one which constantly confronts all those interested in public health. Stated in simple terms it means that about half the people in our country have available for expenditure on food only three-fourths the minimum cost of a nutritionally satisfactory diet. Like the other factors, price rationing does not stand alone but is a part of and a cause of poor food habits, poor budgeting of available resources, and the established use of the highly-milled grain products and refined sugar. Moreover, it is set within a framework of individual, group, and national resources and requirements, and of industrial, social, and economic policies. For this reason, although this aspect of the national nutrition problem belongs properly in the realm of economics, the physician and public health worker must take it into account in planning a nutritional program.

Intercurrent Illness. The fourth factor responsible for nutritional failure is the neglect to prevent and correct malnutrition during and after illness. Methods for the prevention and treatment of specific nutritional failures during illness and convalescence will be given in the following section.

A Program for Better Nutrition

A program for better nutrition consists logically of two main parts. The first is the prevention and eradication of nutritional fail-

ure due to intercurrent illness. In this program the practicing physician plays the chief rôle. The second part consists of a public health nutrition program for which the public health authorities must be chiefly responsible.

Prevention and Eradication of Nutritional Failure Due to Intercurrent Illness. Nutritive impairment may be associated with almost any disease, and in many instances is increased by customary therapeutic procedures. The rôle played by these two factors, that is, intercurrent illness and therapy, in precipitating nutritional failure has scarcely been recognized. It is especially common in patients who have had poor food habits or belong to the groups subject to the price-rationing factor. It is here that the practicing physician can play a major rôle in a program for better nutrition. In Table 2 are listed some of the more important illnesses in which nutritional failure may occur.

The chief reliance for maintaining an adequate supply of all essential nutrients during any illness must be in food, for an adequate diet provides essential proteins and many vitamins impossible to encapsulate or provide in ampules or tablets. The foods around which a diet for the duration of illness and during convalescence should be built are those easily eaten, easily digestible, which provide relatively small residue, and at the same time provide as nearly as possible all the nutritive essentials. Such a diet, given in Table 3, is in use by the author, and seldom requires alteration.

This diet provides a safety margin over the allowances of the Food and Nutrition Committee of the National Research Council of about 100 per cent in riboflavin and ascorbic acid, and over 50 per cent in calcium and iron; it just meets the allowances in vitamin A and thiamin. It is probable that the allowance for nicotinic acid is considerably exceeded. The mere fact, however, that there is no safety margin for vitamin A, a fat-soluble vitamin, and for thiamin, an important member of the group of B vitamins, emphasizes the gross inadequacy of many diets provided to patients during illness.

I. *By Interfering with Food Intake*
- 1. Gastrointestinal Disease
  - Acute Gastroenteritis
  - Cholecystitis and Cholelithiasis
  - Peptic Ulcer
  - Diarrheal Diseases
  - Carcinoma of Stomach and Esophagus
- 2. Food Allergy
- 3. Mental Disorders as
  - Neurasthenia
  - Neurosis
  - Psychoneurosis
  - Psychosis
- 4. Operations and Anaesthesia
- 5. Infectious Diseases Associated with Anorexia
- 6. Loss of Teeth
- 7. Heart Failure (Anorexia, Nausea, and Vomiting by Visceral Congestion)
- 8. Pulmonary Disease (Anorexia, Vomiting Due to Cough)
- 9. Toxemia of Pregnancy (Nausea and Vomiting)
- 10. Visceral Pain (As in Renal Colic, and Angina that Reflexly Produces Nausea and Vomiting)
- 11. Neurologic Disorders Which Interfere with Self-Feeding
- 12. Migraine

II. *By Interfering with Absorption*
- 1. Diarrheal Diseases as
  - Ulcerative and Mucous Colitis
  - Intestinal Parasites
  - Intestinal Tuberculosis
  - Sprue
- 2. Gastrointestinal Fistulae
- 3. Diseases of Liver and Gallbladder
- 4. Achlorhydria
- 5. Carcinoma of the Stomach

III. *By Interfering with Utilization*
- 1. Liver Disease
- 2. Diabetes Mellitus
- 3. Chronic Alcoholism

IV. *By Increasing Requirement*
- 1. Abnormal Activity, as Associated with
  - Prolonged Strenuous Physical Exertion
  - Delirium
  - Manic-Depressive Psychosis
- 2. Fever
- 3. Hyperthyroidism
- 4. Pregnancy and Lactation

V. *By Increasing Excretion*
- 1. Polyuria, as in
  - Diabetes Mellitus
  - Diabetes Insipidus
  - Long Continued Excessive Fluid Intake, as in Urinary Tract Infections
- 2. Lactation

Table 2. Illnesses that may contribute to nutritional failure.

This applies to a great number of diets given in text-books for use either as an adjunct or as the specific therapy of many diseases. The necessity of supplementing even a diet as adequate as this with either a daily portion of beef liver (not calf liver) or providing at least vitamin A and thiamin, if the illness is of more than a few days' duration, is thus obvious.

By appropriate substitutions this diet can be made to suit almost any patient and illness. If the patient is stuporous and requires tube feeding the following changes should be made: The meat, butter,

(a) *Food*	*Amount*
Orange Juice	500 cc. (16 oz.)
Milk (Vitamin D)	1,000 cc. (1 quart)
Cream (20 per cent)	200 cc. (7 oz.)
Butter	30 Gm. (1 oz.)
Eggs	2
Meat (lean), Fish, Chicken, or Liver	200 Gm. (7 oz.)
Cereal (Whole Grain), Cooked (or Dry, 30 Gm. or 1 oz.)	200 Gm. (7 oz.)
Bread (Whole Wheat or "Enriched")	200 Gm. (7 oz.)
Sugar (or Honey, Jam, Marmalade)	30 Gm. (1 oz.)
(b) *Nutritional Essentials Furnished by Above Diet*	
Calories	2,500
Carbohydrate	210 Gm.
Protein	125 Gm.
Fat	135 Gm.
Calcium	1.6 Gm.
Iron	17 Mg.
Vitamin A	5,300 I.U.
Vitamin D	(Over) 400 I.U.
Thiamin	2 Mg.
Riboflavin	4.5 Mg.
Ascorbic Acid	250 Mg.

Table 3. Constituents of a diet for sick patients.

and bread are omitted. In their place eight egg whites, an additional 150 cc. of 20 per cent cream, and 60 gm. of barley flour made into a gruel, are given. These foods plus the milk, cream, and sugar can then be combined and water added to a volume of 2,500 cc., and given through a nasal catheter in twenty hourly feedings of 125 cc. The orange juice should be given separately in four feedings of 125 cc. For patients extremely ill, though not requiring tube feeding, the same mixture can be given by mouth at frequent intervals.

When a diet of less residue is required, skimmed milk may be substituted for whole milk, 200 gm. of cottage cheese may be substituted for the cream and butter, the bread should be white enriched, and the cereal, farina; the orange juice should be strained. When a high residue diet is required the orange juice should be replaced by whole orange, and leafy green and yellow vegetables should replace a part of the cereal or bread.

	Calories Number	Carbohydrate Grams	Protein Grams	Fat Grams	Calcium Mg.	Phosphorus Mg.	Iron Mg.	Vitamin A I.U.*	Thiamin Mg.	Riboflavin Mg.	Nicotinic Acid Mg.	Ascorbic Acid Mg.
Dairy Products												
Cows Milk, Whole	69	5	3.5	4.0	120	93	0.24	110	0.05	0.20	0.08	Tr
Cows Milk, Whole, Dried	690	50	35.0	40.0	1,200	930	2.40	875	0.30	1.5	0.8	Tr
Cows Milk, Skimmed	36	5	3.4	0.3	122	96	0.25	2	0.05	0.20	0.09	Tr
Cows Milk, Skimmed, Dried	365	51	34.0	3.0	1,220	960	2.50	20	0.375	1.80	0.90	Tr
Cheese (Except Cottage)	455*	4.1*	27.0*	36.0*	930*	680*	1.4*	2,500	0.04	0.75	0.20	Tr
Cheese (Cottage)	110	4.3	21.0	1.0	82	263		500				0
Butter	770	0	1.0	85.0	Tr	Tr	0	2,500	Tr	0.3	Tr	Tr
Cream 20 Per Cent	200	4.5	2.5	18.5	86	67	Tr	600	Tr	Tr	Tr	Tr
Eggs (Whole)	150	0	13.5	10.5	67	180	2.50	1,000	0.15	0.5	0.3	0
Egg White	46	0.8	10.8	0	15	14	0.10	0	Tr	0.23	1.5	0
Bread												
Whole Wheat	245	50	9.7	0.9	50	175	1.6	0	0.42	0.08	1.8	0
Wheat White	260	53	9.2	1.3	27	93	0.9	0	0.04	0.03	0.7	0
Wheat White, Enriched	260	53	9.2	1.3	70	93	0.83	0	0.2	0.13	2.2	0
Flour												
Whole Wheat	355	72	13.8	1.9	50	350	3.75	0	0.43	0.24	6.0	0
Patent Wheat White	355	73	13.8	1.5	15	92	0.9	0	0.05	0.03	1.1	0
Enriched Patent Wheat White	355	73	13.3	1.5	100	92	1.3	0	0.35	0.25	1.3	0
Cereals												
Oatmeal	377	64.2	17.5	6.3	60	340	4.0	0	0.8	0.25	1.0	0
Enriched Farina	359	72.8	12.1	1.3	4.8	90	1.3	0	0.345	0.25	1.3	0
Yellow Corn Meal	356	77.7	8.9	1.1	3	140	0.6	500	0.2	0.08	1.0	0
White Corn Meal	359	77	9.3	1.5	4	100	0.7	0	0.14		1.8	0
Rice, Polished	345	79	8.0	0.3	9	96	1.0	0	0.04	0.07	0.9	0
Rice, Unpolished	345	79	8.0	0.3	68	200	2.0	0	0.1	0.08	2.0	0
Wheat Cereal, Whole Grain	350	79	11.4	1.6	30	300	3.7	0	0.6	0.25	2.5	0
Corn Flakes	360	81	8.1	2.0	133	170		0	0.6	0.24		0
Shredded Wheat												0
Fruits												
Apples	64	14.2	0.4	0.5	7	12	0.4	40	Tr	0.02	0.5	10
Apricots	57	13.4	1.1	0	14	25	3.6	2,000	0.03	0.09		Tr
Bananas	99	22.0	1.3	0.6	9	31	1.8	80	0.05	0.03		25
Berries	64	23.8	1.2	0.8	32	30	0.8	300	0.04	0.1		25
Grapefruit	52	12.2	0.6	0.1	21	20	0.3	0	0.07	0.02		40
Melons	40	9.3	0.6	0	17	15	0.5	1,400	0.06	0.07		25

Shredded Wheat												45
Peaches	41	9.4	0.7	0.1	16	24	0.4	1,000	Tr	0.01		10
Pears	63	14.1	0.6	0.5	15	26	0.5	20	Tr	0.02		5
Pineapples	43	9.7	0.4	0.3	18	28	0.3	200	0.10	0.09		20
Plums	85	20.1	1.0	0	20	32	0.8	160	0.50	0.03		5
Prunes (Dried)	300	73.0	2.1	0	54	105	2.9	2,500	0.20	0.06		0
Vegetables												
Asparagus	22	3.3	1.8	0.2	24	35	0.8	900	0.18	1.29	0.5	40
Beans, Green Snap	41	7.4	2.3	0.3	46	52	1.0	700	0.07	0.35	0.6	20
Beans, Lima	120	22.0	7.1	0.7	28	133	11.7	1,000	0.34	0.06		40
Beets, Roots	46	9.7	1.6	0.1	29	39	1.8	200	0.05	0.09	0.3	10
Cabbage	31	5.6	1.6	0.3	45	29	0.3	900	0.08	0.12	0.3	100
Carrots	45	9.3	1.1	0.4	56	46	1.0	7,500	0.07	0.02	0.4	Tr
Cauliflower	30	4.7	1.8	0.5	123	61	1.4	40	0.17	0.02		40
Celery	18	3.3	1.1	0.1	78	37	0.8	50	0.04	0.04		10
Lettuce	19	2.9	1.2	0.3	43	42	1.9	2,500	0.10	0.08	0.5	10
Onions	48	9.9	1.6	0.3	34	45	0.3	6,000	0.03	0.01	0.1	10
Peas, Garden	100	16.9	7.0	0.5	28	127	1.7	1,000	0.4	0.2	1.3	25
Potatoes	85	18.4	2.2	0.1	14	58	0.9	50	0.15	0.10	0.5	25
Spinach	24	3.2	2.1	0.3	67	68	6.6	24,000	0.1	0.08	1.7	50
Sweet Corn	101	19.7	3.1	1.1	6	103	0.5	1,500	0.15	0.17		40
Sweet Potatoes, Yellow	124	27.4	1.8	0.7	19	45	0.9	5,500	0.09	0.13	0.1	30
Tomatoes	23	3.9	0.9	0.4	11	26	0.6	19,000	0.08	0.14	0.4	30
Meats												
Beef, Muscle	205	0	20.6	3.7	12	216	3.0	56	0.39	0.25	7.0	Tr
Fowl, Muscle	220	0	19.3	16.3	16	218	1.4	Tr	0.74	0.14	7.5	Tr
Lamb, Muscle	110	0	19.4	3.7	14	270	4.0		0.38	0.33	8.0	Tr
Pig, Muscle	190	0	19.8	10.6	10	215	2.2		3.95	0.29	7.5	Tr
Sheep, Muscle	190	0	19.8	12.4	15	278	4.0		0.60	0.27	4.1	Tr
Beef, Liver	130	1.7	14.1	4.2	8	373	12.1	24,000	1.20	2.8	25.0	45
Calf, Liver	136	4.0	19.0	4.9	8	373	12.1	12,000	0.52	2.2	25.0	50
Fish and Sea Food												
Lean Fish	50	0	12.0	0.3	12	120	0.5	Tr	0.08	0.18	3.0	Tr
Fatty Fish	130	0	19.0	6.1	21	220	0.8	300	0.09	0.14	5.5	Tr
Lobster	83	0.4	16.4	1.8	75	210	0.4		0.38	0.13	2.7	5
Oyster	50	3.7	6.2	1.2	52	155	3.1	420	0.15	0.46	1.3	Tr

[1] Compiled from various sources [7, 8, 10] and represent average figures for 100 grams uncooked portions, except for meat and fish which represent cooked portions. Cooking losses for fruits and vegetables are considerable for thiamin and ascorbic acid, ranging from 30 to 50 per cent for thiamin and 50 to 100 per cent (usually approaches 100 per cent) for ascorbic acid. Cooking losses in vitamin A, riboflavin, and nicotinic acid are smaller, usually 20 to 30 per cent. In estimating the vitamin content of cooked fruits and vegetables, calculate: thiamin as 50 per cent of fresh value as given in the table; ascorbic acid as nil, except for tomatoes which may be given full value; vitamin A, riboflavin, and nicotinic acid as 75 per cent of fresh value as given in the table.

* Wide variations in values.

Tr.—Trace, calculate as absent, for ascorbic acid values less than 5 mg. per 100.

Grams are recorded as Tr.

Blank spaces—Indicate values not available.

If a higher carbohydrate diet is desired, this can be obtained by increasing the amounts of cereal, bread, or orange juice. This should never be accomplished by increasing the amount of sugar, jam, or jellies. Less fat can be obtained by serving skimmed milk and omitting cream and butter. If less protein is thought advisable, some of the meat, some of the milk, and the whites of eggs may be omitted. It must be remembered that if this is done provision should be made for supplying iron and, if continued for a considerable period of time, calcium. If more protein is desired this can be easily obtained by adding egg whites (each egg white furnished 6 gm.) or lean meat (100 gm. cooked meat furnished 25 gm. protein).

This basic diet should be supplemented at the very beginning, if possible, or later as soon as possible, by increasing the meat ration, of which a good portion should be liver, and by adding a variety of fruits and vegetables, pureed if necessary. Under these conditions, if the caloric requirement is exceeded, modifications in the amounts of bread and cereals can be made. In order to facilitate modification of this diet the essential nutritive composition of the foods most commonly used are given in Table 4.

During any illness lasting more than three days, or from the onset if there is interference with food intake, or if there is increased requirement or excretion, it is necessary to supplement the diet with various nutritional essentials. The amounts recommended here are based on the principle that it is better to err on the side of wasting the vitamins than giving too little. Routinely these patients should be given daily by mouth 25,000 to 50,000 units of vitamin A, and a source of the vitamin B-complex. For the latter such products as 30 gm. of brewer's yeast, 20 gm. of vegex, 45 cc. of aqueous liver extract, or 15 gm. of a yeast concentrate are preferable to synthetic products in capsule form from which some factors as yet impossible to encapsulate are possibly missing. If there is interference with absorption or utilization, or if the requirement is markedly increased, the vitamin A should be increased to 100,000 units or more, and the

B vitamins should be given parenterally. To accomplish this it is advisable to administer daily by intramuscular injection 2 or 3 cc. of crude liver extract (1 cc. equivalent to 1 U.S.P. unit of anti-pernicious anemia factor), to which should be added 10 mg. thiamin, 2 mg. riboflavin, and 100 mg. nicotinic acid amide.

At times the oral administration of bulky sources of vitamin B-complex cannot be tolerated. Under such circumstances crystalline B vitamins should be given twice daily in the following amounts: Thiamin, 2.5 mg.; riboflavin, 3.75 mg.; nicotinic acid amide, 25 mg. If for any reason orange juice cannot be taken, 200 to 300 mg. of ascorbic acid may be given in two doses.

In many patients clinical evidence of nutritional failure is already apparent by the time the patient consults a physician. This should be treated by the same diet, the same supplements by mouth, and the same parenteral injections of crude liver extract. The chief difference in therapy is in giving additionally larger amounts of the vitamin specifically indicated by the signs and symptoms. A guide to the daily dosages of the specific vitamins is given in Table 5. If the patient has liver disease or diarrhea, or is an alcoholic, the larger of the recommended doses should be given. Clinical observation as well as experimental evidence indicate that in these conditions much larger doses of vitamins are required to produce maximal re-

Table 5. Daily dosages of vitamins for specific deficiencies.

Deficiency	Mild	Moderate	Severe
Vitamin A	100,000 U. (m)	200,000 U. (m)	200,000 U. (m)
Vitamin D	2,000 U. (m)	2,000 U. (m)	2,000 U. (m)
Thiamin	10-30 mg. (p)	20-50 mg. (p)	50-300 mg. (p)
Riboflavin	10 mg. (m)	10-20 mg. (m)	20-50 mg. (m)
		10 mg. (p)	10 mg. (p)
Nicotinic Acid	300-500 mg. (m)	500-1,000 mg. (m)	1,000 mg. (m)
or			
Nicotinamide			200 mg. (p)
Ascorbic Acid	500 mg. (m)	500-1,000 mg. (m)	1,000-2,000 mg. (m)
			500 mg. (p)

(m)—by mouth, (p)—parenterally.

sponse than when absorption is unimpaired and the liver normal.

Although the author has never seen hypersensitivity or allergy to vitamins, it is not impossible that such a response will occur, especially on resuming parenteral injections of certain of the vitamins after they have been interrupted (10). Patients giving a history of previous parenteral vitamin medication should always be tested for hypersensitivity prior to resumption of parenteral vitamin therapy. The author routinely tests all patients for the preparation that is to be used.

A Public Health Nutrition Program. The public health program for better nutrition is dependent upon three factors. The first is education, to make people want the proper foods and includes by necessity the teaching of the wise use of income. The second is nutritional improvement of staple foods, in order to surround people with better food. The third is economic, to make more and better food purchasable at every income level.

These three factors are not independent methods of approach but three methods that should be applied simultaneously. For example, the ability to purchase more and better food and the availability of adequate quantities of good food would fail to solve the problem without education to create a desire for these foods. The trilinear approach here outlined requires a coordinated effort of governmental agencies, the medical profession, economists, educators, producers, and consumers.

Education. A clear demonstration of the value of good nutrition should be one of the first methods in the educational program. The demonstration in a community of actual nutritional therapy, such as carried out by Ebbs, Tisdall, and Scott (11) at Toronto on pregnant women not only convinces the physician of its value but by word-of-mouth dissemination from patient-to-neighbor and neighbor-to-neighbor may be of more value than all other educational methods.

The Food and Nutrition Board of the National Research Coun-

cil has already provided the first step in a formal educational program. This was the formulation of daily allowances of the various essential food factors that would constitute a satisfactory daily diet. Although the Technical Commission on Nutrition of the League of Nations adopted nutrition standards in 1935, we have added greatly to our knowledge in this field since then, and the allowances recommended by the Food and Nutrition Board are definitely higher.

Table 6. Recommended daily allowances for specific nutrients.[1] Food and Nutrition Board, National Research Council.

	Calories	Protein	Calcium	Iron	Vitamin A[2]	Thiamin[3]	Ascorbic Acid[3]	Riboflavin	Nicotinic Acid	Vitamin D[4]
		Grams	Grams	mg.	I.U.	mg.	mg.	mg.	mg.	I.U.
Man (70 Kg.)										
Moderately Active	3,000	70	0.8	12	5,000	1.8	75	2.7	18	
Very Active	4,500					2.3		3.3	23	
Sedentary	2,500					1.5		2.2	15	
Woman (50 Kg.)										
Moderately Active	2,500	60	0.8	12	5,000	1.5	70	2.2	15	
Very Active	3,000					1.8		2.7	18	
Sedentary	2,100					1.2		1.8	12	
Pregnancy (latter ½)	2,500	85	1.5	15	6,000	1.8	100	2.5	18	400–800
Lactation	3,000	100	2.0	15	8,000	2.3	150	3.0	23	400–800
Children up to 12 Years										
Under 1 Year[5]	100/Kg.	3-4/Kg.	1.0	6	1,500	0.4	30	0.6	4	400–800
1–3 Years[6]	1,200	40	1.0	7	2,000	0.6	35	0.9	6	
4–6 "	1,600	50	1.0	8	2,500	0.8	50	1.2	8	
7–9 "	2,000	60	1.0	10	3,500	1.0	60	1.5	10	
10–12 "	2,500	70	1.2	12	4,500	1.2	75	1.8	12	
Children Over 12 Years										
Girls 13–15 Years	2,800	80	1.3	15	5,000	1.4	80	2.0	14	
16–20 "	2,400	75	1.0	15	5,000	1.2	80	1.8	12	
Boys 13–15 "	3,200	85	1.4	15	5,000	1.6	90	2.4	16	
16–20 "	3,800	100	1.4	15	6,000	2.0	100	3.0	20	

[1] These are tentative allowances toward which to aim in planning practical dietaries. These allowances can be met by a good diet of natural foods; this will also provide other minerals and vitamins, the requirements for which are less well known.

[2] Requirements may be less than these amounts if provided as vitamin A, greater if chiefly as the provitamin carotene.

[3] One mg. thiamin equals 333 International units; 1 mg. ascorbic acid equals 20 International units (1 International unit equals 1 U.S.P. unit).

[4] Vitamin D is undoubtedly necessary for adults and older children; when not available from sunshine it should be provided probably up to the minimal amounts recommended for infants.

[5] Needs of infants increase from month to month. The amounts given are for approximately 6-18 months. The amounts of protein and calcium needed are less if from breast milk.

[6] Allowances are based on the middle age for each group, and for moderate activity.

The daily allowances of specific nutrients recommended by the Food and Nutrition Board of the National Research Council for various categories are presented in Table 6. Provisions for men are based on various degrees of activity. It should be remembered that this is for an average size man of approximately 70 kg. It is known that larger individuals would require more of these factors. For women, besides the three categories of activity, additional categories of pregnancy and lactation are listed. In these two the allowances are even higher than for a very active man. The allowances for children up to twelve years are listed by various age groups, and above twelve years there are separate categories for girls and boys.

For the education of the public these nutritional allowances, expressed in calories, grams, milligrams, and units, must be converted into practical menus. To meet the dietary allowances set by the Food and Nutrition Board the following regimen is suggested:

First, eliminate from the diet most vitamin-free or vitamin-poor foods, such as candy, a large part of the sugar (retaining only the amount essential to make the food palatable), jams, jellies, highly-milled grain products that are not "enriched," sweetened carbonated beverages, and alcohol.

Second, include the following in the diet each day:

Milk: For adults, at least 1 pint; for children, 1 quart; a quart a day for all would be better.

One egg.

Meat: 1 serving at least 100 gm. for an adult.

Vegetables: 2 servings, 1 of which should be green or yellow.

Fruit: 2 servings; 1 of these should be a citrus fruit, and the other tomato, apple, or prunes.

Potatoes: 1 or more servings.

Butter, or fortified oleomargarine: 1 to 4 oz.

Whole grain cereal: 1 serving.

Whole grain or enriched bread: 2 to 10 oz.

The balance of the calories, sufficient to furnish the energy requirement, should then be made up from natural or "enriched" food products.

It is impossible within the scope of this chapter to present a detailed dietary list for each of the categories. However, if the caloric requirement of adults and children over twelve years of age is met according to this recommended scheme there is little or no danger that the allowances recommended by the Food and Nutrition Board will not be met. This does not apply to women during the latter half of pregnancy and during lactation. In these two categories, in order to supply the recommended amounts of calcium and iron, ascorbic acid, thiamin, riboflavin, and nicotinic acid it is essential that this basic diet should include at least a quart of vitamin D milk; that the meat ration be not below 200 gm. a day; and that an additional 4 ounces of citrus fruit be provided.

It is recognized that these recommended daily allowances must be translated into many diets. These diets must take into consideration the availability of foods in different sections of our country and at different seasons, and the racial and religious dietary customs of many groups. Above all, each one of these diets must represent to the group which it is to serve a pleasurable experience.

For the successful promotion of this educational program it will be necessary to utilize all the agencies and methods that we now have available. These include our teachers, extension workers in the department of agriculture, home economists, the public health services, the women's clubs, labor, and industry. The methods to be utilized include: first, by example, through serving nutritionally satisfactory noonday meals to children in schools and to workers in industry; second, the teaching of proper nutrition in the schools, from kindergarten to college; and third, education of adults, this to include fathers as well as mothers. All methods of education should be used for all of the groups; that is, assigned lessons and reading, lectures, posters, press, radio, and motion pictures.

Of no less importance is education in the recognition of the early symptoms of nutritional depressions. Laymen should be taught that in infants and children these early symptoms include lack of appetite; failure to eat an adequate breakfast; failure to gain weight steadily; delay in learning to sit, stand, or walk; inability to sit or pain on sitting and standing; aversion to normal play; chronic diarrhea; poor sleeping habits; backwardness in school, and frequent colds. The following physical signs may also be emphasized to lay groups as suggestive of early nutritional deficiency states in children: Lack of subskin fat, paleness, hemorrhage of the newborn, and sores in the angles of the mouth. Public health nurses should be instructed, in addition, to observe children and infants for wrinkling of the skin on light stroking, poor muscle tone, rough skin (toadskin), bad posture, nasal blackheads and whiteheads, rapid heart, red tongue, square head, enlarged wrists and beading of ribs, Vincent's angina and thrush.

The symptoms of nutritional depressions in adolescents and adults that may safely be emphasized to lay groups include lack of appetite, lassitude and chronic fatigue, loss of weight, lack of mental application, loss of strength, sore mouth or sore tongue, chronic diarrhea, nervousness and irritability, paraesthesias, night-blindness, photophobia, burning or itching of the eyes, lacrimation, muscle and joint pains, sore bleeding gums, and tendency to bleed. The signs of which lay groups should be made aware are sores at the angles of the mouth, spongy bleeding gums, and spontaneous hemorrhages into the skin. Public health nurses should be taught to observe also for the following signs in adults and adolescents: Nasolabial sebaceous plugs, cheilosis, glossitis and stomatitis, and facial butterfly, Casal necklace and perineal, scrotal, and vulval dermatitis.

Physicians should be made increasingly aware of the importance of the signs and symptoms enumerated as possibly indicative of nutritional depressions, and in addition should look for vascularize-

tion of the cornea; xerosis conjunctivae; Vincent's stomatitis; minimal changes in color or texture of the tongue such as red, swollen lingual papillae and papillar atrophy; muscle tenderness in the extremities; poor muscle tone; loss or impairment of vibratory sensation in the toes; plantar dyethesia advancing to a sock distribution; changes in the tendon reflexes with particular emphasis on loss of the ankle jerks; skin lesions of pellagra; nonspecific vaginitis; follicular hyperkeratosis of extensor surface of the extremities, and rachitic deformities.

Enrichment of Staple Foods. The Council on Foods and Nutrition of the American Medical Association (12) has established two principles for the improvement of staple foods. 1. In the processing of foods every effort should be directed to retaining in the product the food values of the natural foods from which they are made. 2. For those processed foods which are not nutritionally equivalent to the original food from which they have been made it is in the interest of the public to restore certain dietary essentials so that these processed foods have the full nutritive value of the natural foods with respect to the substances added.

Since wheat and sugar form approximately 55 per cent of the average caloric intake of the American public, it is natural that these two foods should receive first attention. The Food and Nutrition Board of the National Research Council has already recommended the enrichment of flour and bread, and the United States Food and Drug Administration has published a proposed definition and standards for "enriched" flour (8). These standards are presented in Table 1, which also shows the composition of whole wheat and of white flour made from that wheat.

The essential ingredients of an "enriched" flour are thiamin, riboflavin,[8] nicotinic acid, and iron. The optional ingredients for enriched flour include calcium and vitamin D. Although wheat is not a good source of calcium, containing only 240 mg. per pound,

[8] Riboflavin may be made an optional ingredient because of procurement difficulties.

if claims for enrichment with calcium are to be made, flour must contain at least 500 mg. and a maximum of 2,000 mg. per pound. This high figure for enriched flour was adopted because large amounts of calcium are now often added to flour for the quick-rising breads. The whole wheat contains no vitamin D; but since it is a satisfactory carrier, the Food and Drug Administration has permitted an optional enrichment with 250 U.S.P. units of vitamin D and a maximum of 1,000 units. A nutritionally satisfactory flour, meeting the standards for an "enriched" flour, may be obtained in either of two ways: 1, by milling so as to retain most of the vitamin and mineral content of the whole grain; and 2, by adding vitamins and minerals to highly-milled flour.

Various methods can be used in making an enriched bread: 1, by the use of whole grain or enriched flour; 2, by adding the vitamins and minerals to the dough; and 3, by the use of high vitamin and mineral yeast. It is very important that enrichment should not be limited to commercial baked goods but that all flour for home consumption should be enriched, since about 50 per cent of the flour manufactured in our country is converted into foods in the home.

Pertinent criticism is that flour and bread, if enriched by the synthetic substances, are not enriched by other fractions of the vitamin B-complex which are also in many instances known to be removed in the processing. Those who would not recommend the use of enriched bread unless the whole vitamin B-complex can be added must, however, assume the position that good and better are the enemies of the best. All the authorities who recommend the enrichment program recognize that whole-grain flour, bread, and cereals are preferable. But they are not willing to forego providing a better product than is now in use simply because it is not the best possible. Practicability must always be one of the first considerations in any program towards improvement of the public health. In addition, it is believed by many that "enrichment" of white flour and bread will lead to an increased consumption of whole-grain

flour and bread since the necessity for the "enrichment" points out the value of the whole grain products.

The importance of the enrichment program is evident if one studies the plan developed by Carpenter and Stiebeling (13) for adequate diets at four different levels of cost. The weekly allowances of flour and cereals for the moderately active man of average weight are 5 lb. 4 oz. in a restricted diet for emergency use; 4 lb. 8 oz. in a good diet at minimum cost; 4 lb. in an adequate diet at moderate cost; and 2 lb. 4 oz. in a liberal diet. These amounts are those customarily used by many families reported in the various Bureau of Home Economics surveys. The use of "enriched" in place of ordinary refined bread, flour, and cereals would result in significant increases in iron, thiamin, riboflavin, and nicotinic acid intake in these diets. For example, in the emergency diet the amount of thiamin would be increased by 456 I.U.; in the good diet at minimum cost by 390 I.U.; and in the liberal diet by 194 I.U. per person daily. It should be emphasized, however, that those who eat only from one to three slices of bread daily would not receive significant additional amounts of vitamins and minerals.

The Price-Rationing Factor. It is not the function of the physician to point out to the political, agricultural, and industrial economist the means by which more and better food, sufficient to provide a nutritionally satisfactory diet at all living levels, may be made available. It is his function only to point out the existence of this factor as an integral part of the whole problem.

Conclusion

The nutritional status of large groups of the American people represents a challenge not only to the medical profession and public health workers but to the entire nation. For millions of people to be subsisting on diets providing less than the satisfactory levels necessary for good nutrition, is a national disgrace in peace time and a national danger in an emergency.

Our newer knowledge of nutrition, accumulated in the last thirty years, enables us not only to understand the nature of the problem but also to devise effective measures towards solving it. Fortunately, both governmental agencies and scientific organizations have already launched a well-conceived program which gives promise of improved nutrition, better health, and more meaningful living to the American people now and in the future. This is written without undue optimism, and with the understanding that the most far-reaching effects of this program may only make themselves felt in generations rather than years.

It remains for all who are concerned with the public welfare, the leaders in the various fields of culture and endeavor, to give this program their material support in order to win the cooperation of all the people towards the accomplishment of this high purpose.

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