lining for inflation purposes, and is quilted to loculate the air to ensure that there is always a layer of air even at points of pressure. It weighs only 2½ lb. (1.25 kg.), and rolls up to form a stole for the "Mae West." There is a short tube at the neck for inflation by the mouth, and a hood to complete the protection. Even if it is not put on until the dinghy is boarded, it will protect the wearer against further loss of body heat despite wet clothing underneath.

Researches were also carried out with various *life-saving jackets* to assess their efficiency to prevent an injured or unconscious man from drowning. For this purpose a member of the physiology team was kept continuously anaesthetized while immersed in a swimming-bath wearing various types of life-saving jackets in turn, the body being pulled face down from time to time to see if it would right itself. Artificial waves were created to imitate rough water. Though the R.A.F. "Mae West" kept the nose and mouth of the unconscious individual clear of the water, it was improved for use in rough seas by a 2-lb. (0.9-kg.) lift in the back. A new jacket was therefore designed incorporating this and other improvements.

The immersion suit and the "Mae West" life-saving jacket, which are light and easily stowed, will be welcomed by civil air lines, particularly now that land planes are replacing flying boats on most, if not all, cross-sea and ocean flights.

Some Flying Problems

Time does not permit of more than passing mention of many other problems tackled, and solved, to improve man's efficiency in flying, whether in a Service or a civil capacity—for instance:

(i) The protection of vision against *sun and searchlight glare* by special glasses and other devices.

(ii) Means of obtaining and maintaining the *maximum night visual acuity*, by pre-adapting with red goggles, and using red or ultra-violet lighting reduced to the minimum to illuminate instruments and maps.

(iii) Improved design of *microphones* and *earphones* to increase acoustic reception and so lessen fatigue.

(iv) Design and development of *flying helmets* to give perfect fit with comfort even when worn for hours.

(v) Proof of the occurrence of *high-tone deafness* as the result of flying for 100 or more hours without ear protection in non-sound-proofed cabins.

(vi) Means of preventing and treating acute *otitic barotrauma* by x rays or gamma radiation.

(vii) Study of the causes of *dental pain at altitude* and its prevention by proper conservative dentistry, using cement of the correct pH and avoiding undue heat near the tooth pulp.

(viii) Study of *air-sickness* and its prevention, and discriminating between true air-sickness and emotional tension.

(ix) *Design of cockpits and seats* for comfort; removal of projections likely to cause injury; placing of all controls in the most favourable position. The problem is whether the controls most often used or those needed in emergency should have place of vantage.

(x) Simplification of *instrument dials* for ease of reading; grouping of instruments so as to cause the minimum of error and fatigue.

(xi) The *disinsectization of aircraft*, and the *control of mosquito* breeding by aerial spraying of D.D.T.

(xii) The *cooling of aircraft* on the ground in hot climates and protection of those servicing aircraft.

It is evident from the foregoing that the majority of aviation medicine researches carried out on behalf of Service flying have a direct or indirect bearing on civil aviation problems. For this reason, when considering the establishment of the new Institute of Aviation Medicine at Farnborough, it was decided to design, equip, and staff it to meet the requirements of civil aviation as well as of those of the Services—Royal Air Force, Fleet Air Arm, and airborne troops. Throughout the war there has been the closest liaison in all this work not only between the Services but also with the Dominions and our Allies: their scientists have worked alongside ours in the Institute, and in some instances still continue to do so. No less important has been the liaison with aircraft designers and scientists on the material side. It was by this whole-hearted co-operation and fine team spirit that such excellent and rapid progress was made in aviation medicine during the war; it is sincerely hoped that this friendly collaboration will continue

in peace to ensure the fullest support for aviation in general so as to make it the safest, most comfortable, and quickest mode of travel.

This is a high-speed aerial review of the progress made in aviation medicine during the war, and, as in an aerial view, the ground covered is extensive but detail is lacking: you get only glimpses of this new country through the clouds of obscure description and so your imagination must fill the gaps. Likewise, as you cannot see the whole world in an hour, even in the fastest of aircraft, so this picture of aviation medicine covers only a small portion of the valuable work done by as fine a team of scientists and medical officers as anyone has ever been privileged to direct.

I wish to pay high tribute to all those who have given so much and often risked so much in these researches—physiologists, psychologists, Flying Personnel Medical Officers, and Squadron Medical Officers, and to those who gave all—Group Captain Hugh Corner and Squadron Leader D. A. H. Robson.

INADEQUATE FEEDING IN HOSPITALS

A STUDY OF CONTRIBUTORY FACTORS*

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Loss of weight, which is sometimes considerable, is not an uncommon occurrence in patients admitted to hospital. In Royal Canadian Army Medical Corps hospitals in Canada losses of weight have been noted in over half the patients observed, and ranged from 10 to 60 lb. (4.53–27.2 kg.).^{1,2} Lyons³ has reported similar losses of weight in soldiers in U.S. Army hospitals. Such findings are certainly not confined to those treated in military establishments, for Elman,⁴ Taylor,⁵ and others have recorded similar observations in civilian hospital patients. At the end of 1943 this state of affairs in Canadian military hospitals in Canada was surprising, since the raw food-stuffs available for hospital use were, according to accepted standards and practices, more than ample.

In this paper, therefore, we record measurements made on actual food intakes of patients in Canadian military hospitals in Canada, and we report observations made during the past few years on factors which have contributed to inadequate protein and caloric intakes. We will also discuss briefly the relationship of so-called "toxic destruction" of protein to loss of body mass and to protein and caloric requirements. Finally, we will present some data to illustrate the effects of a campaign planned to maintain high standards of nutrition in the sick.

Methods

Dietary histories were taken and measurements were made of the food consumed by patients in Army hospitals in Canada. These men were subsisting on the ordinary ("full") hospital diet; they had normal gastro-intestinal tracts and were convalescent after surgical procedures. Over a three-day period all food actually offered to each patient was weighed before and after the meal. Hospital supplementary feedings were measured, and all patients kept a list of extra food supplied by friends or obtained from the Red Cross or the hospital canteen. Food platters were chosen at random so that the servings would represent those usually given by the nursing sister. The caloric, protein, fat, and carbohydrate values of the ingested food were calculated from National Research Council tables of food composition. The results were analysed statistically.

Various aspects of hospital catering which might affect intake of food were studied in over 30 hospitals. Observations were made on supplies of food available in depots, the ordering of

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food, kitchen and ward equipment, the ability and training of cooks, methods of cooking and serving food, and the attitude of the medical staff, the nursing staff, and the patients themselves toward food intakes.

Results

The ration scale for R.C.A.M.C. hospitals in Canada from which ordinary or "full" diets are prepared consists of 156 g. of protein, 144 g. of fat, and 539 g. of carbohydrate, and provides approximately 4,100 calories. From these sources the patient got three meals a day and sometimes supplementary feedings such as egg-nogs (100 to 200 calories and 10 to 20 g. of protein), milk, cocoa, and biscuits.

We found three main reasons why patients did not ingest their full ration. First, although foodstuffs were plentiful in depots, hospital staffs did not indent for their full entitlement; secondly, some wastage occurred during preparation of the food in the kitchen and through failure to use food left over; thirdly, considerable amounts of food were left on the plates by the patients. Improvement in food intakes which was noted some months after an educational campaign was instituted is here shown in a graph.

Graph showing the daily intake and wastage of calories and protein of patients in a Canadian military hospital before (white) and after (black) an educational campaign planned to improve hospital nutrition.

The results of the observations have been recorded for two hospitals in the accompanying Table. The average quantity of

Table showing the Total Intake of Protein, Fat, Carbohydrate, and Calories of each Patient each Day in Two R.C.A.M.C. Hospitals in Canada. The Amounts of Food Left on each Plate are also shown

Per Man Per Day	Proteins in Grammes		Fat in Grammes		Carbohydrate in Grammes		Calories	
	Hosp. A	Hosp. B	Hosp. A	Hosp. B	Hosp. A	Hosp. B	Hosp. A	Hosp. B
Food actually ingested	54	74	73	93	239	276	1,856	2,272
Food left on plate . .	21	12	22	11	119	69	772	428
Food served to patient	75	86	95	104	358	345	2,628	2,700
Food never obtained and kitchen wastage	102	70	71	40	300	194	2,279	1,435

food ingested by each patient each day, from hospital sources, provided 74 g. of protein and 2,210 calories. The lowest intake for each day of the three-day period was 25 g. protein and 764 calories, and six patients had less than 1,600 calories a day.

The highest intake in any individual was 114 g. protein and 3,094 calories. In one hospital in Canada the patients averaged only 54 g. of protein and 1,856 calories.

Factors Contributing to Hospital Malnutrition

The Medical Officer and Nursing Sister.—Generally speaking, at that time malnutrition was rarely considered as a cause of delayed convalescence or rehabilitation. The present emphasis in R.C.A.M.C. hospitals in paying particular attention to the food intakes and nutritional status of the individual patient was not widely recognized, and these and other points had to be stressed in educational programmes. For example, medical officers had to be told of the necessity for taking steps to see that patients were actually eating the food which had been ordered in the ward order books. This was essential, as we had observed in civilian hospitals²⁰ that, in general, a gross discrepancy existed between the surgeon's or physician's impression that an adequate diet was being ingested and the actual intake achieved by the patient. The following cases illustrate this point.

A patient in a surgical ward suffered from Pott's disease. Because of this and a prolonged attack of infective hepatitis he was placed on a high-protein diet. When his intake was measured it was found that he was getting only 86 g. of protein each day and 2,690 calories. Another patient was recovering from a compound fracture of the femur and developed jaundice. Orders were written for him to have a high-protein low-fat diet. When measurements were made he was found to be taking a relatively high-fat low-protein diet, for his protein intake was only 67 g. a day. In neither instance had the discrepancies been noted by the attending medical officers.

The necessity for frequent consultations between the medical officer, the dietitian, and the nursing staff regarding special diets, special foods, and special feeding techniques for individual patients who required special nutritional care was also pointed out.

It was found, too, that, during their training, nursing sisters had not been taught the importance of ensuring adequate intakes of food in the average patient who was not subsisting on "special" diets. This was not surprising, since the medical profession has only recently recognized that ensuring adequate food intakes is a therapeutic measure which speeds recovery and rehabilitation. Consequently, nursing sisters, as in civilian life, looked upon feeding the patient as a routine measure and let the individual patient's appetite be the guide to intake. We therefore encouraged them to see that food was served hot and in an attractive manner, to offer second helpings, to persuade patients to eat, and generally to attend to the intake of protein foods by the individual patient.

The Patient.—The majority of patients correctly believed that the caloric requirements of a man in bed are much lower than those of a man doing work. But they made no distinction between the requirements for a healthy man lying in bed and those of a sick man in bed. The patient's appetite was poor immediately after trauma, operations, and burns, or during the acute phase of an illness. Poor appetites persisted, and patients got into the habit of not eating unless they were stimulated by attractive food, or through education, suggestion, or persuasion given by the attending medical officer. Patients often disturbed their appetite by eating chocolate, biscuits, and other confections just before or between meals. In summer, especially, aerated soft drinks were consumed in large quantities and disturbed appetite considerably.

The Dietitian and Cooks.—Nearly all dietitians and cooks were anxious to prevent waste, and in some hospitals did not provide enough food. Consequently helpings served to the patients were often skimpy. There was also a tendency to serve too many stodgy and unappetizing dishes made from inexpensive types of food, such as bread and flour, in an effort to keep down costs. Such dishes contributed to much wastage on the plates.

The Hospital Administrative Staff.—The hospital administrative staff, quite rightly, attempted to keep costs down when purchasing food, but in a considerable number of hospitals the amount of money spent on raw foodstuffs was ludicrously small, and consequently food purchases did not cover nutritional requirements.

Spacing of Meals and Supplementary Feeding.—In many hospitals, although meals are supposed to be properly spaced,

we found patients getting breakfast late in the morning and lunch being served at noon or soon after. Since the midday meal was the main meal of the day, patients who had had a late breakfast left food on their plates. The common practice of serving supper at 4.30 or 5 p.m. meant that many patients went without food, save for cocoa and biscuits, for 15 hours or longer. Supplementary feedings, such as egg-nogs, were used frequently. Water and sweetened orange juice were the main fluids provided at the bedside, and none of these drinks contributed much to either the caloric or the protein intake of the patient.

Equipment.—Special modern equipment, such as Hobart mixers, which help cooks and dietitians to prepare and serve attractive food, was often not in sufficient supply. Chipped white enamelware and cracked crockery, which was used occasionally in some hospitals, certainly did not stimulate the appetites of those who were ill.

Discussion

Peters⁸ points out that, despite the discovery of new agents and techniques which have reduced mortality, complications, and permanent disabilities, the overall duration of the period in hospital and of disability has not been reduced. He states that loss of strength and undernutrition were prominent among the factors which appeared to retard convalescence and rehabilitation.

In our experience many physicians and surgeons who regard loss of weight in hospital patients as inevitable explain wasting as "disease atrophy" or believe that most of the loss is due to harmless utilization of body stores of fat at a time when appetite is poor and the body requires some source of energy. The investigations of Shaffer and Coleman on typhoid fever⁷ in 1909 showed that the wasting which occurred in that disease was due to breakdown of protein tissue with excretion of large quantities of nitrogenous substances in the urine. Since then this phenomenon, which by long usage is still described as "toxic destruction of protein," has been shown to occur after burns,⁸ injury and elective operations,^{9,10} haemorrhage,¹¹ and other conditions.^{12,13}

In some patients the excretion of nitrogenous end-products is very large. Browne of McGill¹⁰ reports excretions of between 25 and 35 g. of nitrogen in the urine each day in convalescent surgical patients. This is equivalent to the metabolic breakdown of $1\frac{1}{2}$ to $2\frac{1}{2}$ lb. (0.68–1.13 kg.) of muscle tissue. In one obese patient who suffered 20% burns marked weight-loss occurred. Investigation showed that he too was excreting nitrogenous waste products. This was the probable cause not only of the loss of weight but also of failure of skin grafts to take. Correction of his diet, which ensured large intakes of protein and cut down the overall nitrogenous loss from the body, resulted in a gain of $1\frac{1}{2}$ lb. (227 g.) a day in weight and considerable improvement in the appearance of the granulating areas. The next attempt at skin grafting was successful, and the grafts took excellently.

As yet there is no adequate explanation of the factors which produce the metabolic or "toxic" breakdown of protein that follows upon insult to the body. However, it is rational to associate it with the loss of strength, loss of weight, and atrophy which we have seen in patients in military hospitals. While no specific therapy is available to stop the body protein from breaking down, Taylor,¹⁴ Elman,¹⁵ Mulholland,¹⁶ Browne,² and others have all shown that the phenomenon can be controlled by adequate feeding, with larger quantities of protein and calories than has been the practice.

Taylor advocates¹⁴ a daily intake of about 2 to 3 g. of protein and between 50 and 60 calories per kilogramme of body weight (approximately 150 g. of protein and 3,500 calories for a 70-kg. man). In some individuals he has had to feed (by use of gavage or intravenous methods) up to 300 g. of protein a day to maintain body mass. Browne and his colleagues² suggest similar intakes of food to maintain adequate nutrition in the average hospital patient.

As the food intake of patients in R.C.A.M.C. hospitals in Canada fell short of the above-mentioned standards, and as so many of our soldiers were losing weight, a vigorous educational campaign was launched in the summer of 1944 to increase the intake of protein and calories. Studies¹⁷ made some eight

months later showed a satisfactory improvement (see Graph). These and other observations indicated that about 100 g. of protein and approximately 3,000 calories were probably as much as the average patient would consume at three meals by means of the ordinary diet, and that protein and calories above these amounts would have to be provided through supplementary feedings.

By the end of 1944 the Research and Development Branch of the Directorate General of Medical Services, in co-operation with the National Research Council of Canada, MacDonald College, and the Royal Victoria Hospital, McGill,^{18,19} had developed a satisfactory powdered high-protein milk-shake mix* with five assorted syrup flavourings which was easily reconstituted into a palatable and acceptable drink. The tinned powder stored well, could be made up in large quantities in the kitchen, and provided high food value in small bulk: this was also important, as the patient judged his food intake by volume rather than food value. By this means an extra 72 g. of protein and 1,100 calories could be given in the form of two small and one large milk shake taken during the day.

By clinical trial it was found that the most suitable routine was to serve the meals exactly at 7.30 a.m., 12 noon, and 5 p.m., and to give one 8-oz. (227-ml.) milk shake at 10 a.m. and another at 2.30 p.m. A 16-oz. (454-ml.) milk shake was taken at bedtime, usually 9 p.m. In some patients one or two of the supplementary feedings were omitted because it was considered that their requirements for protein and calories were at a lower level. It was found to be impracticable to give more than 8-oz. feedings at each of the two daytime supplementary feeds, as a larger quantity interfered with the appetite for the next meal. For the same reason it was imperative to ensure that the meals and supplementary feeds were served on time.

With increased food intakes, such as occur with the regime outlined above, clinical improvement in our military patients is noticeable. It is our belief that civilian patients would obtain similar benefits. Therefore we recommend adoption by civilian hospitals of the educational and catering programmes mentioned in this paper.

Summary

The cause for the loss of weight of patients in military hospitals in Canada has been investigated. Primarily this appears to depend on the "toxic" or metabolic destruction of body protein, but is aggravated by the inadequacy of the usual hospital diets. These diets were particularly inadequate in proteins and calories, having reference to the requirements of these patients.

The cause for the inadequate diets was found to lie in: (1) tendency of hospital staffs to economize; (2) lack of proper supervision of dietary intakes by the medical and nursing staffs; (3) improperly spaced meals and lack of appetizing dishes. Correction of these faults and the introduction of a high-protein milk shake raised the food consumption to satisfactory levels. The average maximum tolerable consumption has been defined.

The advisability of applying the lessons learned in military hospitals to civilian hospitals has been discussed.

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