EVALUATION OF THE NUTRITIONAL STATUS OF PATIENTS AT A REHABILITATION CENTER

Thesis for the Degree of M. S.

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Mary E. Furnivall

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THESIS

This is to certify that the

thesis entitled

EVALUATION OF THE NUTRITIONAL STATUS
OF PATIENTS AT A REHABILITATION CENTER

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Mary E. Furnivall

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Margaret A. Ohlson
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Mary E. Furnivall

A THESIS

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

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Department of Foods and Nutrition
School of Home Economics

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AN ABSTRACT

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Approved Margaret A. Ohlson

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An Abstract

The study was undertaken as an attempt to evaluate the nutritional status of selected patients at the Ingham County Rehabilitation Center.

Micro-chemical analyses for haemoglobin, serum protein and serum ascorbic acid were made on capillary blood samples. The findings were correlated with the dietary intake estimated from a 24 hour recall record. Dietary histories were used to investigate individual food patterns.

The haemoglobin concentrations were estimated by an alkaline haematin method, using a Beckman spectrophotometer. The values found ranged from 11.12 to 16.39 gm./100 ml. blood. The mean value for the men was 14.44 gm./100 ml. and for women 13.35 gm./100 ml.

The serum protein concentrations were determined by the gradient tube method. The values found ranged from 5.9 to 8.5 gm./100 ml. The mean value for men was 7.07 gm./100 ml. and for women 7.13 gm./100 ml.

The serum ascorbic acid concentration was estimated as total ascorbic acid with 2,4 dinitrophenylhydrazine. The values found ranged from 0.15 to 1.53 mg./100 ml. The overall mean values for men were 0.4 mg./100 ml. and for women 0.6 mg./100 ml. Newly admitted female patients showed concentrations averaging 0.80 mg./100 ml., while the longer term patients showed a range

of from 0.39 to 0.42 mg./100 ml. These latter values were suggestive of a state of chronic Vitamin C deficiency, probably due to the fact that the patients had not all taken advantage of the Vitamin C supplies made available to them.

The meals supplied in the Center were good and carefully planned. The calorie and protein intakes of the men were, in general, above the estimated requirements calculated from the National Research Council Recommended Allowances. The mean caloric intake of the women was within the limits of previously published studies, while their protein intake was relatively high. The overall Vitamin C intakes ranged from 8 to 208 mg./ day.

Predicted calorie and protein requirements for 12 men for whom both height and weight data were available were contrasted with their estimated intakes. The value of serial weight records is indicated. Suggestions are made for improving the patient's understanding of his nutritional status through the use of simple educational materials.

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INTRODUCTION

The Ingham County Rehabilitation Center was established in February 1953, at the Ingham County Hospital. A programme was set up, guided by the Research Committee, to assist in the clarification of the many problems now unfolding with advances in rehabilitation and geriatric care.

The present paper therefore forms part of a wider project. While articles by other authors (19,22,51,64), have been published previously on the nutritional status of the geriatric patient, none have specifically stated whether such patients were at the same time undergoing any form of rehabilitation.

The extent of the adjustment required of any person who has undergone either a natural or enforced slowing down of their previous mode of life has perhaps only now come nearer to full realisation. Reports on the initial condition of the aged living alone and those who have suffered a crippling disablement have consistently indicated the danger of a relapse into apathy (19,34,51,57,64). When this apathy is extended to the quantity and quality of food ingested and superimposed on the factors of poor dentition, pre-existant food patterns, physical degeneration and, for those living alone, often low economic status, a vicious circle has been set up (Vinther-Paulsen (64).

The importance of adequate nutrition for all forms of activity has been amply demonstrated. In this paper the writer has attempted to evaluate the nutritional status of patients undergoing rehabilitation, in whom it is hoped that the vicious circle has been or is being broken. The majority of the patients interviewed should also be considered as geriatric cases. It is proposed that this evaluation be carried out for each patient by a correlation of a diet history, a 24 hour recall diet record and a microchemical study of the concentrations of haemoglobin, serum protein and serum ascorbic acid of the blood.

REVIEW OF LITERATURE

Methods of Assessing Nutritional Status

In considering the geriatric patient, ..."it is essential that there be individualization in analysis of the nutritional status and in any diet therapy. Generalisations are dangerous" (Steiglitz (60).

Food Intake

Methods of assessing food intake as a contributory factor to the nutritional status of an individual range from a dietary history, through estimates of food eaten over a 24 hour period and records kept of food intake over a week or more, to the detailed weighed intake used in laboratory controlled balance experiments.

The dietary history has been most generally used to describe food patterns (43). More detailed histories have been evaluated in terms of the presence of good sources of specific nutrients (8,22,57). The accuracy of the 24 hour recall diet is dependent on the informant's memory and knowledge of portion sizes. In studying the nutrition of aging women Ohlson et al (44), found "The apparent mean intake of all nutrients was greater when measured by the recall diets." The contrast was made with 10 day periods when weighed intakes were recorded. It was considered that the increase was due in part

to eating between meals during the recall periods, a practice temporarily relinquished when the food had to be weighed, and to the emotional tension induced by the attempt to keep accurate records.

Weekly food diaries were kept by the participants in surveys done in London and Sheffield (51,19), on the diets of old age pensioners. In each case a dietitian of the Scientific Advisors Division of the Ministry of Food visited each subject 3 to 4 times a week to check the record and help weigh food portions. The use of this type of individual food intake record presupposes that the participants will be sighted, literate and at least sufficiently intelligent to be able to co-operate under supervision. Nevertheless, careful records of this type provide information on the food intake and habits of such a population group.

Pyke (51), in London, and Vinther-Paulsen (64), in Copenhagen, investigated the food intake of institutionalized geriatric patients by pre-weighing the portions offered and calculating the actual intakes from food tables. In Copenhagen the food was weighed without the patient's knowledge and any "extras" brought in by friends were also recorded, (Table I). The low calcium and phosphorus intakes recorded from the "De Gameles By" hospital were attributed to poor milk consumption. Elderly Danes apparently considered milk constipating. The intakes of the institutionalized patients in London, however, compared very favorably with those reported in the food

TABLE I. PUBLISHED RANGES OF FOOD INTAKE IN ELDERLY MEN AND WOMEN

Subjects	Intake	Calories	Protein	Calcium	Iron	Vitamin A	Thiamin	Riboflavin	Niacin	Vitamin C
			gm.	gm.	mg.	I.U.	mg.	mg.	mg.	mg.
A. Pyke (50). Gp. I. 10 women, at home, doing own cooking. Age, 50 to 91 yrs.	Range	422-2313	18.6-73.7	0.4-1.0	3-14	600-2500	0.2-1.0	0.5-1.5	2-11	6-36
	Mean	1409	48.6	0.6	7.5	1450	0.8	0.9	6	16
Gp. II. 18 women, in almshouses, doing own cooking. Age, 65 to 85 yrs.	Range	1079-1877	32.7-58.8	0.4-0.7	5-11	1600-6200	0.4-1.1	0.5-1.0	5-8	5-21
	Mean	1431	45.4	0.6	8.4	1025	0.7	0.8	7	12
Gp. III. 12 ambulent men, in small institution. Age, 60 to 85 yrs.	Range	2050-2251	70.8-77.6	0.7-0.8	15-16	3500-3700	1.4-1.5	1.1-1.4	14-17	31-53
	Mean	2137	74.5	0.78	15	3600	1.4	1.3	16	33

TABLE I continued

Subjects	Intake	Calories	Protein	Calcium	Iron	Vitamin A	Thiamin	Riboflavin	Niacin	Vitamin C
			gm.	gm.	mg.	I.U.	mg.	mg.	mg.	mg.
Gp. IV. 12 infirm men, in large institution. Age, 61 to 85 yrs.	Range	1903-2272	67.7-78.1	0.9-1.1	13-14	2900-3300	1.1-1.4	1.4-1.7	10-13	37-42
	Mean	2069	75.0	1.1	13.5	3000	1.3	1.6	12	40
Gp. V. 12 infirm women, institutionalized, average age 71 yrs.	Range	1252-1717	53.9-66.1	0.6-0.9	9-12	1730-2160	0.9-1.1	0.8-1.3	8-11	13-17
	Mean	1579	60.4	0.7	10	2000	1.1	1.0	10	15
B. Vinther-Paulsen (63).										
I. 16 women, aged, infirm and institutionalized.	Range	--	20-43	190mg.-650mg.	3.2-9.2	--	--	--	--	--
	Mean	1037	29	340mg.	4.5	1395	0.47	0.7	5.1	22
II. 4 men, aged, infirm and institutionalized	Range	--	36-43	190mg.-650mg.	3.2-9.2	--	--	--	--	--
	Mean	1332	38	340mg.	4.5	2052	0.47	0.7	8.0	32

records of similar London patients living at home (51). It was considered that more food was eaten when it was presented ready prepared. Food rationing and shopping imposed very real difficulties on the aged at this period in England.

Biochemical Investigation

The investigation of the amounts of specific nutrients in body fluids has been gradually extended to the geriatric patient. With the introduction of micromethods of analysis (Bessey (4), it has become possible to make estimations of the blood concentration of many nutrients without subjecting the elderly patient to the trauma of venipuncture. As data are relative to geriatric cases collected, it becomes more imperative that such data should be presented in absolute terms and include the range of distribution of blood values (43). Albanese (1), who investigated well-nourished older women on a self-selected diet, indicated the need to consider any findings in a geriatric case in terms of a "geriatric norm" and not in contrast to the "average" adult levels.

Biochemical methods of investigating the nutritional status of the geriatric case have most usually been used to indicate either the existing quantity of a nutrient in the body fluids or the results of "saturation" tests, with concommitant data on excretion. Since the most frequently reported deficiencies in the elderly have been in intakes of protein, iron, calcium and phosphorus, attention has been directed towards investigating such cases together with those showing varying degrees of

hypovitaminoses. In the present evaluation the concentrations of haemoglobin, serum protein and serum ascorbic acid were chosen for investigation. These factors have been considered to reflect the dietary intakes of iron, protein and ascorbic acid, nutrients especially important in any rehabilitation scheme.

Haemoglobin Concentrations

The haemoglobin concentration in the blood of geriatric patients has been reported as carboxy-haemoglobin by a modification of the Haldane-Gowers method (18,33), as cyanmethaemoglobin (Collier (33), as oxyhaemoglobin (King (25), by an acid haematin method (Newman (41) and by an alkaline haematin method using either dilute sodium carbonate (Williamson (68), or dilute ammonia (Welch (66). In all these methods 0.02 ml. blood is used. In the Sahli and Haldane-Gowers methods, the amount of haemoglobin is determined by matching a standard by dilution, using visual comparison. In the other methods the concentration is measured photoelectrically by light absorbtion following dilution and the result calculated in gm. haemoglobin/100 ml. blood. The alkaline haematin method has been adapted to a micromethod using 10 cmm. blood laked in 2.5 ml. 0.2 percent ammonium hydroxide. The haemoglobin concentration is then calculated from a density reading obtained with a Beckman spectrophotometer set at 542 mμ. (11).

Published reports on haemoglobin values in the aged (Table II), indicate that the sex difference is maintained. Jefferson (21), Miller (37) and Olbrich (46), found decreases

TABLE II. PUBLISHED MEAN HAEMOGLOBIN VALUES FOR THE AGED

Author	Ref. No.	Method	No. Sub-jects	Age Range	Sex	Hb. Concentration gm./100 ml.	
						Mean	Range
Fowler	(16)	Newcomer	100	65-80	M.+F.	12.9	9.7-16.0
		Haden-Hausser	73		M.	13.1	
			27		F.	12.5	
Jefferson	(21)	Cyanhaemoglobin		50-97			
		Capillary	330		M.	14.0	
			175		F.	13.6	
		Venous	145		M.	14.5	
			108		F.	13.8	
Hobson	(19)	1. Haldane					
		2. M.R.C. photometer	177	66-85	M.	14.4	
			246	61-87	F.	13.8	
		Results pooled					
Laing	(28)	Walsh (1951)	30	"aged"	M.	13.4	
			30		F.	12.73	
Miller	(35)	Hellige Wedge hemometer	160	60-104	M.	14.3	12-17.5
Olbrich	(47)	Haldane/M.R.C. method	-	61-88	M.	13.9	
			-	58-80+	F.	13.2	
Newman	(41)	Sahli	50	65-91	M.	12.65	9.7-15.0
			50	66-104	F.	11.7	9.5-16.0

TABLE II continued

Author	Ref. No.	Method	No. Subjects	Age Range	Sex	Hb. Concentration gm./100 ml. Mean	Hb. Concentration gm./100 ml. Range
Shapleigh	(58)	Oxyhemoglobin	50	60-94	M.	14.1	9.7-17.5
		Evelyn	50	60-90	F.	13.7	9.7-16.2
Williamson	(68)	Alkaline hematin	115	51-76+	M.	16.24	15.22-16.97
			112		F.	12.27	15.04-16.08
Osgood	(48)	Osgood & Hasking	-	14-30	M.	15.8	.14-18
			-		F.	13.8	11.5-16
Wintrobe	(69)	Newcomer	Reviewed averages		M.	16.0	14-18
					F.	14.0	12-16

with aging in male values, while Olbrich (46), found female values to rise, but not to overtake those of men. The values reported were all taken from persons showing no clinical evidence of active disease.

The values reported by Osgood (48), and Wintrobe (69), on healthy young adults are presented for comparison.

Fowler (16), found that the incidence of achlorhydria had no significant effect on haemoglobin concentrations. Hobson (19), reported a significant difference in the haemoglobin concentrations of 46 men living alone, (13.9 gm./100 ml.) and 141 men living with their wives, (14.5 gm./100 ml. blood). This was attributed to lack of cooking knowledge and facilities in the solitary men. Osgood (48), considered that Williamson's (68) values "were generally recognized as being 10 percent too high, although accurate in relation to each other."

Serum Protein Concentrations

Estimations of plasma and serum proteins in geriatric cases have been made primarily by the Micro-Kjeldahl and electrophoretic methods of analysis (1,7,35,47). Both these methods involve the use of venous samples. Albanese (1), evolved an ultra-micromethod enabling determinations of both haemoglobin and plasma proteins to be made on 0.02 ml. blood. Determinations of serum and plasma protein concentrations have also been made by the falling drop method originated by Barbour (2), in which the specific gravity of the drop is related to that of known standard solutions.

Kagan (23), used a falling drop method, based on Stokes Law, in which the specific gravity of a drop is determined by its rate of fall in a mixture of known specific gravity. Kagan found capillary blood satisfactory. The application of stasis in obtaining venous blood resulted in increased protein values. Other factors influencing the accuracy of the protein determination included: a reduction in values if more than 500 cc. of fluids were ingested during the 4 hours prior to the sampling; the age of the sample, which should be tested within 24 hours and be kept refrigerated in a well stoppered tube; the blood tube should be stoppered when being centrifuged to avoid increases in value of up to 0.5 gm. percent at 3,000 r.p.m. in 15 minutes; there was no change in value in properly stored blood whether it was centrifuged immediately or at 4 or 12 hours after collection; the finger should not be squeezed in collecting capillary samples. Kagan considered serum protein values to be the most reliable, since with oxalated plasma the amount of water withdrawn from the red cells varied with each individual, while heparinized plasma gave an increase in value of up to 0.5 gm./100 ml. Haemolysis also increases the protein value of serum.

Lowry and Hunter (30), have described a gradient tube method of determining serum protein concentration against potassium sulphate solutions of known specific gravity. This method is rapid, easy and requires only 10 cmm. serum for triplicate determinations.

Plasma and serum protein levels in the aged reported by Albanese (1), Brock (7), and Rafsky (53), all fall within the norms established by Peters and Eisenmann (49), for healthy young adults. In these the total protein ranged from 5.7 to 8 gm. percent. Olbrich (47), drawing early morning samples with the patient at rest, found serum protein values of 5.15 gm. percent for men and 5.51 gm. percent for women. McCance (39), reported a 0.5 gm. percent drop in serum values in blood obtained from recumbent subjects. The protein intake in Olbrich's cases ranged from 46 to 81 gm., with a mean of 62 gm. daily, of which 16 to 42 gm. was animal protein, with a mean of 29 gm. Dyson (15), found a mean serum protein of 6.56 gm. percent in 353 civilian donors, with a range of 5.56 to 7.65 gm. percent, as opposed to 6.78 gm. percent, with a range of 5.95 to 7.86 gm. percent in 100 Canadian soldiers. This difference was attributed to the higher protein content of the army ration. Dyson also took samples from recumbent patients. Madden and Whipple (32), in a review article, advanced the concept that the plasma proteins were formed in the liver from amino acids supplied by the food.

Serum Ascorbic Acid

The majority of the published studies on blood, plasma and serum ascorbic acid concentrations in the aged have been designed to investigate the effects of saturation tests. The chemical methods of analysis used have been a measurement of the reducing capacity of an acid extract of the test material

with 2,6 dichlorophenolindophenol (38) or the estimation of total ascorbic acid in blood or serum with 2,4 dinitrophenylhydrazine (56). Micromethods of the latter using only 10 cmm. serum have been adapted by Lowry et al (31) and Bessey (4).

The primary physiological function of Vitamin C is to assist in the production and maintainence of intercellular substances. Wolbach (70), reviewing pathological changes which result from vitamin deficiencies, considered that "The intercellular substances concerned in Vitamin C deficiency are the collagen of all fibrous tissue structures, the matrices of bone, dentin and cartilage, and all nonepithelial cement substances, including that of the vascular endothelium." Wolbach thought the haemorrhages characteristic of scurvy to be "due to a failure of cement substances in blood vessels."

King (24), demonstrated in guinea pigs the influence of Vitamin C on resistance to infection. Control guinea pigs receiving 5.0 mg. ascorbic acid a day showed no injury to their incisor teeth when injected with diptheria toxin. Other guinea pigs fed on 0.8 mg. ascorbic acid a day, an amount sufficient for normal growth, showed only slight histological evidence in their incisor teeth of Vitamin C deficiency. Nevertheless the injection of diptheria toxin at this intake of ascorbic acid resulted in marked injury to the dentin and odontoblasts of the incisor teeth.

Observations on the relationship of Vitamin C to protein metabolism have also been made. Levine (29), found that infants receiving 5 gm. of protein or more a day from cow's

milk exhibited a spontaneous defect in the metabolism of aromatic amino acids. The excretion of l-p-hydroxyphenylpyruvic acid and p-hydroxyphenylpyruvic acid in the urine ceased with the administration of ascorbic acid. The Vitamin C sub-committee of the Medical Research Council (34), fed a tyrosine supplement to two of their scorbutic volunteers, but found "no appreciable increase in the urinary excretion of phenolic substances". They concluded that "the capacity of the human adult to deal with tyrosine may not be as readily affected by Vitamin C deficiency as that of infants".

The connection of Vitamin C with protein metabolism and its role in protecting connective tissue have not yet been fully evaluated. The protein collagen is present in both connective tissue and the matrix of cartilage. This matrix may be resolved into several proteins, including collagen and chondromucoid, the latter a complex glycoprotein containing chondroitin sulphuric acid (67). Meyer (36), thought that chondroitin sulphate played a part with hyaluronic acid and a collagen precursor in fibre production. Duran-Reynals (14), who first described the action of a mucolytic enzyme, hyaluronidase as being capable of liquifying hyaluronic acid, stated that the permeability of the tissues which would permit such action decreased with age. The enzyme has been demonstrated to be present in various invasive bacteria, including staphylococcus aureus, haemolytic streptocci and the pneumococcus (5). Meyer (36), did not consider chondroitin sulphate, which he thought might contain some ascorbic acid

in place of part of the glucuronic acid in the molecule, subject to such enzyme activity. King (24), has demonstrated the protective action of Vitamin C against attack by bacterial toxins.

Duran-Reynals (14), felt that very little was known about the infectious process in the aging. A concept of resistance to infection with aging had grown up, but he considered that "this resistance may but modify the infection in such a way that its manifestations are unrecogniseable as compared to manifestations of the same infectious agent in the young individual. It seems justifiable to wonder how many diseases of old age fall into this category." In this connection one might also wonder what part Vitamin C plays in maintaining normal arteries in the aged, a subject which has not been explored.

The literature available varies widely in the interpretation of what are considered normal levels of ascorbic acid in the body fluids. Prunty (50), and Rafsky (52), suggest 0.4 mg. ascorbic acid/100 ml. plasma and 1.0 mg./100 ml. blood, respectively. These variations reflect the difference in the English and American views on desirable ascorbic acid intakes. Butler (9), found that there was a variation in the ascorbic acid concentration in different constituents of the blood. This was also reported by Crandon (12), and the Medical Research Council of Great Britain (34), in experimental studies of scurvy. On Vitamin C free diets the plasma

concentration fell to zero in 41 and 37 days (12,34), while the ascorbic acid in the white cells did not fall to zero until just before the onset of symptoms of scurvy at 19 to 21 weeks (12,34).

The saturation studies reported by Stotz (61), are of interest. Six mg. ascorbic acid/kg. body weight were given to 20 elderly patients after a fasting blood specimen had been taken. Two further specimens were taken at 2-1/2 and 5 hours, the subjects receiving only black coffee and toast in the interim. The resulting curves fell into 4 types, designated as "I - saturated, II - high normal, III - low normal, and IV - under-saturated." It was considered that in IV the flow of ascorbic acid from the plasma to the unsaturated tissues apparently always exceeded the rate of absorbtion. The 6 senile and schizophrenic patients fell into this fourth group, while the 14 other patients, also aged from 65 to 90 years, who had had the same hospital diet, showed fasting plasma concentrations of over 0.7 mg./100 ml. When a further 300 mg. ascorbic acid was given orally to the six patients for two days, these also showed type I and II curves, thus indicating that there was no failure of absorption.

This finding confirms the work of Berkenau (3), who found that seven cases of senile psychoses, aged 72 to 82 years, required 8 to 11 days to become saturated on 300 mg. ascorbic acid daily, as compared with three controls of similar age, who became saturated in 2 to 5 days. The administration of 300 mg. ascorbic acid intravenously to two of the senile patients

still unsaturated after 5 days produced no increase in excretion. These patients finally became saturated in 8 to 11 days, after receiving further oral doses of 300 mg. ascorbic acid daily, again indicating that no absorptive failure was present. Stephenson (59), found a "slight but definite improvement in mental condition and muscular function" in cases of senile dementia treated with 200 to 300 mg. ascorbic acid daily. The improvement ceased when the supplement was withdrawn.

Reviewing work done in Norway, Kirk (26), reported decreasing plasma concentrations of ascorbic acid in succeeding decades. Kirk found a similar decrease in patients in St. Louis receiving 45 mg. ascorbic acid daily, but the relationship between age and the plasma ascorbic acid content was significant only in men. Prunty (49), considered that the plasma ascorbic acid content reflected the ascorbic acid intake. It would appear that this reflection may be delayed in the elderly. The plasma level remains at zero for about six months before the onset of symptoms of scurvy.

EXPERIMENTAL PROCEDURE

Selection of Patients

The list of patients undergoing treatment at the Center was discussed with Mrs. Bates RN, Mr. Face and Dr. Fink. Initially the patients fell into two catagories, those in the infirmary section and those in the hospital. Subsequently a new wing designed to accomodate cases for rehabilitation was opened on June 8th, and newly admitted cases became available for investigation. A list of patients was compiled on the basis of mental competence to recall, as accurately as is compatible with the method, the food they had eaten in the previous 24 hours. For operative convenience the patients were divided into groups of approximately five, if possible from the same or adjoining rooms. It was hoped to avoid, by this procedure, any appearance of discrimination against a particular patient which might lead to a lack of cooperation. Background information on the patients chosen was collected by reading the existing case records, and, in some cases, by questioning Mrs. Bates and Dr. Fink as to their opinions about particular patients whose records were not immediately available.

Estimation of Blood Sample Concentrations

Collection of the samples was made between May 26 and June 18, 1954 on Mondays, Wednesdays and Fridays. A small

portable anglehead centrifuge was installed in a second floor room at the Center. The requisite apparatus for the collection and refrigerated transportation of the blood samples was taken out on each visit.

The patients designated for each visit were interviewed briefly at the conclusion of the preceding session and requested not to eat anything after breakfast on the specified day. Instructions to this effect were also left with the relevant person serving the patient's meals. Few of the patients had personal food supplies, so this request met with a good response. Breakfast was served at 7 A.M. and consisted of cereal, milk, toast, butter, coffee and fruit juice. Eggs were served only to "special diet" cases.

Whenever possible the patients walked or were brought to the second floor; samples were drawn between 10:30 and 11:30 A.M. One hand was warmed under running hot water and dried. In cases of hemiplegia the active hand was chosen. With bedfast cases the hand was soaked in a basin of hot water and carefully dried.

Haemoglobin

The patient's hand was placed comfortably in the supine position on either a table or the knee. The second or third finger was swabbed with alcohol above the first joint. A transverse stab incision was made with a Bard-Parker blade mounted in a cork and the first drop of blood wiped off with clean cotton. The succeeding two or three drops were collected

on a small wax mould. The remainder of the flow was collected by an assistant in tubes drawn from 1/4 inch tubing. Care was taken not to fill any tube more than half full or to squeeze the finger.

The haemoglobin content was determined by the method of Bessey (11), on triplicate 10 cmm. samples drawn from the blood collected on wax. The blood was laked in dilute ammonium hydroxide and the haemoglobin concentration determined by calculation from the density reading in the Beckman spectrophotometer. All readings were completed in the late afternoon of the same day.

Serum Protein

Serum samples were obtained by centrifuging the blood collected in glass tubes for 30 minutes. The bulk serum remaining, after samples for the ascorbic acid determinations had been withdrawn, was transferred to 6 x 50 mm. serological tubes, capped with parafilm and returned to the laboratory in an iced thermos bottle.

The serum protein concentration was determined by the gradient tube method described by Bessey (4). Each sample was read against a series of potassium sulphate solutions of known specific gravity. The results were calculated from a graph plotting the position of the standards against their equivalent serum protein concentration.

Serum Ascorbic Acid

The serum ascorbic acid values were determined by the method described in the N. E. Co-operative Nutritional Status Studies (11), based on that of Bessey (4). Triplicate 10 cmm. samples of serum were withdrawn immediately the centrifuging was complete and delivered into 40 cmm. percent trichloracetic acid in 6 x 50 mm. serological tubes. The pipette was not allowed to enter the acid. The samples were mixed, capped and frozen immediately on dry ice, then, on return to the laboratory, stored in the deep freeze until the following morning.

The determination, based on Roe and Kuether's method (56), is dependent on the separation of dehydroascorbic acid as an osazone derivative of 2.4 dinitrophenylhydrazine (54). The proportionality of the colour obtained when this substance is treated with sulphuric acid shows good agreement with Beer's Law (55). A standard curve of dilutions of pure crystalline ascorbic acid (Eastman Kodak Co.) was made with each batch of samples and the serum ascorbic acid concentrations calculated from this.

Diet Histories and 24 Hour Recall Records

Patients from whom blood samples had been collected were interviewed on the same day to obtain diet histories and 24 hour recall records. Copies of the mimeographed sheets used may be found in the appendix, (Figures I and II).

The fact that all patients received essentially the same menu simplified taking the 24 hour recall records. A prior note was taken from the menu as to what food had been served, but leading questions were studiously avoided except in the form of testing queries. Every effort was made to establish the interview on a friendly basis in order to achieve the maximum co-operation.

The food intakes were recorded in common household measures. The diet kitchens were also visited at service time to observe portion sizes. Calculations of the quantity of nutrients present were made from the "average serving" tables of the U.S.D.A. Handbook No. 8 (63), Bowes and Church (6) and Taylor (62).

The dietary history was designed to provide general information as to the formation of any food habits. Evidence of the patient's attitude towards his presence in the institution could sometimes be determined in conversation and from his general demeanour. In several cases it was apparent that resentment of his position was being expressed by the patient by criticising and refusing the food provided. Further information of the subject was sought cautiously, as this represented a sensitive area and, if overstressed, resulted in diminished co-operation.

RESULTS

Estimation of Blood Sample Concentrations

The findings on the patient's haemoglobin, serum protein and serum ascorbic acid have been summarized in Table III. The results are presented in terms of averages for all the men and women separately and by category. The latter indicates whether the patient was housed in the infirmary, the hospital, or had been admitted recently to the new wing. The individual data have been tabulated in Tables IV and V.

The haemoglobin concentrations ranged from 11.12 to 16.39 gm./100 ml. blood. The mean value for men was 14.44 gm./100 ml., and for the women 13.35 gm./100 ml. There did not appear to be any correlation with age in either sex. The haemoglobin concentrations found are within the ranges reported by various authors (Table II).

The serum protein concentrations ranged from 5.9 to 8.5 gm./100 ml. The mean value for men was 7.07 gm./100 ml., and for women, 7.13 gm./100 ml. These values are also within previously reported ranges (13,34,36,40). Again there was no apparent correlation with age. In four of the original number of patients haemolysis or an unsufficient sample prevented the carrying out of serum protein determinations.

The serum ascorbic acid concentrations ranged from 0.15 to 1.53 mg./100 ml. The mean value for men was 0.6 mg./100 ml.

TABLE III. MEAN HAEMOGLOBIN, SERUM PROTEIN AND SERUM ASCORBIC ACID CONCENTRATIONS FOUND IN A SAMPLE OF PATIENTS FROM INGHAM COUNTY REHABILITATION CENTER

Patients	Haemo-globin	Serum Protein	Serum Ascorbic Acid	Mean Age
	gm./100ml.	gm./100ml.	mg./100ml.	years
1. Men	14.44	7.07	0.4	60.1
2. Women	13.35	7.13	0.6	71.3
Overall ranges				
a. Men	12.14-16.28	6.1-8.3	0.15-0.8	33-87
b. Women	11.12-16.39	5.9-8.5	0.15-1.53	47-93
3. Hospitalized cases				
a. M. + F.	13.78	7.01	0.39	66.2
b. M. only	14.01	6.93	0.42	64.1
c. F. only	13.63	7.08	0.37	73.7
4. Infirmary cases				
a. Men	14.55	7.17	0.41	57.1
5. Hospitalized cases admitted between 4/4/54 and 6/9/54				
a. M. + F.	13.19	7.11	0.698	73.0
b. M. (1 case only)	16.02	6.1	0.15	68.0
c. F. only	12.84	7.24	0.80	73.6

TABLE IV. MEN. HAEMOGLOBIN, SERUM PROTEIN AND SERUM ASCORBIC ACID CONCENTRATIONS FOUND IN SELECTED CASES FROM INGHAM COUNTY REHABILITATION CENTER

Patients Code No.	Age	Haemo-globin	Serum Protein	Ascorbic Acid	Months in Residence	Salient Features
	yrs.	gm./100ml.	gm./100ml.	mg./100ml.		
M.						
23	33	15.63	7.2	0.25	73	L. paraplegia
28	37	13.04	6.9	0.60	38	Homeless. Low I.Q.
15	41	14.82	7.2	0.45	90	Hydrocephalic
10	46	16.28	8.3	0.20	1	Multiple sclerosis
1	55	14.89	6.5	--	18	Spastic paraplegia
12	56	15.82	--	--	1	Diabetic
3	57	15.10	7.1	0.36	8	Amnesia
26	58	13.32	6.8	0.80	14	Lues
27	60	13.68	6.9	0.60	109	Homeless
11	62	16.19	7.2	0.30	13	Query, duodenal ulcer
7	63	13.90	7.5	--	91	L. Hemiplegia
29	63	13.71	7.2	0.37	84	Query, senile dementia
22	64	13.70	6.8	0.30	51	Paraplegia
5	64	13.54	7.2	--	79	Rheumatoid arthritis
25	66	13.65	6.8	0.38	50	Homeless. Low I.Q.
24	67	14.29	7.7	0.30	40	Homeless
36	68	16.02	6.1	0.15	< 1	Parkinsons
9	72	15.97	--	--	102	Chronic osteomyelitis
13	73	13.90	6.5	0.68	129	Cardiac
14	74	13.14	7.0	0.27	103	Cerebro-vascular accident
16	87	12.14	6.6	0.27	18	Cardiac
Mean	60.1	14.44	7.07	0.4		
Range	33-87	12.14-16.28	6.1-8.3	0.15-0.8		

TABLE V. WOMEN. HAEMOGLOBIN, SERUM PROTEIN AND SERUM ASCORBIC ACID CONCENTRATIONS FOUND IN SELECTED CASES FROM INGHAM COUNTY REHABILITATION CENTER

Patients Code No.	Age	Haemo-globin	Serum Protein	Ascorbic Acid	Months in Residence	Salient Features
	yrs.	gm./100ml.	gm./100ml.	mg./100ml.		
F.						
18	47	12.24	7.8	--	26	Von Recklinghausens disease
18*	47	11.12	5.9	0.30	26	Asthmatic attack
35	53	12.85	6.6	0.15	< 1	Parkinsons disease
8	54	16.39	--	--	173	Multiple sclerosis
20	66	14.41	7.4	--	54	Epileptic
4	68	13.41	6.6	0.35	15	L. Hemiplegia
34	68	12.41	6.6	0.22	< 1	Parkinsons disease
33	71	15.10	8.5	1.00	< 1	Newly admitted
37	71	12.27	6.6	0.65	< 1	Cardiac. Newly admitted
19	73	13.87	7.5	--	187	(Diabetic. Glaucoma.
19*	73	13.62	6.8	0.80	187	(Paralysed
6	74	14.35	7.8	0.18	112	Multiple sclerosis
17	75	14.45	--	--	194	(T.B. Kidney.
17*	75	13.32	6.6	0.42	194	(Hypertension
21	77	13.81	--	--	94	Senile dementia
41	77	12.33	7.6	0.91	2	Diabetic. Cardiac
30	77	13.01	6.7	0.90	1	Senile
31	79	12.55	8.5	0.78	< 1	Newly admitted
32	82	12.53	7.3	0.18	< 1	Senile
42	93	12.20	6.8	1.53	< 1	100 mg. ascorbic acid b.i.d.
Mean	71.3	13.35	7.13	0.6		
Range	47-93	11.12-16.39	5.9-8.5	0.15-1.53	1-194	

*Repeated samples

and for women 0.4 mg./100 ml. The values obtained showed no consistent correlation with age. The correlations with intake of Vitamin C and length of residence will be discussed later. Haemolysis, an insufficient sample and a laboratory mishap prevented the serum ascorbic acid concentrations being ascertained in eleven of the original number of patients.

Dietary Intakes

Meals served to the patients were well planned and varied, but, as a result of individual idiosyncrasies in food habits, the patients did not invariably benefit fully from the food provided for them.

Patients in the hospital received trays served in the diet kitchens from bulk containers. Second helpings were given only on request, if any food was left over. The men in the infirmary ate in a dining room and served themselves from a sidetable. Bread, milk and sugar were freely available on the tables. Some foods, noticeably meat and butter, were portioned out, but second helpings were available from any food left, once all had been served. All the patients' meals were served after the staff meal. Approximately one third of the 24 hour recall records obtained were taken on Monday. These therefore included two Sunday meals. While the food served was always appetising, the Sunday dinner seemed to be a "highlight" in the week. It is therefore probable that, as has been frequently observed previously, the intakes recorded for these Sundays

were higher than they would have been for a weekday.

The detailed dietary intakes of 20 men, aged from 33 to 87 years, and 15 women, aged from 47 to 93 years, are tabulated in Tables VI and VII.

Height and weight data were available for 12 men only. Predicted values for weight and calorie and protein intake were calculated from the "desirable weights for height" listed in the National Research Council's Recommended Dietary Allowances pamphlet (40), (Table VIII). Starting from the specified percentage of the calorie allowance for the "standard man" required to maintain the desired weight, adjustments were made, where applicable, for increasing ageand decreasing activity. Since only a few measurements for both height and weight were available, the values tabulated can only be regarded as examples. Unfortunately no comparable data was available for the women.

The calorie intakes for all the men ranged from 1196 to 3577, with a mean of 2325. A comparison of mean calorie intake with the predicted requirement of the 12 men is made in Table VIII. If Case M16, ill,bedridden and a poor eater, is excluded, therecorded intakes exceed the predicted requirements by 245 and 275 calories for the hospital and infirmary patients respectively. It is unlikely that there is any significance in the difference in intakes between the two groups.

The remainder of the recorded nutrient intakes were considered in terms of the values predicted for the "standard" man and woman of 65 years in the National Research Council's

TABLE VI. DIETARY INTAKES OF 20 SELECTED MEN AT INGHAM COUNTY REHABILITATION CENTER

Code No.	Age	Calories	Protein	Calcium	Iron	Vitamin A	Thiamin	Riboflavin	Niacin	Vitamin C	Salient Features
	yrs.		gm.	mg.	mg.	I.U.	mg.	mg.	mg.	mg.	
M.											
23	33	2128	46.9	762	9.1	1965	1.18	1.28	9.0	44	Ambulent. Cerebrovascular accident.
28	37	3537	172.6	2900	18.6	3820	2.18	1.83	23.5	48	Works in kitchen.
15	41	2176	80.2	1684	9.4	6480	0.96	2.78	7.2	40	Hydrocephalic.
10	46	2782	111.6	2002	16.4	5436	1.19	3.29	9.5	42	Works in kitchen.
1	55	2572	82.4	1183	10.3	3378	1.75	2.34	10.8	80	Wheelchair. Workshop.
12	56	1683	81.8	1380	11.6	4288	2.25	3.37	7.9	102	Diabetic.
3	57	2663	97.3	1886	14.6	5656	1.19	3.32	11.4	114	Works in kitchen.
26	58	2009	61.5	916	12.0	3588	1.10	1.72	2.9	26	Works in kitchen.
27	60	3577	155.6	2537	20.2	4361	1.83	4.74	18.7	31	Works outside.
11	62	1623	63.5	677	7.9	1924	0.82	1.45	10.0	19	Carpenter.
7	63	2277	76.8	872	10.9	2037	1.86	2.56	9.8	17	Wheelchair. Workshop.
29	63	2776	104.8	1350	15.6	2424	2.39	2.69	18.4	44	Query reliability.
5	64	2686	88.2	1302	11.9	3025	1.68	3.00	9.9	38	Wheelchair. Workshop.
25	66	2683	76.7	1747	8.7	3325	1.70	2.99	8.0	45	Works in kitchen.
24	67	1534	43.6	816	6.2	1942	1.76	1.83	2.5	49	Carpenter. "Watching his weight".
36	68	1729	68.0	1465	7.1	3400	0.90	2.40	7.7	57	Parkinsons disease.
9	72	1900	75.7	699	16.4	2744	1.23	1.48	7.8	8	Osteomyelitis.
13	73	1913	74.9	1527	9.3	4900	0.86	2.64	4.4	23	"Watching his weight".
14	74	2438	87.1	1486	13.4	6326	1.03	2.68	10.7	50	Ambulent.
16	87	1196	49.3	921	6.3	3365	0.52	1.70	2.3	7	Senile.
Mean	60.1	2325	85.0	1375	12.0	3800	1.43	2.60	10.25	43	
Range		1196-3577	43.6-172.6	699-2900	6.2-20.2	1924-6480	0.82-2.39	1.28-4.74	2.3-23.5	7-114	
N.R.C.*	65	2600	65.0	800	12.0	3000	1.3	1.6	13	75	

*National Research Council (39).

TABLE VII. DIETARY INTAKES OF 15 SELECTED WOMEN AT INGHAM COUNTY REHABILITATION CENTER

Code No.	Age	Calories	Protein	Calcium	Iron	Vitamin A	Thiamin	Riboflavin	Niacin	Vitamin C	Salient Features
	yrs.		gm.	mg.	mg.	I.U.	mg.	mg.	mg.	mg.	
F.											
18	47	2297	99.1	545	14.8	2427	0.95	1.53	16.5	12	Allergic to milk.
18*	47	1719	65.1	361	15.3	32,251	0.91	3.15	15.1	49	"Liver day". Asthmatic attack.
35	53	2030	75.7	1431	9.9	2757	0.85	2.32	8.0	25	Parkinsons disease.
20	66	1726	50.0	560	5.9	1923	0.39	0.90	6.9	62	Epileptic.
4	68	1389	59.8	1382	6.7	2541	1.01	2.25	8.9	35	Query reliability.
34	68	1825	60.1	952	8.6	1863	1.14	1.65	8.9	75	Parkinsons disease.
33	71	2110	93.4	1309	11.2	3747	0.98	2.41	10.2	16	Newly admitted.
37	71	1444	68.2	1325	8.0	2438	0.60	2.12	6.3	33	Newly admitted.
19	73	1587	91.4	1273	11.3	5860	0.92	2.36	7.8	106	Diabetic. Glaucoma.
19*	73	1230	96.7	695	14.8	62,971	0.86	6.06	20.3	176	"Liver day".
6	74	1503	45.5	496	11.2	4138	1.09	1.22	12.7	52	Multiple sclerosis.
17	75	1272	64.6	210	11.6	2022	0.55	0.86	10.1	23	T.B. Kidney.
17*	75	1407	63.5	265	19.6	63,039	2.04	6.23	32.4	65	"Liver day".
21	77	2129	80.1	1480	9.0	3105	1.09	2.43	8.2	28	Senile.
41	77	1770	81.3	1512	11.3	4240	0.92	2.55	7.5	78	Cardiac. Diabetic.
30	77	1872	78.1	712	10.6	1554	1.17	1.53	13.5	87	Senile.
31	79	1247	65.3	835	5.5	2794	0.59	1.70	7.5	14	Newly admitted.
42	93	332	12.6	89	3.5	913	0.23	0.23	0.16	208	100 mg. ascorbic acid, b.i.d.
Mean	71.3	1578	69.8	830	7.9	11,143	0.86	2.34	11.26	70	
Range	47-93	332-2297	12.6-99.1	89-1512	3.5-19.6	913-63,039	0.23-2.04	0.23-6.23	0.16-32.4	12-208	
N.R.C.†	65	1800	55	800	12.0	3000	1.0	1.4	10	70	

*Repeated samples.

†National Research Council (39).

TABLE VIII. CALCULATED AND RECORDED WEIGHT, CALORIE AND PROTEIN VALUES FOR 12 MEN AT INGHAM COUNTY REHABILITATION CENTER

Patients Code No.	Age	Height	Weight, lb.		Calories		Protein, gm.		Comment
			Expected	Actual	Calculated Requirement	Recorded Intake	Calculated Requirement	Recorded Intake	
	yrs.	ins.							
1. Hospitalized men									
M.23	33	74	178 ± 18	145	2750	2128	81	47	Very tall and thin. Ambulent.
M.1	55	66	142 ± 14	136	2040	2572	65	82	Solidly built. Wheelchair.
M.7	63	68	150 ± 15	187	1890	2277	68	77	Could afford to lose 30 lbs. Wheelchair.
M.5	64	66	142 ± 14	160	2000	2686	65	88	Well covered. Wheelchair.
M.13	73	65	138 ± 14	122	1900	1913	63	75	"Watches his weight". Ambulent.
M.16	87	64.5	138 ± 14	92	1840	1196	63	50	Poor eater. Bedridden.
2. Infirmary men									
M.28	37	66	142 ± 14	122	3000	3537	65	173	Active worker.
M.26	58	70	158 ± 16	160	2350	2009	72	62	Ambulent.
M.27	60	68	150 ± 15	170	2860	3577	68	156	Active worker. Wt. gain in last 2 yrs.
M.29	63	72	167 ± 17	146	2260	2776	76	105	Tall and thin Ambulent.
M.25	66	67	146 ± 14	164	2050	2683	66	77	Well covered. Ambulent.
M.24	67	64	135 ± 14	200	1950	1534	61	44	"Watches his weight". Ambulent.

TABLE VIII continued

Patients Code No.	Age	Height	Weight, lb. Expected	Weight, lb. Actual	Calories Calculated Requirement	Calories Recorded Intake	Protein, gm. Calculated Requirement	Protein, gm. Recorded Intake	Comment
	yrs.	ins.							
Mean values									
1. Hospitalized men									
	62.5	67.2 (164.6 cm.)	148 (67.3 kg.)	140.3 (63.8 kg.)	2070	2128 (2315)*	67.5	69.8	
2. Infirmary men									
	58.5	67.8 (166.1 cm.)	150 (68.2 kg.)	160.3 (72.9 kg.)	2411	2686	68	103	

*Excluding Case M.16

Allowances (40). Many of the individual intakes were high in relation to other published figures on older people, (Table I).

The mean calorie intake for the women was 1578, with a range of 332 to 2297. If Case F42, a bedridden woman of 93 who was a very poor eater, is excluded, the mean calorie intake for the remaining women becomes 1650, again a high value in contrast to the published figures, but approximating to the National Research Council "standard" allowance.

The mean protein intakes of 85 gm. for men and 70 gm. for women are above the recommended allowance of 1 gm./kg. desirable body weight. Only one woman and three men consumed substantially less protein than the allowance.

Among the women, 50 percent of the calcium intakes were below the recommended 800 mg. Only three men consumed less than this amount. Individual variations in milk consumption accounted for these differences.

Individual intakes of iron among the men ranged from 6.2 to 20.2 mg. The mean intake was 12.0 mg., equalling the recommended allowance, but 50 percent of the men had intakes below this figure. For women, the mean iron intake at 7.9 mg. was 4.1 mg. below the N.R.C. allowance. Only four women had intakes of more than 12 mg. iron daily.

The Vitamin A intakes were expressed as pre-formed Vitamin A. The inclusion of liver in a mid-day meal eaten by five of the women interviewed raised their mean intakes to 11,143 I.U. The men also were served liver, but none were

interviewed on that day, so that their actual intake would have been higher than the mean recorded in Table VI, of 3800 I.U. These figures compare well with the N.R.C. Recommended Allowance of 3000 I.U. pre-formed Vitamin A per man per day.

The mean thiamin intake for men was 1.43 mg. and for women 0.86 mg. Nine women and four men had intakes of thiamin providing less than 0.6 mg. per 1000 calories consumed.

The riboflavin intakes varied widely in both sexes, but the means of 2.60 mg. for men and 2.34 mg. for women were well above the recommended allowances.

The mean niacin intake for women was 11.3 mg. with a range of from 0.16 to 32.4 mg. Two-thirds of the women, however, showed intakes of less than 10.0 mg., the recommended allowance. The mean intake for men was 10.25 mg. niacin, with a range of from 2.3 to 23.5 mg. Only three men had intakes above the recommended allowance of 13.0 mg. The excellent protein intakes would, however, ensure an adequate supply of tryptophane, which is considered to be a source of niacin. The wide range of intake reported was due to the inclusion of the "liver day" for the women and individual high meat intakes among the men.

No further deduction was made for cooking losses in calculating the Vitamin C intakes recorded. The mean intake for the men was 43 mg., with a range of from 8 to 114 mg. Seventeen of the men had intakes below the recommended 75 mg. Among the women there was a range in intake of from 12 to 208 mg. Vitamin C, with a mean of 70 mg. equalling the recommended allowance.

Only six of the women, however, had intakes above the allowance. The intake of 208 mg. was supplied by two daily doses of 100 mg. ascorbic acid in the form of tablets. The patients did not always take advantage of the dietary Vitamin C available to them.

Case Studies

Dietary histories were taken as a means of evaluating individual food patterns. In several cases the information so obtained provided an explanation as to why the intake of a particular nutrient appeared low. Some examples are presented below to illustrate how such evidence may confirm the findings compiled from a 24 hour recall diet record.

Case M27. Low Vitamin C intake. Found fruit juice "too acid".

Case M11. Low Vitamin C and calcium intake. Poor teeth and possible duodenal ulcer. Found fruit juice "too acid" and vegetables "upsetting". Professed to have liked milk previously, but did not drink it now.

Case M7. Low Vitamin C intake. Found fruit juice "too acid".

Case M29. Low Vitamin C intake. Found orange juice "too acid".

Case M24. Low protein and calcium intakes. Previously had high intake alcohol, desserts and concentrated carbohydrates. Now "watching his weight". Had stopped eating cereals and potatoes and took little bread and milk.

Case M9. Low calcium and Vitamin C intakes. Milk taken only as a scant serving on cereal or when flavoured with

chocolate. No fruit, fruit juice or vegetable, except potato, taken.

Case F18. Low calcium and Vitamin C. Allergic to milk. Disliked all vegetables except potatoes. Took no fruit juice or fruit except bananas and grapefruit. Forced as a child to take milk, fruit and vegetables, now determined not to.

Case F35. Low Vitamin C intake. Disliked fruit juice.

Case F20. Low calcium and thiamin intakes. Had never drunk milk. Disliked breakfast cereals. Liked "plenty of sugar and candy".

Case F4. Had not previously drunk milk but now took it "for the vitamins". Ate no potatoes and only half a slice of bread a day because she was "afraid of getting diabetes".

Case F33. Low Vitamin C. Found fruit juice "too acid".

Case F37. Low thiamin. Had always made own bread. Disliked "shop bread".

Case F6. Low calcium. Milk not liked, although she had had to drink it as a child.

Case F17. Low calcium and Vitamin C. Disliked milk, cereals and most desserts. Took no fruit juice except tomato.

Case F41. Found fruit juice "too acid".

Case F31. Low Vitamin C. Found fruit juice "too acid now". Vegetables said to "give her diarrhoea".

Case F42. Diptheria as a child left her with a "weak throat". Had never been able to take any acid or rough fruit or vegetables. Ate very little.

DISCUSSION

In general, the findings reported in this study indicate that the patients investigated at the Ingham County Rehabilitation Center have a reasonably good nutritional status.

The haemoglobin concentrations found are well within the expected limits. The intake of dietary iron is relatively low. In this connection it should be remembered that there is no evidence to indicate that, in the absence of blood loss, grown men and women past the menopause have a specific iron requirement. Certainly the haemoglobin concentrations reported indicate that the dietary intakes of iron of these men and women are apparently sufficient for their needs.

The serum protein concentrations reported are also good, a finding to be expected in view of the excellence of the majority of the dietary protein intakes.

The serum ascorbic acid concentrations reported vary considerably, as do the Vitamin C intakes in the dietaries. In view of the marked differences in the average ascorbic acid serum concentrations reported for each of the three categories of patients, (Table III), scatter diagrams were plotted showing serum ascorbic acid concentration against dietary intake of Vitamin C.

Six of the nine patients admitted to the hospital between April 4 and June 9, 1954 were women whose serum ascorbic acid

concentrations ranged from 0.65 to 1.53 mg./100 ml. (Table V). The other three patients, all cases of Parkinsons disease, had serum ascorbic acid concentrations of 0.15, 0.15 and 0.22 mg./100 ml. respectively. It is considered that plasma or serum ascorbic acid concentrations reflect both the degree of tissue saturation and the recent dietary intake of Vitamin C (Stotz (60). It is therefore probable that the serum ascorbic acid concentrations of these six women reflected to some extent their Vitamin C intakes before admission. Excluding these cases, there was some trend towards a straight line relationship between the serum ascorbic acid concentration and the Vitamin C intake in the other women. The correlation coefficient was 0.714, a significant finding (probability less than 0.05).

The cases of Parkinsons disease show low serum ascorbic acid concentrations associated with Vitamin C intakes of 25, 57 and 75 mg./day. The dietary histories suggested that Vitamin C intakes prior to admission had been reasonably satisfactory.

Taylor (5), described Parkinsons syndrome as due to degenerative changes in the corpus striatum. He thought that the disease might also result from cerebral arteriosclerosis, encephalitis lethargica, or from poisoning by carbon monoxide or manganese. Taylor reported that "the corpus striatum and other parts of the extraphyramidal system seem to be peculiarily susceptible to the action of certain toxic substances". The three cases of Parkinsons syndrome reported on here had each contracted the disease some time previously, in one case, with

a background of hereditary syphilis, over 18 years before. One case, F34, reported that she was in the habit of pulling out her own teeth when they became sufficiently loose. In view of Taylor's opinions and the known function of Vitamin C in aiding resistance to infection and maintaining intercellular substances, one might raise a question as to why these ascorbic acid serum concentrations have remained low in the face of apparently good Vitamin C intakes.

Among the men, Cases M13, M26, M27 and M28 probably had higher dietary intakes of Vitamin C than those recorded. These four men either worked in the kitchen, with possible access to extra food, or drank relatively large quantities of milk, which could provide an extra source of Vitamin C. If these cases are excluded the remainder of the serum ascorbic acid concentrations are between 0.2 and 0.4 mg./100 ml. These values tally closely with those reported by Horwitt (20), for over 1000 blood samples from patients of unspecified age at Elgin State Hospital. Horwitt found the plasma ascorbic acid concentration to fluctuate from 0.2 mg./100 ml. in April to June to 0.59 mg./100 ml. in October and November, with a mean of 0.4 mg./100 ml. The calculated average dietary intake of Vitamin C was 25 mg. daily. The relationship between the serum ascorbic acid concentration and the Vitamin C intake of the men reported from Ingham County Rehabilitation Center is expressed by a correlation coefficient of -0.1009. The lack of relationship indicated by this finding is most probably due to

the fact that some of the men served their own food in the dining room, so receiving less uniform portions. It is also likely that the men were less able to indicate quantitatively what the size of their portions had been than the women were. These circumstances would lessen the reliability of the data on the intake of Vitamin C.

The majority of the patients investigated, who were not newly admitted, had serum ascorbic acid concentrations ranging from 0.18 to 0.45 mg./100 ml. The picture presented would serve as an illustration of Kruse's concept of a state of chronic deficiency (27). The continued ingestion of an insufficient supply of a nutrient such as Vitamin C will result in the gradual depletion of the body stores. Eventually an equilibrium is reached, by which time the concentration of the vitamin in the body is below the accepted norm, but at which the body has not been depleted of Vitamin C. A continued low intake of the vitamin will maintain this concentration, provided no infection or other insult to the body intervenes. With the passage of time, and, possibly, with lack of activity, the tissue concentration of the nutrient may even rise slowly. Higher intakes of Vitamin C will improve the serum concentration, although published reports indicate that this takes longer in the elderly, who may require considerable persuasion to accept a sufficient intake of Vitamin C.

Acidity is the most frequently used excuse for not eating citrus fruits. Achlorhydria is frequently found in the aged,

often accompanied by poor dentition (Freeman (17). The post-prandial discomfort attributed by many of the Rehabilitation Center patients to the "acidity" of fruit juice may, in fact, have been due to fermentation resulting from lack of gastric acid. Acid fruit juices may actually improve the gastric phase of digestion in these cases, if the patient can be persuaded to take them.

Appreciation of the difficulties imposed by lack of teeth is evident in the carefully thought out menus used at the Center. The acceptance of fruit juice as a source of Vitamin C also could be improved by patient education in the importance of its contribution to nutrition. Many people tolerate fruit juice better if it is taken after, rather than before, a meal. Orange or lemon juice may be incorporated in fruit cup, or in stewed fruit after it has been cooked. Citrus fruit juice may be served as a sauce to accompany cake or cornstarch pudding. To avoid loss of Vitamin C in cooking, it is advisable to cook the thickening agent of the sauce first, in as little as possible of the required amount of liquid. Citrus juice sufficient to make up the bulk of the liquid may then be beaten in when the sauce is cold.

Human caloric requirements are known to be reduced by an increase in age or a decrease in activity (DuBois (13). Table VIII, explained in detail in an earlier section, was constructed, using such data as was available, to compare the predicted and actual intake calorie values.

The value to a rehabilitation scheme of such a comparison of desirable and actual weights will be immediately apparent. Case M7, for example, is some 37 lbs. over his desirable weight. While it is reasonable to expect that at 68 years of age he would have gained some weight, the extra 30 lbs. will militate severely against his chances of learning to walk again. Plans have already been made at the Center for recording regular monthly weights for as many patients as possible. If these could be kept serially, or in the form of a small graph for each patient, they would enable trends of weight gain or loss to be seen immediately. The appropriate action could then be instituted.

The comparison of the desirable and actual protein intakes again indicates that, in general, a plentiful supply of protein is available. Ohlson (45), studying older women, found the predicted protein requirement for the maintenance of nitrogen equilibrium to remain between 65 and 70 gm./day for the age ranges studied here. The low protein intake of Case M24 may be attributed directly to his attempt to lose weight without supervision. Ohlson (44), reported that a reduction in bread, milk and potato intake, (see Case Studies, page 36), was a common finding in women desiring to lose weight. There was a comcomitant reduction in nutrient intake. Reducing diets for the elderly require careful planning to ensure an adequate intake of essential nutrients.

The importance of nutrition in a rehabilitation scheme has not yet perhaps been fully evaluated. While good and

adequate foods may be available to the patient, it is still necessary to educate him to accept those essential for good nutrition. Overweight here, as in other branches of medicine, is an impediment to the patient. The provision of "things to do" can help lessen the importance of meals in a patient's day. Nutrition education can guide the patient in his eating. The education or regeneration of unusual or unused muscle groups will necessitate making available to the patient food containing the nutrients essential for muscle growth and repair. In this way the value of the already outstanding programme of physical re-education at Ingham County Rehabilitation Center could be enhanced.

The co-operation of the patient is the essential factor in rehabilitation. Simple, colourful educational materials are available which could be used to improve the patient's understanding of the importance of nutrition to him. A check sheet listing good sources of the important nutrients could be used to bring home to the patient where he needs to improve his eating habits. Patients who are able might well keep such a sheet for themselves (42).

SUMMARY

A nutritional evaluation was carried out on patients at a rehabilitation centre in Ingham County, Michigan.

Micro-chemical analyses for haemoglobin, serum protein and serum ascorbic acid were made on capillary blood samples. The findings were correlated with the dietary intake estimated from a 24 hour recall record. Dietary histories were used to investigate individual food patterns.

The haemoglobin and serum protein concentrations were found to be within the limits expected. The serum ascorbic acid concentrations of the newly admitted patients were essentially normal, while those of the longer-term patients were suggestive of a state of chronic ascorbic acid deficiency due to the fact that they had not all taken advantage of the Vitamin C supplies made available to them.

The meals supplied in the Center were good and carefully planned. The calorie and protein intakes of the men were, in general, above the estimated requirements calculated from the National Research Council Recommended Allowances (40). The mean calorie intake of the women was within the limits of previously published studies, while the protein intake was relatively high. The Vitamin C intakes ranged from 8 to 208 mg./day; the significance of their correlation with the serum ascorbic acid concentrations are discussed.

The importance of good nutritional status to the patient in a rehabilitation project is discussed. Means of providing the patient with nutrition education are suggested.

Nutrition is one of the keys to living. It is vitally important that it should never be neglected when considering those who are being taught to live again.

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APPENDIX

LIST OF FIGURES

FIGURE I

RECORD OF MEALS FOR ONE DAY

Name_____ Code No._____ Date_____

FOODS EATEN FOR BREAKFAST

1._____ 4._____ 7._____

2._____ 5._____ 8._____

3._____ 6._____ 9._____

What foods were on the table that you did not eat?_____

What foods did you eat or drink between breakfast and noon?____

FOODS EATEN AT NOON

1._____ 4._____ 7._____

2._____ 5._____ 8._____

3._____ 6._____ 9._____

What foods were on the table that you did not eat?_____

What foods did you eat or drink between the noon and evening meal?_____

FOODS EATEN AT EVENING MEAL

1._____ 5._____ 9._____

2._____ 6._____ 10._____

3._____ 7._____ 11._____

4._____ 8._____ 12._____

What foods were on the table that you did not eat?_____

What foods did you eat or drink before you went to bed?_____

_____

Medications_____

FIGURE II

Code No._____ Name_____ Hospital No.____

Date of interview_____ Home town_____

Sex_____ Age_____ Marital Status - S M W D Sep.

Wt._____lb. Ht._____in. St. Wt._____lb. Teeth_____

Diagnosis_____ Prognosis_____

Condition)_____ Condition)_____
)
On entry)_____ Now)_____

Rehabilitation

Begun_____ Progress_____

_____ Workshop_____

Family Background

Father_____

Mother_____

Siblings_____

Wife_____ Children_____

Previous occupation

_____

_____

_____

_____

Meals at work

_____

_____

_____

_____

Food Preferences and why:

Foods previously eaten	Times/week	
	Adult	Child
Milk, fresh		
canned		
Cheese		
Eggs		
Meat		
Bacon or ham		
Fish		
Cream		
Butter		
Oleo		
Oil or other fat		
Fruit, raw		
cooked		
Vegetable, raw		
cooked		

	Times/Week	
	Adult	Child
Potatoes		
Rice, pasta, corn		
Cereal, type		
Bread, type		
Crackers		
Cookies		
Desserts		
Preserves		
Sugar		
Candy		
Tea		
Coffee		
Other beverage		
Alcohol		
Special Family dishes		