THESIS

on

THERMAL INJURY. ITS EFFECT ON NUTRITION, WITH SPECIAL REFERENCE TO BODY WEIGHT AND FOOD INTAKE

SUBMITTED FOR THE DEGREE OF

M.D.

by

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CONTENTS

CHARTS /

CHARTS

TABLES /

TABLES
(At end of volume)

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INTRODUCTION

During the past thirty years as surgical techniques have advanced and anaesthetic hazards diminished, the general management of patients, who have sustained injury, or undergone surgery, has assumed increased importance and been subject to constant investigation. Without study of the natural course of events in such patients little advance in general management would have been made. Cuthbertson (1930) was probably the first to report disturbances in metabolism following injury. His early observations were restricted to bony injury, but later (1934) he extended the study to other forms of trauma and grouped the observed changes under the term of "The Metabolic Response to Injury". He suggested that the metabolic changes had two phases - one of depressed vitality, followed by the second of renewed functional activity and healing. He showed that within twenty-four hours of injury there was a relative or absolute anuria, followed by increased urinary volume and increased urinary nitrogen output, the latter reaching a maximum during the fourth to eighth day. He showed further that the excretion of phosphorus and sulphur followed the pattern of the nitrogen, and that the sulphur nitrogen ratio, and the phosphate nitrogen ratio suggested that the catabolised material was probably muscle. He also noted a rise in body temperature of around $2^{o}C$, and an increased consumption of oxygen, and emphasised that the response was general rather than local in nature.

Following upon these early reports, many investigators have

reported /

reported a similar pattern (Howard,1944; Peters 1948) and the studies have been extended to follow the pattern subsequent to operative trauma (Peters et al. (1948); Werner et al. (1949); Wilkinson et al. (1950). In most of these investigations, however, various feeding régimes have been used in an attempt to reverse the period of negative nitrogen balance and tissue catabolism. In other words, some investigators began to question whether, in fact, a period of negative nitrogen balance occurred as a response to the injury, or whether it was induced by enforced starvation. Peters (1948) suggested that the period of negative nitrogen balance could be prevented after herniorrhaphy and osteotomy, but not after appendicectomy or fracture. It was stated also that those who claimed reversal of the negative nitrogen balance frequently were presenting studies on chronically ill patients, who do not show an intense response to operation or injury. Keeton et al. (1948), studying patients after herniorrhaphy or cholecystectomy only, considered they could reverse the negative nitrogen balance with very high levels of nitrogen and calorie intake. Werner et al. (1949), studying similar patients to those of Keeton,proposed that simple calorie lack explained the post-operative nitrogen loss uncomplicated by infection. Wilkinson et al. (1950) on the other hand, while stating that protein and calorie lack may play a part, considered that the increased urinary nitrogen excretion was related to the operation or injury and to the initial total mass of protein, the latter dependent on previous nutrition and previous disease. Conflicting opinion continued until Moore presented his classic monograph (Moore and Ball, 1952). He reported his findings of the /

the response to a single trauma, the effects on this observed response of starvation, immobilisation, endocrine factors, and prior depletion. He discussed changing the balance, referring to some of the investigations already mentioned here, and despite statements made in those regarding the doubtful existence of the period of negative nitrogen balance, he submitted that there was indeed a normal pattern of response dependent on the trauma itself. His findings are perhaps more detailed but do not differ significantly from Cuthbertson's earliest work. He defined this normal pattern of response as follows:-

(1) A transient slight elevation of temperature and pulse rate.

(2) A transient decrease in urinary excretion.

(3) A loss of nitrogen from the body for three to seven days, followed by positive nitrogen balance yielding to zero balance as convalescence is completed.

(4) A loss of potassium for two to five days followed by potassium retention with little or no change in plasma potassium levels.

(5) A decreased urinary excretion of sodium for two to five days followed later by a sodium diuresis. A fall in plasma sodium concentration often accompanied the period of positive sodium balance.

(6) A loss of weight greater than that accountable by the above balance changes due to fat oxidation.

(7) A period of starvation and relative calorie deficiency is normally an accompaniment and in part a cause of the changes in weight and balance. After five to seven days, resumption of

calorie

calorie and nitrogen intake and a positive balance are vital pre-requisites to recovery.

(8) As a general rule, operations of greater magnitude evoke a response of greater depth and duration.

Additional observations on the metabolic response to trauma have been made since this time (Cuthbertson, 1954; Taylor, 1955), but have only tended to elaborate Moore's conception.

It was perhaps inevitable that similar studies should be made on patients who had sustained thermal injuries. While there are many inherent technical difficulties in the study of such patients, they can be grouped more readily for severity of injury because the extent and, in some instances, the depth of the burn can be estimated fairly accurately. Further, the possibility of large numbers of casualties with thermal injury has increased with the development of nuclear weapons and burns continue to account for a large proportion of accidents in the home especially, and also in industry. This has stimulated investigation in order to gain a fuller understanding of the problems of the burned patient.

The first metabolic study in a patient with burns was presented in 1940 by Lucido. His main finding was evidence of tremendous protein destruction.

Meyer et al. (1945) studied nitrogen balance in experimental burns. The main findings were that the nitrogen loss was not due to reduced intake because the diet consumed was equal to that required to maintain positive balance prior to burning. Further, weight gain did not occur until the diet was increased.

The observations of Cope et al. (1943) on patients from the Coconut Grove Disaster suggested, however, that the need for nitrogen /

nitrogen and calorie intake was increased. The period of observed negative nitrogen balance was short - about one week - and the level of excreted nitrogen was fairly constant and not altered by rising protein intake. These findings are difficult to understand in the light of later work, but may be due to the fact that exudate loss was not measured. However, Keyser (1948) also reported that in only a few of the burned patients he studied was urinary nitrogen excretion greater than normal. He considered that the negative nitrogen balance was due more to low intake than to increased loss. Again, however, exudate nitrogen was not measured in allcases.

Moore and Ball (1952) presented the patient with burns as one of the complex problems in the metabolic response. They showed that during the first three to four days there was positive nitrogen balance, considered to be due to plasma infusion or oliguria and not to tissue synthesis. This was accompanied by a transient potassium loss phase lasting only two to four days and by a massive positive sodium balance due to renal conservation, and to sequestration of sodium in wound oedema. The extrarenal loss of protein and electrolyte depended on whether the injury was a burn with a dry surface, or a scald with a wet one.

During the next fourteen to twenty-eight days, the nitrogen balance became strongly negative and positive balance could not be attained irrespective of the level of intake of nitrogen and calories. Early in this period, the potassium balance became positive and there was a sodium diuresis. Later, in the deep burn, as the slough began to separate, extrarenal nitrogen loss rose abruptly. Thereafter, there was a gradualtshift to anabolism /

anabolism, the earliest indication being zero and then positive nitrogen balance. Potassium balance became positive, and sodium equilibrium was reached.

From studies such as these, it was seen that the response to thermal trauma was similar to that following other forms of trauma, although the abnormalities were probably more pronounced and of longer duration. The same arguments were raised, as in the post operative patient, regarding the existence of the negative nitrogen balance and whether it was in fact a reflection of starvation rather than a true metabolic derangement.

In many of the studies quoted, however, it was difficult to differentiate any abnormal findings from the effect of the therapy used in any particular centre. This applied throughout the whole of the post burn course. For example, in studying the early sodium balance, resuscitation might, and usually did, incur a large sodium load, and this load would vary depending upon the amount of plasma, dextran (with saline), and normal saline used. Such a load must affect the pattern of sodium retention and excretion and, therefore, body weight in the days that follow. Similarly, depending upon food intake, the pattern of nitrogen excretion may well be altered not only by the level of nitrogen ingested, but also by the level of calorie intake achieved. Such details were frequently omitted from reported studies.

There are then two schools of thought, the one following the conclusions of Moore, believing that there is indeed a true metabolic response following thermal injury; the other supporting the concept that the findings are merely those subsequent to starvation and that they can be abolished by counteracting the starvation. It is in the light of these conflicting beliefs that the study which follows is presented.

INITIAL STUDIES

In the first instance, the general condition of patients who had sustained burns and in whom no supplementary intake had been given apart from whole blood transfusion, was investigated. This was a much more difficult task than it appeared for even in 1954, which marked the beginning of this study, enough had been written to suggest that intake should be supplemented if treatment were to be adequate. Older case records, while providing some assistance, were, for the most part, lacking in significant detail. However, if the injury does have an effect whether by virtue of the metabolic response or by starvation or by a combination of both, it should be reflected in the patient's general condition.

On studying older case records both in the adult unit at Bangour and at the Royal Hospital for Sick Children, the statement was made fairly frequently that "the patient had lost a great deal of weight". This could be only a clinical observation at this time, as no method was available for weighing such patients with any degree of accuracy. It is probable, therefore, that the weight loss must have been of some magnitude to be noted by attendants seeing such patients very frequently. Under such circumstances, steady weight loss is not easy to detect until it becomes strikingly obvious.

The following details of three cases serve as illustrations.

Case 1.- A youth, age fifteen, received burns of 40 per cent of his body surface when a van, in which he was a passenger, crashed and caught fire. The burns involved the whole of both legs, both arms and hands.

His condition during resuscitation remained satisfactory and the local wounds were treated by a combination of exposure and dry dressings.

Eighteen days after the accident, his general condition continued to be satisfactory apart from the haemoglobin, which had fallen to 6.5 g. per cent. From this time onwards, it was difficult to maintain his haemoglobin, which ranged from 7.2 - 9.1 g. per cent, despite frequent blood transfusions.

From the twenty-fourth day onwards, he ran a persistent pyrexia, which frequently reached 105°F (40.6°C.).

The burned areas were dressed twice weekly under general anaesthesia, the exposed areas having been dressed as the slough separated. Homograft skin was applied on the twenty-ninth and thirty-first day post burn with poor "take" on both occasions, and the surface became infected. Autograft skin was applied on the forty-fifth day, but this also failed to "take".

The first recording of the plasma protein was on the twenty-eighth day post burn, when the level was 4.9 g. per cent. Despite repeated whole blood and plasma transfusion (thirteen pints of blood and seven pints of plasma excluding resuscitit-ation), the plasma proteins continued to fall, being 4.7 g. per cent on the thirty-first day, 4.4 g. per cent on the forty-sixth day, and 4.0 g. per cent on the fiftieth day.

There was a continued slow deterioration with two episodes of acute pulmonary oedema before death, which occurred on the sixtieth day post burn. The surgeon in charge of the patient in his final summing up made the following statement :-

"In spite of all we could do with blood transfusion and general measures, his condition deteriorated steadily, associated with marked loss of weight. When his heart eventually failed, he had the appearance of a Belsen victim".

Another example is provided by the patient who is referred late, and who was admitted during the early period of the study.

Case 2.- A man, aged twenty-one years, received burns of his legs and buttocks, when paraffin ignited accidently and his clothing caught fire. The total body surface involved was estimated at 35 per cent.

He was admitted to a small local hospital, where he remained during the next eight months. Throughout this time, the wounds were dressed frequently without anaesthesia. No grafting was attempted. His general state deteriorated slowly as did his mental state, and one month prior to transfer he was seen by a psychiatrist on account of hysterical outbursts.

Little was known concerning his food intake although questioning of the patient himself suggested that he had had no appetite for about four months and was eating very little. However, he did know that his weight before the accident was about /

about fifteen stones (90 Kg.).

On admission, he weighed 51 Kg. He was pale, emaciated, and apprehensive. The haemoglobin was 8.3 g. per cent, and the plasma proteins 6.3 g. per cent with an albumen globulin ratio of 3.5 ; 2.8. Both legs were completely raw and covered by bleeding infected granulations.

Further evidence was obtained in the following case of a child with extensive burns, who was under treatment at the start of the period of study.

Case 3.- This girl, aged seven years, was admitted with flame burns involving 51 per cent of her body surface caused by her clothes catching fire.

Her weight on admission was 22 Kg. Resuscitation was uneventful considering the magnitude of the injury.

On the tenth day after injury, she had a slight haema-;temesis followed by profuse melaena, which persisted inter-;mittently for the next six days. Blood replacement was in the order of twice her normal blood volume.

The burns were exposed until the seventeenth day post burn. Thereafter, all dressings were changed under general anaesthesia twice weekly.

Homograft skin was applied to the burns of the anterior surface (about 30 per cent of the total) on the twenty-fourth, thirty-first, and thirty-eighth day after injury and "took" well. Autograft skin was applied on the forty-fifth, fifty-seventh, sixty-sixth, and eighty-seventh day post burn, as the homografts separated. These grafts "took" well.

From admission onwards, she ran a persistent tachycardia of 140 to 170 per minute, and a persistent fever of 100-102°F. (37.8 - 38.9°C.).

Eight days after admission, she developed pneumonic consolidation of the right upper lobe, which cleared rapidly with penicillin therapy.

Feeding, which was noted to be reasonably satisfactory early, became progressively more difficult.

On the one hundredth day, her weight was 16 Kg. - a loss of weight of 6 Kg., representing 27 per cent of her total body weight. (Plate 1).

PLATE 1

Case 3.- To show state of nutrition at day 100.

Discussion

Such records suggest that a diagnosis of starvation could be reasonably made, a starvation which was in no case absolute, but apparently relative to the needs of the patients concerned. Even accepting the part played by the metabolic response to injury in terms of nitrogen loss, it is difficult to believe that this alone can explain such extreme inanition.

There are only four possible causes of such obvious weight loss.

(1) Reduced Intake.

(2) Increased Excretion.

(3) Increased Requirement.

(4) Diminished Absorption.

Do any of these causes operate in the post burn course?

Reduced Intake

Conditions are certainly present, which could lead to a reduced intake of food. In the early days following the injury, intake is, of necessity, low. During the first forty-eight hours, (the period of resuscitation) little is taken by mouth other than clear fluids with perhaps a little added glucose. Frequently, fluids are restricted because of the maximal antidiuresis present during this period. At the end of this forty-eight hour period, however, many patients, especially those with less severe injuries, are probably able and willing to take food by mouth. In many instances this is apparently denied because tradition has deemed that early feeding of patients after injury is not well tolerated. Intravenous therapy with 5 per cent glucose is frequently continued for up to seven days after injury, and little given by mouth.

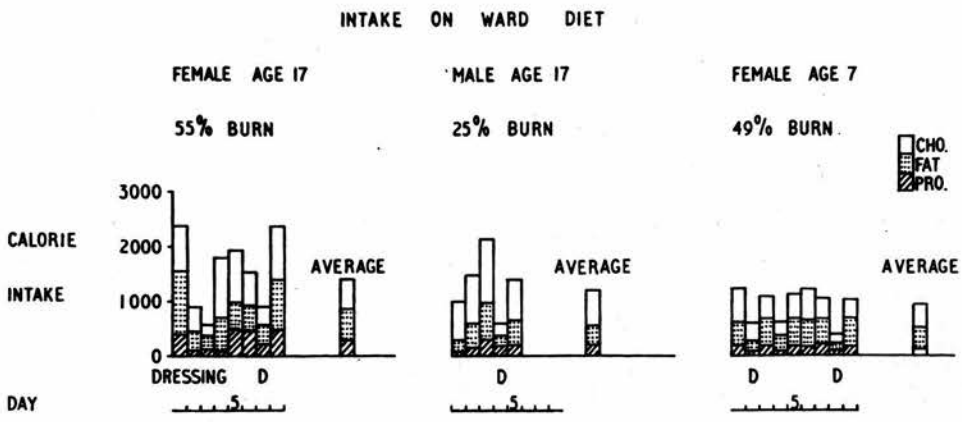
In /

In the later stages after the injury, it may not be appreciated that there is a reduced intake of food. The usual routine is to order for such patients a high protein, high calorie diet. The crucial question, however, is, how much of this diet the patient actually eats? It frequently happens that the feeding of the patient, who can do little for himself, is left to the most junior nursing staff on the ward who probably do not appreciate the importance of maintaining an adequate intake in such patients. This point was emphasised by getting the nursing staff to record all intake in three burned patients - two adults and one child - for short periods (Chart 1).

Reduction in intake is obvious. Significantly, all three had been put on hospital high protein, high calorie diets. There are only two possible explanations. Either these diets are totally inadequate, or are not acceptable. On investigation, it was found that the diets, as prescribed, were adequate, but not acceptable to the ill patient. The main reasons for this lack of acceptance were the bulk of the diet and the effort required to ingest it by a patient whose appetite was poor, and whose interest in food was minimal. In many instances, the ward staff were too busy and too few in number to allow even one member to spend the required amount of time to feed the patient and to encourage feeding.

Another important point emerged from the study of intake and is apparent in Chart 1. The days of really low intake coincide, as might be expected, with days on which a general anaesthetic was given for dressing purposes. Although the anaesthesia itself was excellent, there was, inevitably, a period of starvation before anaesthesia /

CHART 1



To show the intake of three burned patients on ward diet.

anaesthesia, in many instances from the evening before, and an equal period on return to the ward. These periods are often lengthened where burns are not the only type of case being cared for, because in many instances they will come at the end of a "clean" operating list late in the day. Often, too, post-operative starvation will be prolonged because of traditions in post-operative care.

Thus anaesthesia may well affect intake not only on the day of operation but on the day before and, in some instances, on the day after. Obviously, in patients whose visits to the operating theatre are few in number, this is of little importance. In the burned patient, under a routine of dressing change twice weekly, it means two days of almost complete starvation added to five days of poor intake, all of which contribute to a very poor average intake for the weekly period.

An additional cause for reduced intake was found in other patients whose burns involved the face or mouth, and for whom eating and chewing were painful.

Increased Excretion

If there is a period of obligatory nitrogen loss with increased excretion of urinary nitrogen, this factor will be operative under this heading. If, on the other hand, starvation is thought to be the cause of the negative nitrogen balance, the excretion of nitrogen will be prolonged by this starvation. If endogenous protein is broken down, its end-products willbe excreted in the urine. In starvation, such breakdown will occur if either the protein or the calorie intake be inadequate, but in time will reach a constant low figure. In the /

the burned patient, protein will be required in the healing process. Co Tui (1953) quotes various investigators who suggest that exogenous protein may not be available for this purpose, and that the body mobilises its own amino acids for repair. If this be so, excess nitrogen will continue to be excreted in the urine as long as this process is active. Increased excretion will, therefore, continue. This may well be the explanation in those less severely injured, who continue to exhibit a negative nitrogen balance and weight loss after the time when any metabolic response to the injury itself must be over. This is shown in Chart 2. This patient had a small injury, in which the exudate loss would be small. It will be noted, however, that the intake was low both of protein and calories. The nitrogen balance is not complete, but it can be seen that the period of negative balance was prolonged, and weight loss continued.

Whether the exudate is accepted in the overall nitrogen balance, or as a separate entity, it surely represents a source of increased excretion. In deep burns of any magnitude, there must come a time when the gangrenous eschar begins to slough, leaving at best a clean granulating area, or an infected gramulating surface, and at worst a raw area devoid of granulations. From such areas, there will be a constant exudate loss containing protein and electrolytes, and this loss will continue until skin cover is achieved. The loss from this source has been investigated. Hirschfield et al (1944) showed that the exudate nitrogen at its peak could contribute 11-25 per cent of the total nitrogen loss. The majority of his patients had small burns. As might he anticipated, the amount fell as the superficial burns healed /

healed and as skin cover was achieved in the deep burns.

Co Tui et al (1945) studied the exudate in seven cases of burns, ranging from 8 per cent to 5o per cent in extent. They all had a mixture of superficial and deep burns, and most of the collections were made early in the post-burn course. Again, there was great variation from 9.07 g. per twenty-four hours in the 50 per cent burn to 1.38 g. per twenty-four hours in the 10 per cent burn. This variation may have been caused in part by the time interval from burning to estimation, which was variable, and by the relative amounts of superficial to deep burn. Keyser (1948) estimated that the exudate nitrogen constituted 2-25 per cent of the total, Moore et al (1950) showed that the exudate nitrogen may constitute 25-30 per cent of the total nitrogen losses during the period of maximum wound sloughing and purulent discharge, and Reiss et al. (1956) considered that although it was highly variable, it could constitute as much as 50 per cent of the loss. This last study was a particularly accurate one, as it included all dressings and bed linen, which were washed thoroughly in a washing machine and aliquots of the wash water analysed.

Thus, although the figures vary greatly, there is little doubt that the contribution of the exudate to the nitrogen loss is of some magnitude.

Althouth not a source of increased excretion, the actual tissue loss sustained on the separation of the eschar in the deep burn may assume some importance in the bigger burns.

Increased Requirement

Beaause of the loss of nitrogen by the various routes, however/

however induced, there will be increased nitrogen requirement to make good this loss. It will obviously be related to the extent and depth of the burn, both in the severity of the initial response, or the starvation induced, and in the size of the subsequent granulating area, and the degree of infection in this area.

It might be argued that infection itself may increase requirement. Grossman et al (1945) showed that there was a definite increased excretion of nitrogen in acute infections, citing scarlet fever as an example. If the burn becomes acutely infected the patient might react in the same way. Infection seldom occurs before the slough separates, at which time most patients will be in the late catabolic, or anabolic phase. A second insult at such a time, however, is known to provoke little, if any, response, and this may well be the state of affairs produced in the burned patient if infection occurs. Grossman also stated that patients with chronic infections stored nitrogen despite elevation of temperature and it is possible that the infected burn falls into the chronic category.

If the nitrogen provided to meet the demand is used for regeneration and repair, then the calorie intake must be adequate to allow the protein to be so used. Further when protein us used for synthesis, as in this instance, energy is expended to the extent of more than half the calorie value of the protein (Elman, 1954).

There willbe, therefore, an increased calorie requirement also. Over and above this need for calorie increase, there is a further factor to be considered in the burned patient. Cope et al (1953) showed that following severe thermal injury, the metabolic rate was elevated to levels of + 30 an +60 for as long as two months after injury, and that it receded as the wounds healed.

This /

This rise is not related to increased thyroid function, as shown by normal values for protein bound iodine and uptake of I^{131}, nor to the effect of a high protein diet. He concluded that the local metabolism of the wound must be chiefly responsible for the rise, with fever, pain, and anxiety adding in some measure.

Diminished Absorption

There is little to suggest that this is a factor. The gastrointestinal tract is apparently normal both mechanically and functionally following thermal injury. The only complications occurring are Curling's ulcer and acute dilatation of the stomach, which are both uncommon and usually occur within the first two weeks. Neither would be the cause of long continued poor absorption.

On the other hand, diminished absorption may be induced by therapy, or by the lack of it. Inadequate resuscitation is frequently associated with vomiting, and later the institution of feeding, either too suddenlyor by the use of poorly designed intakes, is frequently accompanied by diarrhoea and in some instances with vomiting.

If deficiency of the major constituents of the diet is present there is no reason to believe that the vitamin and mineral content will be adequate. There might, however, also be an increased requirement of these factors.

The Vitamins

In 1946, Levenson et al. showed that following severe injury there was a low level of plasma ascorbic acid, both in the fasting state and following saturation tests. Similarly, there was a low excretion of ascorbic acid, thiamin, nicotinamide, and riboflavin /

riboflavin in the fasting state and following saturation tests.

In 1947, Lund et al. repeated these same tests in patients with thermal injuries and obtained similar results. They showed that there was little change in minor burns unless there was some complicating factor such as previous deficiency, alcoholism, or infection, but that the abnormality paralleled the severity of the burn. The changes were greatest early in the post burn course but were similar to the upset in nitrogen metabolism in duration. They excluded pre-existing deficiency, inadequate dosage, failure of absorption, and excretion in sweat. The vitamins were given parenterally in higher dosage than the optimum in health. They suggested that there might be some loss in the exudate especially later in the course and very early due to loss of plasma at the burn site, but loss from this route was minimal at the time of maximal low values. While excretion in other forms, storage and excessive destruction were possible causes, they considered that the most likely cause was increased utilisation.

Kark (1953) stated that stress or adrenocortical activity may increase the utilisation or storage of ascorbic acid, but he did not believe that it can be related to increased consumption by the adrenal gland. He gave corticotrophin to patients in the post-operative period, thereby stimulating adrenocortical activity and produced a diuresis of ascorbic acid similar to that produced when corticotrophin is given to normals. He concluded, therefore, that adrenocortical activity was not responsible for the retention following operation, but that ascorbic acid is mobilised from tissues and organs and selectively concentrated in the traumatised area /

area. This is only one of many studies on ascorbic acid requirement in surgical patients and while there are many conflicting opinions most are agreed on the increased requirement for the vitamin following injury or operation and that wound healing is interfered with if adequate levels are not provided, although very low levels have to be reached before this occurs. Crandon et al (1953) considered that a plasma ascorbic acid level of 0.2 mg. per 100 ml. was suggestive of serious deficiency but that healing would occur even at this level if the buffy coat ascorbic acid was greater than 8 mg. per 100 g. and there was no wound infection or other local stress.

More recently, Levenson (1957) has studied healing of laparotomy wounds in burned guinea pigs. He has shown conclusively that there is impaired healing, demonstrated histologically, of laparotomy wounds in burned guinea pigs indistinguishable from that in the scorbutic animal at seven days following injury. Such findings do not occur in the unburned controls. Further, large doses of ascorbic acid restore the healing picture to normal.

Thus, although the reasons for the increased requirement are still obscure, supplementation should be given.

While Lund and Levenson's work on the vitamins of the B complex also indicated an increased need, Cuthbertson (1954) pointed out that during the catabolic phase the catabolism of protein is associated with excretion of associated substances of which riboflavin is one. Also, it should be noted that additional vitamins of this group will be required with high levels of carbohydrate and calorie intake if satisfactory utilisation is to be /

be achieved.

Fat soluble vitamins A and D are, of course, important in the burned child, in whom the normal intake must be assured, but there is no evidence to suggest that increased intake is necessary either in the child, or in the adult, at any time during the post burn course.

The Minerals

If, under this heading, is included electrolyte, potassium and sodium must be considered. While in some instances supplementary potassium may be required in the early stages, when the balance is negative, in the later stages, provided food intake is well maintained, supplementary potassium is seldom, if ever, required. This despite the large losses which may occur in the exudate.

Because of the large sodium load frequently required in the resuscitative phase, it may be prudent to avoid large sodium intakes by mouth during the first week. Apart from this, as with potassium, maintenance of food intake usually supplies an adequate sodium intake.

The only other mineral element, which appears to be of importance, is iron. Anaemia of an iron deficiency type occurs very frequently in the patient with extensive burns, and will be present at least until the granulating areas are covered with skin. There are many possible aetiological factors for this anaemia.

There is early haemolysis of red blood cells consequent upon the injury itself, which will be made good if transfusion of whole blood is given in the resuscitative phase. Moore et al (1946) placed this destruction in the order of 10 per cent of the red cell mass. Thereafter, they considered that there were many possible factors which /

which predisposed to the development of anaemia, including blood loss from the open wound, infection, disordered iron metabolism, depressed bone marrow function, altered liver function, blocking of protein synthesis, and retardation of globin formation.

Despite frequent transfusion, it is difficult to maintain the haemoglobin at satisfactory levels. Certainly, there must be adequate provision of blood forming elements and especially protein, vitamins and iron.

In summary, therefore, there appears to be sufficient evidence from studies of intake of burned patients in Bangour Hospital and the Royal Hospital for Sick Children to show that there is a real and drastic reduction in intake. Further, although personal corroboration is lacking, there is also sufficient evidence to suggest that such patients require an increased intake of protein, calories, ascorbic acid, vitamins of the B-complex and iron.

The morbidity and mortality shown in cases 1, 2, and 3, emphasised that any further nutritional studies undertaken would have to be carried out in patients receiving supplementation of the ordinary hospital intake, possible exceptions being those with minor injuries.

REQUIREMENT

While most authorities agree that intake must be increased, few give any guide as to what levels of each constituent are required. Such levels are important and must be known, at least approximately, before any methods for supplementation of intake can be evolved.

Protein

It is reasonable to suggest that, in the first instance, the protein requirement in health should be met. It has long been accepted that this should be 1 g. portein per Kg. of body weight, although the Committee on Nutrition of the British Medical Association (1950) recommended that it should be related rather to total calories consumed, and that for the normal adult 11 per cent was an adequate figure. As the calorie level in the burned patient will also be increased, it is more useful in them to use the figure of 1 g. per Kg. To this would have to be added an amount at least equivalent to the estimated daily loss from all routes. This, in a small burn, will be in the order of 10-15 g. of nitrogen (60-90 g. protein) per day, while in the larger burns nitrogen excretion may reach 25-30 g. (150-190 g. protein) per day.

If these figures are then converted into requirement using a 70 Kg. patient with a 40 per cent burn as an example, the actual daily intake of protein necessary would be calculated thus :-

Protein Requirement = Normal requirement + Replacement of Loss

= 70 X 1 + 150-190 g.

= 220-260 g.

= 3-3.5 g./Kg. body weight.

Probably by working on some such basis, although how actual figures /

figures were decided upon has never actually been stated; various suggestions have been made as to the possible daily protein requirement.

The Committee on Nutrition of the National Research Council (1951) placed requirement at 2 g. protein per Kg. per day, while Levenson et al. recommended 1.5-4 g. per Kg. per day. This spread, in terms of actual protein in a 70 Kg. man, would range from 105-280 g. Thus, the actual amount to be given to any particular patient has to be decided arbitrarily, depending upon the extent and severity of his injury. Further, these studies all relate requirement to body weight and do not take into consideration body build. If this were of importance, then surface area derived from weight and height might be a more useful parameter. Levenson's figures, however, conform fairly closely to those obtained in the possible method of estimating requirement just presented, and were, therefore, used as a guide.

Calories

The calorie intake must be adequate if the protein is not to be used merely as a caloric source. In this connection Co ..ui (1953) stated that hypoproteinaemia was due not only to low protein intake but also to insufficient calorie intake.

The fact that in many studies the calorie intake has been inadequate, either because the need was not appreciated or because it was technically impossible, may well explain why some investi-:gators believe that during the catabolic phase increased nitrogen intake will result in increased nitrogen excretion.

As with protein, the basic need for calories must be met. In this respect, surface area is again important, as basal calorie /

calorie requirement is estimated from it. Standard figures represent basal needs at 40 calories per square metre per hour in the male and nearer 35 calories per square metre per hour in the female. Elman (1954) gives an overall working figure of 900 calories per square metre per day, or 25 per Kg. body weight per day. Using this latter figure, the range for most patients will be 1250-1750 calories per day, and occasionally 2000 per day. For the ordinary surgical patient, Reigal et al (1947) suggested a total calorie intake of 30 calories per Kg. per day. For the 70 Kg. man, this would represent only 350 calories over the basal requirement. The burned patient, however, appears to require more than this, probably because of the high basal metabolic rate.

As to actual amounts required, Levenson et al (1952) state that the female remains in fairly good nutritional status when given 45 calories per Kg. per twenty-four hours, but the young adult male may require up to 70 calories per Kg. per twenty-four hours, especially in the anabolic phase.

Therefore, there is a range of 45-70 calories per Kg. per day, the amount again graded arbitrarily according to the extent of the burn and the age and sex of the patient.

Levenson et al (1952) did not consider the calorie requirement in terms of protein and non-protein calories, but as total calorie requirement. Moore and Ball (1952) considered that a calorie nitrogen ratio of 200 : 1 was "ideal", 100 : 1 "passing", and 50 : 1 or below was a failure. Only in the lower levels of suggested intake, that is in the smaller burns, is the ideal ratio approached. If, for example, two patients are considered :-

(1) /

(1) Male - Weight 70 Kg. 20 per cent burn.

Estimated Requirement

Protein : 1.5 g./Kg. = 105 g. = 16.8 g. nitrogen

Calories: 45 /Kg. = 3150

Calorie:N = 184:1

(2) Male - Weight 70 Kg. 50 per cent burn

Estimated Requirement

Protein : 4 g./Kg. = 280 g. = 44.8 g. nitrogen

Calories: 70 /Kg. = 4900

Calorie:N = 109:1.

It is doubtful, however, if the more severely burned patient would tolerate higher calorie intakes than those in example 2.

Therefore, as in the case of the required protein level, the recommendations of Levenson have been used as a guide.

Vitamins

Very little information is available as to the necessary requirement for the individual vitamins. Lund et al. (1947), on the basis of fasting blood and urine levels and the response to test doses of the vitamins, made some recommendations. These are shown in relation to recommended intakes in health (Report of the Committee on Nutrition, 1950), in Table 1.

These are the levels recommended for patients with severe burn injury, but it was also stated that some supplementation was required for burns of moderate extent.

Iron

Again, there is no real evidence as to requirement, apart from giving the usual therapeutic dose of a ferrous salt daily.

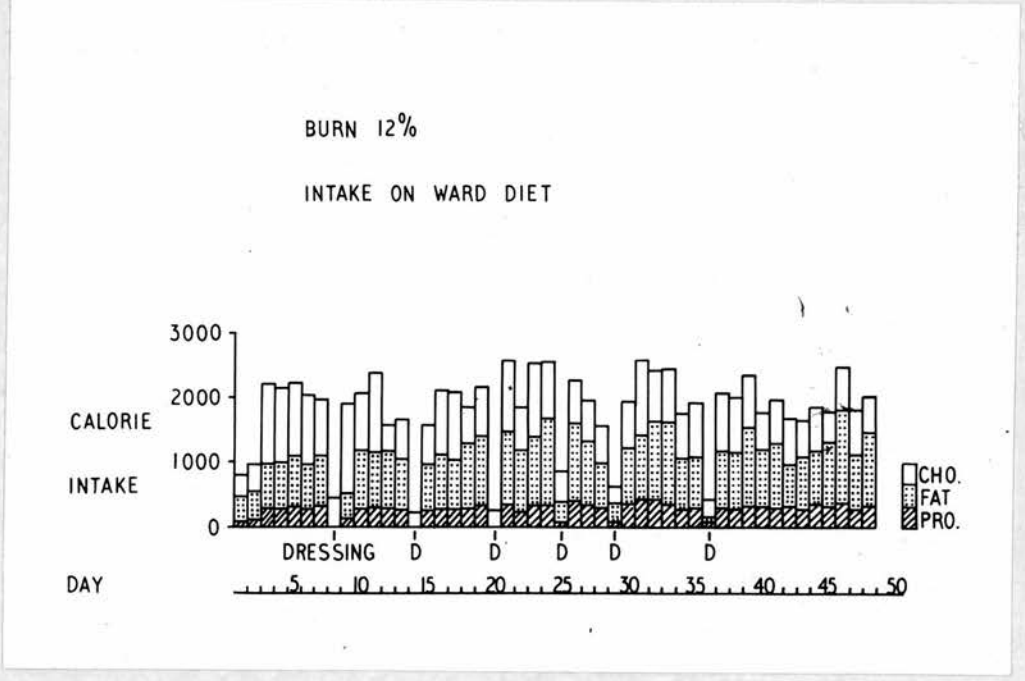
Possible Requirement in Childhood

All /

All the levels of intake discussed so far have applied to the adult patient. The intake of the child with thermal injury is equally important for the same reasons. In addition, however, growth is a continuous process in the healthy child and the requirement for growth and development must be provided in the burned child, as well as the needs consequent upon the injury itself.

Little evidence is available either in terms of the response of the burned child to injury or in the levels of intake in terms of protein, calories, vitamins, and minerals, which may be required. Levenson et al. (1952) suggested that if the intake for a normal healthy child of the same age, sex, and weight is given, requirement will be met. These levels of intake are set out in Table 2 and are taken from the recommendations of the Committee on Nutrition of the British Medical Association (1950). They relate intake to age only.

CHART 3



To show the intake of a patient with a minor injury.

METHODS OF SUPPLEMENTATION OF INTAKE

There appeared to be three possible ways in which the levels of intake, thought to be required, could be attained,-

(1) Hospital diet plus a supplement

(2) Oral fluid intake.

(3) Nasogastric tube feeding.

The Hospital Diet Plus a Supplement

If this route were adopted, then the patient would continue as before on the hospital high protein, high calorie diet, and be encouraged to eat as much of this as possible. In addition, he would be given a supplement in the form of some type of fortified fluid.

As was shown in Chart 1, solid food intake, at least in the more severely injured, gave a very low level of intake. It was felt, however, that this might be a possible method in those with smaller injuries and, therefore, intake charts were kept on several such patients. A typical example of the levels of intake achieved is shown in Chart 3. This pattern was repeated almost constantly in many such patients studied (Table 3). In effect, it showed that the maximum intakes that could be achieved with solid food averaged 65-70 g. protein and 1600-2000 calories in the adult, being rather less in the female and, depending on the age of the child, 50-60 g. protein and 1100-1700 calories. It was noted that the children consumed relatively more protein, especially those in the younger age groups. This was due almost entirely to the amount of milk taken. It should be emphasised again that these were the values of what the patients actually ate and not of what the diet provided, which was in all instances more. Also, in no case was the food

analysed /

analysed, the food value being calculated from standard tables (McCance and Widdowson, 1946).

At the lower end of the scale, with recommended intakes of 1.5 g. protein and 45 calories per Kg. of body weight, the fortified fluid would thus have to provide 30-50 g. protein and 1000-1500 calories in the adult, and 20-50 g. protein and 500-1100 calories in the child, depending on age.

At the upper end of the scale, with recommended intakes of 4 g. protein and 70 calories per Kg. of body weight, the fortified fluid would have to provide 200 g. protein and 2500-3000 calories in the adult. No further increment would be needed in the child. On the other hand, from previous observation, it was known that the patient with more severe injuries would not eat as much solid food, (Chart 1) and, therefore, the amount, which the fortified fluid would have to provide in these cases, would be more.

Oral Fluid Intake

The requirement might be met by giving a completely fluid intake, in a form similar to the supplement added to the ordinary ward diet, but using a greater volume. If this were the method of choice, then the volume presented would have to be kept within reasonable amounts for consumption in any twenty-four hour period. The maximum intake to be provided would be in the nature of 280 g. protein and 5000 calories in the adult, and 100 g. protein and 2500 calories in the child.

Nasogastric Tube Feeding

In those in whom very high intakes would be required, it might not be possible for the patient to ingest the volumes of fortified fluid, which would be required. If this were so, then the /

the total requirement might have to be given in a tube feed, or alternatively, the patient would take what he could of solid diet and the requirement made up to the desired level by tube feeding.

The Development of Acceptable Oral Supplement

It appeared that patients with less severe injuries could probably be treated adequately with some form of oral fluid supplement given in addition to the ward diet. The development of such a supplement was, therefore, a primary task.

The requirements of such a supplement were:-

(1) It should contain the maximum amount of nourishment in a minimum volume and in an easily absorbable form.

(2) It should be acceptable to patients over a long period of time.

(3) It should be palatable.

(4) It must be tolerated and, therefore, designed to avoid diarrhoea and vomiting.

(5) It should be as simple as possible to prepare so that it could be made up easily in the ward.

Reference to standard dietetic textbooks was not of any great help. Fortified fluids appeared to consist mainly of milk, eggs, and sugar, with some additional carbohydrate and chocolate, Ovaltine or Horlicks added, often more as a flavouring agent than for their food value.

Using such ingredients, it became clear that in all but the smallest injuries, the volume that any burned patient would have to ingest in twenty-four hours would be excessive and in many instances impossible.

In addition to these normal foodstuffs, there was also available /

available Casilan (Glaxo), which certainly could be of immense value in boosting protein intake, containing as it does 90 per cent protein, but there remained the difficulty of providing the required calorie intake. The other sources of commercial protein - the hydrolysates - were not considered for several reasons. They are expensive, highly unpalatable, and there was no indication in the burned patient that a predigested protein would confer any advantage whatsoever.

The provision of an adequate protein intake did not appear to present any real problem. Without the provision of calories, however, much of the protein would be wasted. Fat offered the best calorie source, giving as it does, twice the calorie value per gram of protein and carbohydrate. Cream might have been the answer, but was expensive and not readily available in hospital. An excessive amount of carbohydrate would have been required to make up the additional calories.

It was at this time that the first reports of the use of oral fat emulsion appeared.

Stein et al. (1952) in a study of seventy-six patients with a wide variety of conditions, showed that up to 400 g. of fat per day was usually tolerated and almost completely absorbed. Further, a marked positive nitrogen balance was obtained with moderate protein but high calorie intakes.

Van Itallie et al. (1952 a, b), studying healthy volunteers, showed that there was apparently no appreciable loss in the stool when 50 per cent or more of the total calories came from fat, and these high levels of fat intake were tolerated well, although individual tolerance varied. It was demonstrated further that high /

high calorie intake made possible effective utilisation of marginal quantities of dietary protein. Much earlier, Forbes and Swift (1944) had shown that fat spared protein more effectively than a comparable amount of carbohydrate.

Shoskes et al. (1951) and Shoskes (1952) used an oral fat emulsion in a wide variety of surgical conditions and were impressed by the weight gains, especially in really ill patients during the first two weeks of treatment. There was, however, some intolerance in 25 per cent of patients, but seldom of a severity necessary to cause the emulsion to be discontinued. The main features of intolerance noted were mild upper abdominal discomfort, nausea, vomiting, and very occasionally diarrhoea.

Mindrum (1953) studied nine critically ill patients, who were given a supplement of fat emulsion. He was impressed by the weight gain, the increased resistance to infection, and, particularly, with the healing of decubitae previously resistant to all therapy.

Levenson et al. (1952) reported on its use in burned patients using fat emulsion to supply 25-50 per cent of the total calories.

Therefore, if such a preparation were available, it appeared to offer the caloric source, which, until this time, had been lacking. With the cooperation of Duncan, Flockhart and Company Limited, a form of fat emulsion became available for clinical trial. In its final form, the formula for the emulsion contained:-

Ground-nut oil	50 per cent
Glycerol Mono Stearate	3 per cent
Polyoxyethylene Sorbitan Monostearate	1 per cent
Sodium Benzoate	0.1 per cent
Butyl Hydroxyanisole	0.1 per cent

Particle /

Particle size of 1-3μ was aimed at, as this was important if consistency and palatability were to be satisfactory. The oral fat emulsions developed in the United States of America all contained some added dextrose, but it was felt that it would be more useful to have the emulsion supplied unsweetened and unflavoured, so that this aspect could be left to the preference of the individual patient.

The food value of the emulsion was 50 g. fat per 100 ml., or 4.5 calories per ml.

Two types of oral supplement were developed, one to provide both protein and calories, the other to provide calories alone. One further supplement, providing protein and calories without the use of the emulsion, was also formulated for use if the emulsion was unavailable, or was not tolerated. Table 4 shows the formulae devised, which were found to be the most satisfactory. In these, and all subsequent calculations of food value, the actual value of individual constituents was taken from standard food tables (McCance and Widdowson, 1946) or, in the case of proprietary preparations, from the manufacturers' specification. The values of commonly occurring constituents are shown in Table 4a.

The final g. totals of protein, fat, and carbohydrate were taken to the nearest whole number and their contribution to the total calories obtained by multiplying by the factors 4, 9, and 4 respectively. It was felt that greater accuracy than this would not be within the accuracy of the observations as a whole.

It was felt that, in the first instance, the burned patient should not be used as the experimental subject for the purpose of studying /

studying the adequacy of these supplements. Subjects were required :-

(a) In whom solid food intake was difficult or impossible.

(b) Who were in reasonably good general condition.

(c) Who might have an inadequate intake.

(d) Who had a normal gastro-intestinal tract.

(e) On whom some simple measures could be made to show the contribution of the supplements to the intake.

(f) Who could give information as to the palatability of the supplements.

A group of such patients was readily available in those who sustain facial injuries, especially those with fracture of the mandible requiring immobilisation by interdental wiring.

Ten such patients were studied for a period of seven days. Admission weights were recorded in all of these patients, but the actual study period began on the third day after injury, as intake prior to this period is limited to clear fluids. Alternate patients were placed either on the ordinary ward fluid diet, or on the ordinary fluid diet plus supplements No. 1 and 2, as shown in Table 4. Weight was again measured at the end of a seven day period. The results are shown in Table 5.

Comment

All patients on the ordinary ward fluid diet lost weight during the period of the study. In all but patient 5, in whom both protein and calories were lacking, the patients on the ward fluid diet received an adequate protein intake, mainly from milk, but the calories were low. Those given the supplement all showed weight gain. The main difference was in the calorie intake /

intake; although the protein was also increased in patients 4, 6, and 10.

The supplements were tolerated well and were acceptable to all the patients. None of the patients developed vomiting or diarrhoea, nor did they complain of nausea. Further, in those not receiving the supplement, it was volume which precluded a larger intake. The patients stated that although they felt hungry they could not increase the volume of their intake in any twenty-four hour period.

Those receiving the supplements, on the other hand, did not complain of hunger, although their intake of the ward fluid diet, except in patient 2, was less. This was expected, as the volume of the supplements was in the order of 900 ml. daily. Fat has long held pride of place for its satiety value and this may well explain why these patients felt satisfied on a fluid intake, its fat content being increased by the use of the fat emulsion.

The emulsion was accepted better when combined with the fruit juice, rather than in any other vehicle. It was interesting to note that none of the patients complained of a fatty or oily taste, whereas, when the same supplements were tested out on members of the staff, who knew the emulsion was being used, oiliness was nearly always noted.

The supplements, therefore, seemed to satisfy the criteria originally laid down. The only point still not known was whether they would be acceptable over long periods.

In the child, palatability was perhaps even more important than in the adult. Also, from the study of the intake of ward diet (Table 3), it would be more important to supply calories than protein /

protein, although in some instances, a protein supplement might also be required.

There was no group comparable to the fractured mandible in the adult, in which to test the feeds for palatability and tolerance. Instead, the supplements were given to twenty children selected at random, varying in age from one to eight years, and with varying surgical conditions. None had disease of the gastro-intestinal tract. The supplement continued for not more than three days and was designed to test palatability primarily. Of the twenty, two refused completely, while the remainder accepted without question. No vomiting or diarrhoea was noted in any of the children during this short trial period. The formulae of the supplements used are shown in Table 6. The volume of the individual feeds is reduced compared with thise used in the adult, but the actual amounts of the feed given will, of course, depend on the age of the child.

With the introduction of Complan (Glaxo) in 1955, it was possible to simplify the formulae used considerably. While the earlier formulae were not really complicated, their preparation took up much valuable time on the part of the nursing staff, the services of a dietition not being available at all times. By using Complan, the number of ingredients required was cut to the absolute minimum and the preparation of the feeds was both simple and rapid. Examples of formulae using Complan are shown in Table 7. They were of value in providing both protein and calories but did not replace the original formulae, which continued to be useful. The main criticism of Complan was, and still is, that unnecessarily high intakes of protein have to be given /

given to obtain the required calorie levels, its calorie nitrogen ratio being 87:1. For this reason, it has never been used as the only constituent for the feed.

As tolerance was good with all these types of formulae, it was tempting to try to increase their nutritive value without increasing the volume. It quickly became obvious that the upper limit of tolerance in the protein-and-calorie feeds was around two calories per ml. In the emulsion-fruit juice type of feed, this could be three calories per ml., provided the feed was spaced out into small quantities throughout the day.

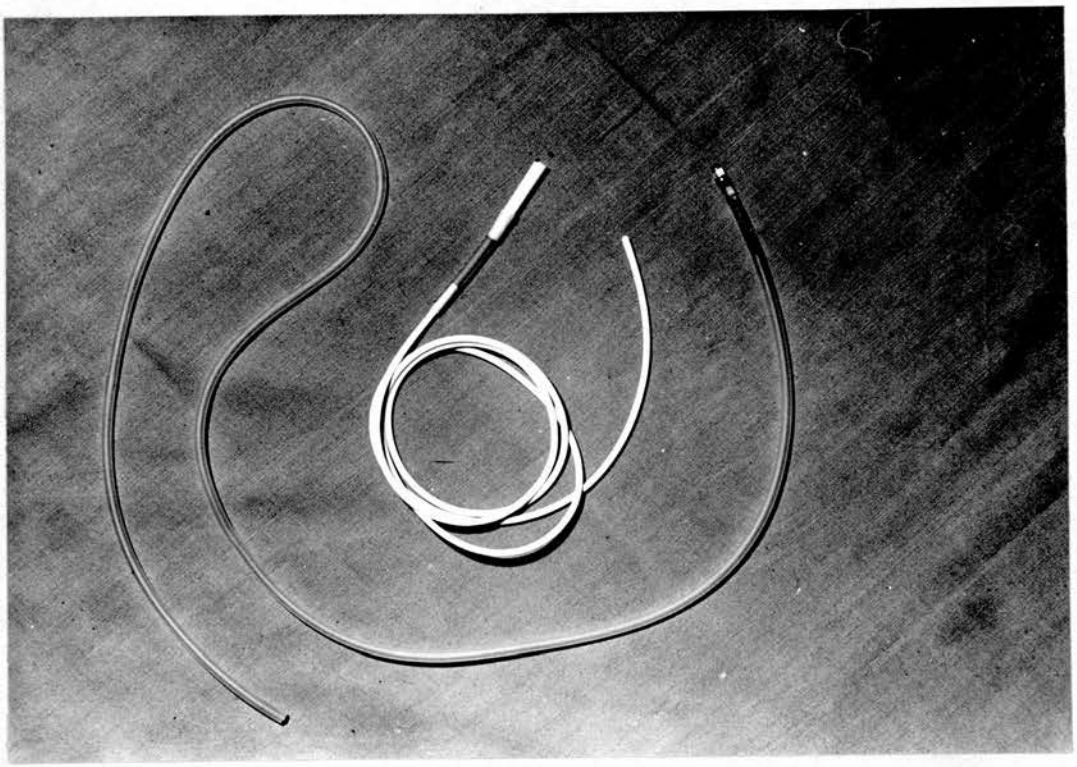
All patients receiving such supplements found that they were much more acceptable when given ice cold and, as a safety measure, the individual feeds were dispensed in waxed, sealed cartons kept at all times in a refrigerator.

Nasogastric Tube Feeding

This method of feeding has nearly always been regarded as a last resort. This is probably due, more than anything else, to the use of a red rubber Ryle's tube for the purpose. These tubes are uncomfortable to the patient, have to be removed repeatedly for cleaning, and frequently cause oesophagitis when left in position for any length of time. These disadvantages obviously outweigh any advantages, which this method can confer, so that tube feeding has usually been postponed and used as a last desperate measure, generally too late to be of any value whatsoever.

The introduction of fine polythene and plastic tubes has completely revolutionised the method, for the patient rapidly becomes accustomed to their presence and can eat and drink past them at will. They can be left in position almost indefinitely without /

PLATE 2



To show typesof feeding tube.

without removal for cleaning and are sufficiently non-irritant so that oesophagitis is no longer met with as a complication. They have a further advantage in that they are radio opaque so that their position can be checked if required.

Experience with many different types of patient has confirmed these findings. The fine bore tube is the tube of choice, but in some patients, for varying reasons, a larger bore tube may be preferred and is available with a weighted distal end. None of the polythene tubes is really satisfactory for gastric aspiration, as they tend to collapse with suction, but only in very rare instances does a feeding tube have to be used for this purpose. (Plate 2).

Tube feeding would appear to be the method of choice in those in whom very high intakes are required. These are, of necessity, the patients who are most severely ill and who cannot, or will not, consume the required intake by use of oral fluid supplements, either as the whole or part of the intake. With the tube, the high levels of intake will be more readily assured and the deficiencies of intake consequent upon anaesthesia can often be made up. With good anaesthesia, which, in many instances, need be no more than analgesia when only a dressing is being changed, tube feeding may be resumed earlier than when oral supplements are being used, as the cooperation of the patient is not required.

The Development of Suitable Formulae for Tube Feeding

The oral supplements could be administered by tube, and by increasing their number in any twenty-four hour period, the high levels of intake could be reached. However, as the majority of patients /

patients so treated would receive little or no oral intake over and above, it was considered that the following requirements should be met.

(1) The total intake of all constituents required must be included.

(2) The consistency must be such that it will pass easily down the fine feeding tube under gravity only.

(3) The volume must be such that it can be given within the twenty-four hour period without causing discomfort to the patient.

(4) The concentration must be such that it will be tolerated.

(5) Preparation must be as simple as possible.

As with the oral supplement, the burned patient was not used to any extent initially in testing out formulae for tube feeding. Opportunity to do this was afforded by studying other patients, in whom tube feeding was the only possible method of maintaining nutrition. These were patients who had suffered severe facial injury, or undergone extensive operative surgery of the face and neck, and also those with malignant disease of the face or mouth, many of whom had buccal fistulae.

While patients with malignant disease formed a useful group for study of tube feeding, it was realised that any weight loss might well be due to the disease itself, and not necessarily to an unsatisfactory régime. Such patients, however, could be observed for long periods, whereas those with trauma, either operative or accidental, required tube feeding for a limited time only.

The Constituents Required

(a) Protein - the total amount required might be as high as

250 /

250-280 g. per day.

(b) Calories - from carbohydrate and fat. With the protein calories, levels of up to 5000 per day might be necessary.

(c) Ascorbic Acid, vitamins of the B. complex and, in children, Vitamins A and D.

(d) Iron.

Consistency

Initially, difficulties were experienced in attaining the desired levels with satisfactory consistency. Casilan (Glaxo) was found to be unsuitable as a protein source for tube feeding, as when used in sufficient quantity it tended to produce too thick a feed. Apart from milk and eggs, the only other readily available source was the protein hydrolysates, which were highly soluble and had a high protein content. They were, of course, unnecessary from the point of view of digestion and absorption and were expensive. Also, if, as occasionally happened, the patient regurgitated, the unpleasant taste of the hydrolysate was most noticeable. Lacking a more suitable substance, however, they could give the required protein levels with the required consistency. The use of fat emulsion was of great value in attaining the required calorie intake and as it was very fluid in itself, it had little effect on the final consistency.

Another method of providing suitable tube feeding mixtures was suggested by Barron and Fallis (1953). A high protein, high caloric, low residue diet was put into a liquidiser with the required amount of water. It was blended thoroughly, strained, and used for tube feeding. While ensuring that all the essential nutrients were provided, there were disadvantages. Special

apparatus was required, the feed had to be strained, and a larger bore tube had to be used for delivery. If the small bore tube was used, a mechanical pump was required. For these reasons, this type of tube feeding was not attempted.

Tolerance

This was much more difficult to assess completely compared with the oral supplement. Many different levels of intake would be required when burned patients were treated and yet high levels of intake might not be tolerated in the patient whose need was little increased from normal. It was decided to test a total intake of around 2.0 g. protein per Kg. per day and 50 calories per Kg. per day, in adult patients in whom nutrition had to be maintained by tube feeding. If these levels were tolerated, an attempt would be made to increase to 2.5 g. protein per Kg. per day and 60 calories per Kg. per day.

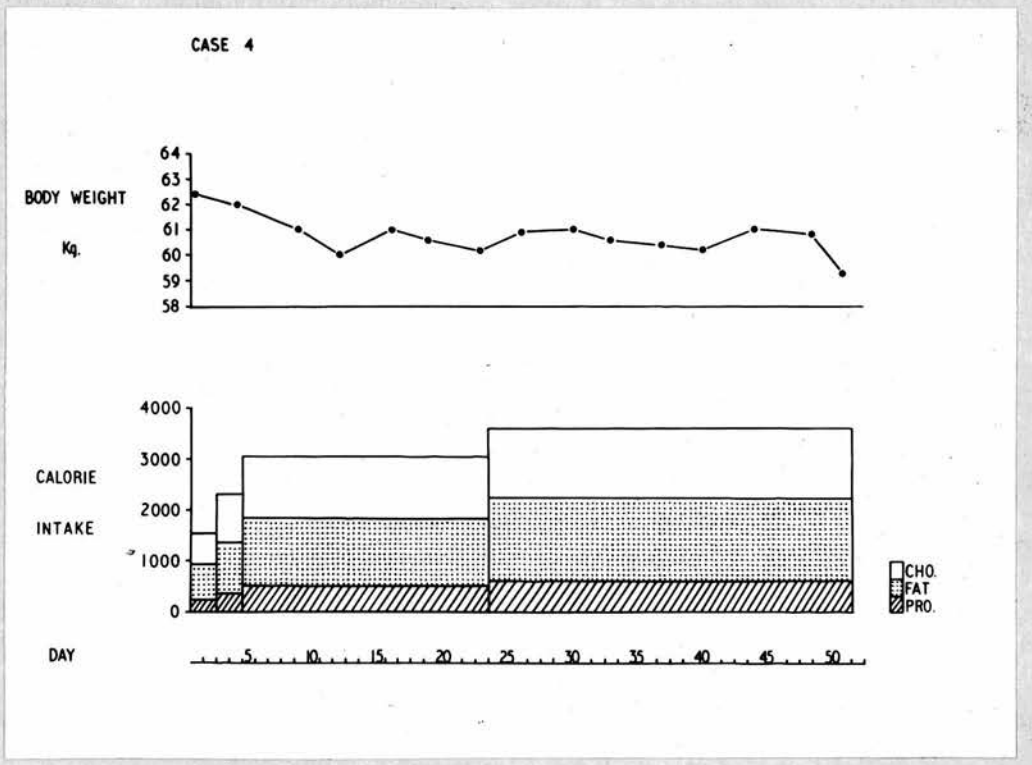
Where all intake was being provided by tube feeding, the proportions of the protein, fat, and carbohydrate relative to the total calorie intake might assume some importance, if tolerance were to be achieved.

Certainly, it was highly probable that in many instances the percentage of calories from protein might be much higher than the normal 10-12 per cent. The real question was what proportions of fat and carbohydrate should be used. This became the problem of how much fat should be included, as in very high intakes, high fat intakes, if tolerated, would allow the calorie requirement to be met much more easily.

The following patients were studied in an attempt to gain a fuller understanding of this problem and, at the same time, to

assess /

CHART 4



Case 4.- To show maintenance of intake by tube feeding

assess the suitability of any particular feeding formula in respect of consistency, volume, and ease of preparation.

Case 4.- This patient, a man of forty-six years, was operated upon for a lupus carcinoma of the cheek. He subsequently developed a buccal fistula, which made adequate nutrition impossible without tube feeding. The tube feeds were introduced gradually, half the amount being given on each of the first two days, three-quarters during the next two days, and finally the full amount.

In the first feed (Table 8, feed 1), the proportion of fat calories was slightly increased from the normal level of 35 per cent to 43 per cent. This meant that the carbohydrate calories fell from the normal level of 55-60 per cent to 41 per cent, with the protein at 16 per cent, representing 2.0 g. per Kg. Fluid intake of 2500 ml. kept the urinary volume at satisfactory levels. The loss of fluid from the buccal fistula was controlled for the most part by a gutta percha mould and, therefore, additional water to replace this loss was not required. The ascorbic acid was given separately to prevent the oxidation which might occur, as the feeds were made up in bulk to cover the twenty-four hour period. The other water soluble vitamins and iron were added to the feed.

The total volume was divided into five feeds of 500 ml. each and given at four hourly intervals, omitting any feeding between 10 p.m. and 6 a.m. This feeding regime was tolerated well with no diarrhoea or vomiting. It was decided, therefore, to attempt to give the higher levels of intake (Table 8, Feed 2).

The proportions of fat and carbohydrate were altered by the increase in the fat emulsion and the hydrolysate necessary to obtain the higher intake of calories and protein. The percentage of fat calories thus rose from 43 to 46, and the carbohydrate percentage fell from 41 to 37.

Again, the regime was tolerated well. There was no vomiting or diarrhoea, and no change in the appearance of the stool. The urine was tested daily, and on no occasion was sugar or acetone detected. Weight was maintained until evidence of recurrence was noted (Chart 4).

The next step was to attempt to estimate to what level the fat content of the feeds might be increased without intolerance developing. Also, if high levels of fat appeared to be tolerated clinically, then it would be worth while checking on the fat absorption to assess its utilisation.

Case 5.- This patient, a female aged thirty-nine, had a lupus carcinoma of the cheek. Operative excision resulted in the /

the development of a buccal fistula and tube feeding was required. It was considered at operation that the tumour had been removed successfully.

Tube feeding was introduced gradually. In this case, the original feed was given in its entirety from the start in five feeds of 400 ml. and with the experience gained in Case 4 the percentage of fat calories in the original feed was 44 per cent (Table 9). Thereafter, the calorie content of the feed was increased at three day intervals by the addition of extra fat emulsion only. The protein and carbohydrate levels, therefore, remained unchanged in amount, but, as the fat content increased, the percentage of the calories from these two sources fell proportionately. No evidence of intolerance occurred clinically, no acetonuria was noted, and a final intake of 130 g. protein and 3150 calories was reached by the fourteenth day, when the percentage of fat calories had reached 60. This intake was continued for a further seven day period and a fat balance study commenced on the twenty-first day.

Carmine was given as a marker before the commencement of feeding on this day and a seven day fat balance carried out. Carmine was again given as a marker at the end of the seven day period.

The following results were obtained;-

Total weight of dried faeces	= 108 g.
Total fat	= 4.3 g.
Split fat	= 90 per cent of total
Total fat given in feeds	=1463 g.
Other fat intake (milk in tea)	= 55 g.
Total fat intake	=1518 g.
Therefore, percentage of fat absorption	= 99.7 per cent

The fat from the fat emulsion totalled 1228 g. representing 80 per cent of the total fat ingested. It appeared, therefore, that high fat intakes were well tolerated and utilised.

Comment

The very high percentage absorption may be due to the proportion of emulsion used. Stein et al. (1952) stated that high intakes of emulsified fatwere almost completely absorbed. It is improbable, however, that the emulsion arrives in the small intestine in finely emulsified form as the acid of the stomach may well "break" the emulsion.

Such high fat intakes may be criticised as being unphysiological. Fat is associated in many minds with digestive difficulties /

difficulties and upsets, but there appears to be little foundation for this, except in those who have some upset in fat digestion or absorption. In those with a normally functioning gastro-intestinal tract, such prejudices are not substantiated by fact.

Furthermore, it should be recalled that milk, which has long held pride of place as an easily digested food, and, in many instances, the first given to an ill patient, has percentage fat calories of 52. The calories from protein and carbohydrate are 21 per cent and 27 per cent respectively. It would seem irrational, therefore, to expect intolerance from a tube feed giving similar proportions. In this respect, it is worthy of note that Smith and Wollaeger (1953), reporting on the results of tube feeding patients in the Mayo Clinic, reduced the incidence of diarrhoea from 39 per cent to 10 per cent, when the fat content was increased from 14 per cent to 43 per cent (from 6 per cent to 25 per cent of the total weight). Pareira et al. (1954), on the other hand, used a feed with only about 8 per cent of the calories from fat and while diarrhoea was reported as a complication it did not appear to have been troublesome and was easily controlled.

Obviously, there must be a limit to the reduction in carbohydrate intake. Peters (1952) has shown that at least 100 g. must be supplied daily to provide oxalacetate to the Krebs cycle and carbohydrate for the central nervous system, which would otherwise have to come from uneconomical use of potein. Further, there are certain metabloic processes which body fat stores by themselves are unable to support fully (Van Itallie et al. 1952).

However, in the formulae so far discussed, this minimum carbohydrate /

carbohydrate intake has never been approached. Also, as more patients were studied both with oral supplements and with tube feeding, high carbohydrate intakes of 500-600 g. per day, which occurred when patients were allowed glucose drinks ad libitum, were nearly always associated with diarrhoea of a fermentative type, which was readily controlled by reducing the carbohydrate intake.

Concentration

As with the oral supplements and independent of the proportions of protein, fat, and carbohydrate, the upper limit of tolerance was found to be around 2 calories per ml. of feed and is probably best kept at around 1.5-1.8 calories per ml. The calorie concentration of milk is around 0.7 per ml., and where tolerance is difficult to establish, this concentration may be desirable, at least initially. Milk alone should, therefore, be used in such patients and the introduction of more concentrated feeding made gradually.

Volume

Unless there was a significant loss of fluid, 2500-3000 ml. of feed was the maximum volume that could be given comfortably in any twenty-four hour period. It was thought unlikely that volumes greater than this would be required to ensure a maximum concentration of not greater than 2 calories per ml - in other words, this volume could give an upper limit of 6000 calories. Where very high protein intakes are being given, more fluid might be required.

Six hundred ml. appeared to be the maximum which should be given in any one feed, or if feeding were continuous, the same amount /

amount should take about four hours to run in. Where interrupted feeding was the routine, at least one hour was taken to deliver this amount. The decision had to be made whether to use interrupted or continuous feeding. Again, from the study of many patients, the interrupted method was preferred for the following reasons:-

(1) The feeds can be spaced out at intervals of four to six hours depending upon the total volume. This allows the patient much more freedom of movement whether he be in bed, or ambulant.

(2) There is less possibility of a milky type of feed "spoiling". When the continuous method is used, the feed remains in a warm atmosphere for longer periods of time, the danger being increased in warmer weather.

(3) The giving apparatus is cleaned between each feed and the nasogastric tube syringed through at frequent intervals. By the same token, the position of the feeding tube is checked more frequently.

(4) The patient does not require the constant attention of the nursing staff to regulate the rate of delivery of the feed.

(5) With the volumes used, it is usually possible to leave the patient undisturbed during the hours of sleep.

(6) There is no indication that there is any difference in nitrogen retention between continuous and intermittent feeding (Pareira et al. (1954)).

The usual routine was to give five feeds at 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m.

Only in rare instances was continuous feeding found to be more satisfactory. This was occasionally the case in patients referred /

referred late in poor nutritional state, in whom tolerance to any form of forced feeding was difficult to obtain initially. Then a slow, continuous drip often gave better results.

It was also important to attempt to find out if nutrition could be maintained over a long period of time with such tube feeding regimes as had been satisfactory in those treated for three to four weeks. It was probable that in many of the more severely burned patients, high intakes would be required for perhaps two to three months. If, in a patient previously depleted, weight gain could be established and maintained over a long period, it was considered that this would serve as a satisfactory index of adequate intake.

Case 6.- A female, aged sixty-five, undergoing reconstruction of the oesophagus after cervical oesophagectomy for carcinoma, was considered suitable for such a study. It was considered at operation that the tumour had been removed successfully.

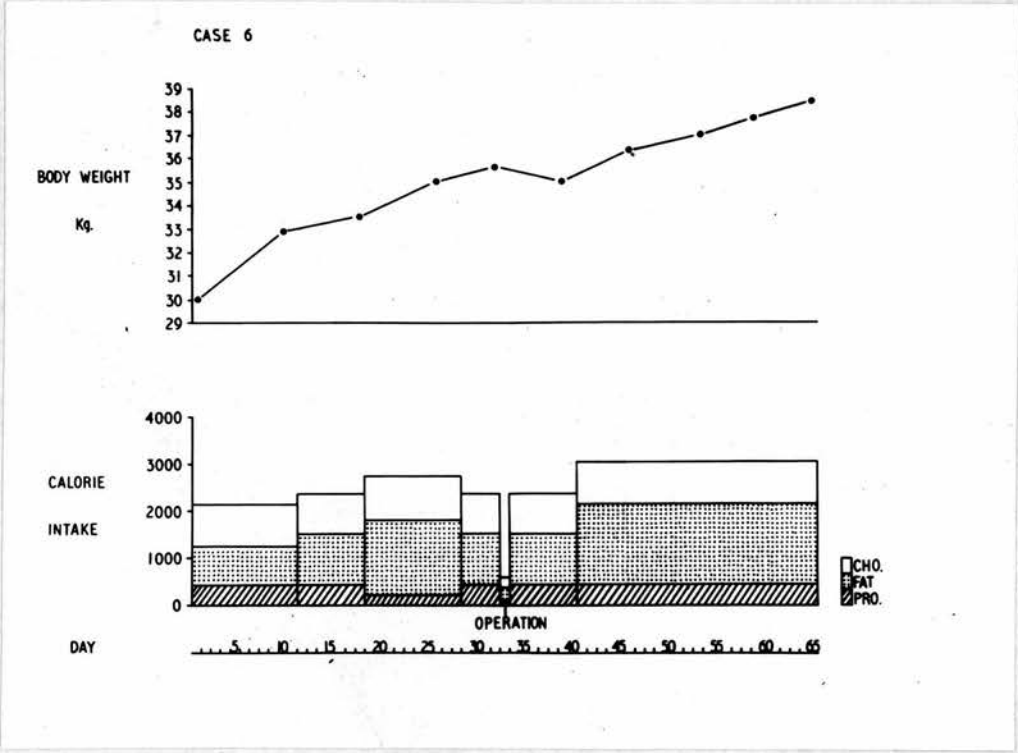
On admission for this reconstruction, the patient had a right lateral pharyngotomy, through which the feeding tube was passed. After reconstruction, by turning in local flaps to give inner lining, and covering the resultant defect by advancement of neck skin, a nasogastric tube was passed through the reconstruction and used for feeding until the wound was soundly healed and satisfactory solid food intake was established.

Her weight, prior to onset of symptoms of carcinoma of the oesophagus, was 45 Kg. On admission for reconstruction, her weight was 30 Kg. Requirement was based on the 45 Kg. weight.

The constituents used for the feeding formulae were very similar to those previously discussed. Increase in intake was made gradually, but, contrary to expectation in the depleted patient, tolerance was excellent. For a period of nine days, the protein intake was reduced to just over 1 g. per Kg., with a small increase in calories. The feed was then increased to its former level, and later a further increase in calories was made. The formulae for these feeds are shown in Table 10.

Comment /

CHART 5



Case 6.- To show tube feeding of the depleted patient over a long period of time and the gain in weight on this regime.

Comment

Weight gain continued throughout, except for a small drop following the operation for reconstruction (Chart 5). Weight gain occurred over a period of decreased protein intake, but no obvious increase in the amount or rapidity of weight gain took place with an increase of calories to 68 per Kg. This high level of calorie intake was, however, well tolerated.

It was, therefore, established that weight gain could be maintained in the depleted patient over a period of two months, during which time intake was given solely by means of tube feeding.

The introduction of Complan (Glaxo) allowed the formulae for tube feeds to be simplified. It was soluble enough to allow it to be used as the main protein source, gave a satisfactory consistence in the same volumes as the previous feedings, and was tolerated well when the percentage calories were kept as before. Examples of two formulae are shown in Table 11 to illustrate its use. They were both found to be as satisfactory on all points as those using the hydrolysates.

Tube Feeding in Children

The same criteria for suitable tube feeds must be met in children - total intake of all nutrients in a feed of satisfactory consistency in the required volume with no symptoms or signs of intolerance.

There were no children requiring tube feeding who could be studied satisfactorily to establish these points and, therefore, the burned child had to be used from the outset. With the experience gained in the adult, however, there were pointers as to what might constitute satisfactory formulae. Before the introduction /

introduction of Complan (Glaxo), the hydrolysates were used as the major protein source. Table 12 shows examples of satisfactory formulae, one using the hydrolysates, the other using Complan, both designed for a child aged five to six years and allowing a slight increase on the recommended allowances. This, in the burned child, was in an attempt to allow for lower intake on days when a general anaesthetic was given, so that where possible the average intake would reach the recommended figure. This age group was chosen as being the middle age group in the children. In younger children, aged two to four, two-thirds to three-quarters of the feeds were used and in older children, aged seven to ten, one and one-quarter to one and one-half the total, fluid volume being adjusted to requirement. The relative proportions of protein, fat, and carbohydrate were, therefore, kept constant in all age groups.

Intermittent feeding was the method of choice for similar reasons to those in the adult. Initially, the volume of any one feed was fixed at 200 ml., but, with experience, it was found that the total fluid intake of children receiving tube feeding tended to be low. The volume for this age group was, therefore, increased to 300 ml. for any one feed and this, with clear fluids allowed ad libitum, brought total fluid intake to satisfactory levels of around 2000 ml. In the age group two to four years, the single feed volume was kept at 200 ml. and, in the older children up to ten years, at 400 ml. Beyond this age group, total fluid intake and individual feed volume was given as in adults.

Tolerance was based on absence of diarrhoea, vomiting and acetonuria /

acetonuria. Stools were inspected regularly and in no instance was a bulky fatty stool noted. Occasionally, there was a mild diarrhoea, but this was again associated with increased consumption of glucose drinks and an excessively high carbohydrate intake. It was easily controlled by cutting the total amount of carbohydrate. The fine nasogastric tube did seem to have a greater tendency to slip up into the oesophagus in children and until this was appreciated as a cause of vomiting, the feeds themselves were often wrongly blamed.

The percentage fat calories, giving the most satisfactory tolerance, was around forty-five, although levels as high as 50 per cent were tolerated in nearly all cases. This value seldom needed to be exceeded except in the older children, who had intake requirements approaching the adult level.

Concentration up to 2 calories per ml. was again noted to be the upper limit of tolerance, with 1.5-1.8 calories per ml. being the more usual concentration in the later types of feeding, where the total fluid volume was increased.

In summary, therefore, the requirements for satisfactory tube feeding can be met.

(1) The required protein levels can be achieved by using protein hydrolysates or preferably, since its production, Complan (Glaxo), combined with varying amounts of evaporated milk. This latter is included to increase the food value without materially affecting the consistency. There should not be any need for hydrolysates except under rare circumstances.

(2) The remaining calories from fat and carbohydrate are easily provided with the use of fat emulsion and glucose.

Percentage /

Percentage fat calories as high as 60 per cent of the total are tolerated and absorbed and are apparently better tolerated than large amounts of carbohydrate.

(3) In nearly all instances, additional vitamins and iron require to be included, or given separately.

(4) Total volumes of 2500-3000 ml. in the adult, and 1000-1800 ml. in the child are necessary to give the required consistency at a concentration, which is tolerated. This concentration should not exceed 2 calories perml.

(5) Interrupted feeding is the method of choice in feeds of 500-600 ml. in the adult and 200-400 ml. in the child.

(6) A simple gravity drip is satisfactory for delivery of the feeds.

(7) The preparation of the feeds is possible in any ward kitchen given a simple scale and fluid measure.

The following points have been found to be of particular importance, if difficulties and complications are to be avoided.

(1) It is advisable to increase the number of perforations at the distal end of the feeding tube. This ensures smoother running of the feed, as one or both of the two holes provided may become blocked, or may impinge on the gastric mucosa. Also, when the fine bore tube is used without adding extra perforations the feed runs very slowly.

(2) The tube must be syringed through with plain water, or normal saline after each feed has been given so that the fine bore of the tube does not become blocked. Glucose solution is to be avoided for this purpose, as it tends to make the inside of the tube sticky and because of this, it tends to block more easily.

(3) /

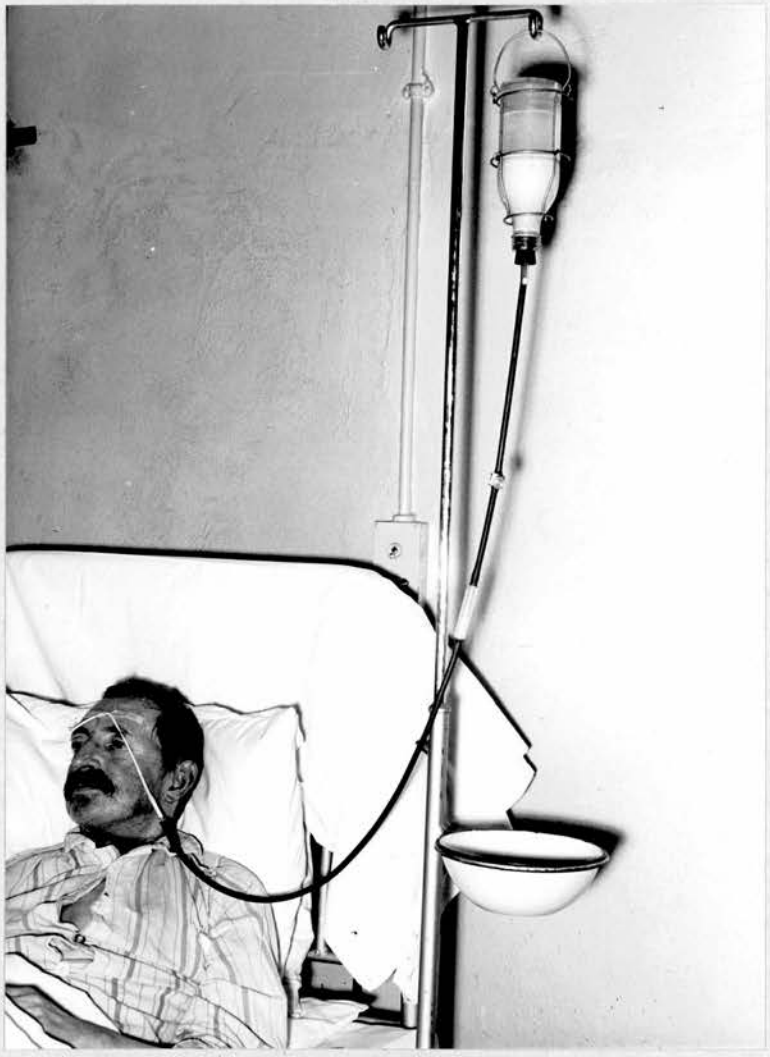
(3) The position of the tube must be checked on insertion to ensure that it is in fact intragastric and its position should be checked frequently, preferably before every feed. The purpose of this check is not only to avoid insertion into the trachea, for the thin tube can slip upwards and become coiled at the lower end of the oesophagus, which is not a problem with heavier and wider bore tubes. The feed is then delivered into the oesophagus, and while in normal circumstances all fluids would probably pass on into the stomach, it has been found that such a state of affairs is in many instances associated with vomiting. This may be due to irritation of the cardia.

As has been stated previously, suction used on these tubes may not be satisfactory because they tend to collapse. Therefore, checking by attempted aspiration of stomach contents is not always satisfactory, although in many cases it is all that is required. If aspiration is not achieved, some other method of cross checking is imperative. It is found in practice that the most reliable method is to inject forcibly ten c.c. of air down the tube with a syringe, as the same time listening over the epigastrium. If the tube is intragastric an unmistakable "plop" is heard.

The tube may also pass through the pylorus, in which case the feed is given into the duodenum. Feeding tolerated by the stomach is seldom tolerated if given directly into the duodenum, and diarrhoea is an almost inevitable result. While this is not a frequent complication, the fact that the position of the tube can be checked by X-ray is of great value.

If these possible changes of position are not appreciated with resulting vomiting or diarrhoea, this method of feeding may be /

PLATE 3



To show method of delivery of tube feed.

be abandoned as being unsuccessful.

(4) The feeds should be delivered by means of an ordinary blood transfusion giving set, under gravity only (Plate 3). Feeds of satisfactory consistency flow easily under gravity, and the rate can be adjusted by means of a screw clip. With the clip fully open, the rate of administration may be excessive. Using this method, the actual giving of the feeds does not need a nurse to be at the bedside throughout, as the tube and funnel method does, nor are there the mechanical difficulties often associated with a food pump.

(5) Obviously, the bottles, tubing, and glassware must be kept scrupulously clean to avoid contamination. Thus, although the giving apparatus is boiled up between each feed, it is probably more important to ensure that the inside of the giving set tubing is free from any collection. For this reason, latex rubber tubing is preferred, which, being translucent, can be inspected regularly for this hazard.

The routine syringing of the feeding tube itself after each feed, keeps this part of the apparatus sufficiently clean. The proximal end is kept wrapped in a clean gauze swab, held by an elastic band, with the tube clamped off between feeds. While no definite times are set for changing the feeding tube, it is probably advisable to replace the tube at least once every two weeks.

No real differences were noted when a burned patient was fed in this manner. Total fluid intake is, however, of great importance. Frequently such patients run some degree of fever. They are, in most instances, wrapped in thick dressings, and until skin /

skin grafting is well advanced the raw area in an additional avenue of fluid loss. In addition, these patients are relatively immobilised for long periods and tend to have an increased excretion of urinary calcium with a slight rise in urinary pH, which will favour deposition of calcium phosphate (Dietrick et al. (1948)). Also, the very nature of the intake will increase the intake of calcium. An adequate urinary output is thus of extreme importance. Frequently too, some patients, by the nature of the distribution of their burns, require an indwelling urinary catheter for varying periods of time, again emphasising the need for an adequate urinary volume in an effort to prevent the development of, or treat the presence of a urinary infection.

If the feeds themselves do not meet this need, then either the individual feed volume should be increased with water, which may not be practicable, or where maximal individual feed volume is already being given, additional water should be given by the tube between feeds.

One further point is worthy of mention in the burned patient. Experience with tube feeding of high intakes produced little evidence of intolerance and again the percentage fat calories was high in nearly all instances. A further fat balance study was carried out in a patient with burns. This female patient, aged twenty-one years, was admitted with burns totalling 35 per cent of her body surface. Tube feeding was instituted on the sixth day post burn. The formula used was the same as that in Table 9, except that the first feeding used contained 100 ml. fat emulsion instead of 150 ml. The emulsion was increased in similar stepwise fashion with additions of 50 ml. to 350 ml. daily, the additions /

additions being made at intervals of one week. As in the previous balance study, four days were allowed to elapse after the final intake was reached and then Carmine was given as a marker. The study was continued for six days, during which time the patient was given one general anaesthetic for change of dressings. In addition to the tube feeds, the patient was taking small amounts of ordinary ward diet.

The following results were obtained:-

Total weight of dried faeces	= 127 g.
Total fat	= 14.6 g.
Split fat	= 70 per cent
Total fat given in feeds	= 1254 g.
Other fat intake (from diet)	= 61 g.
Total fat intake	= 1315 g.
Therefore percentage of fat absorption	= 98.9 per cent.

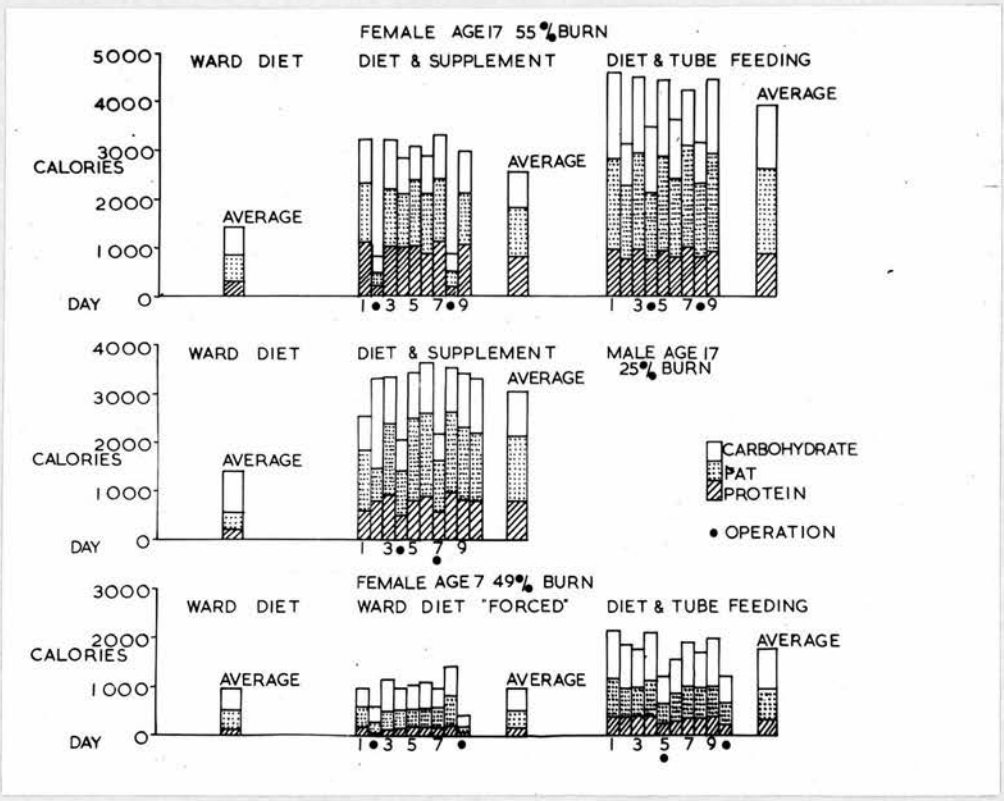
As in Case 5, the percentage absorption was abnormally high, but again nearly all the fat was in emulsified form. Because of the previous balance in Case 5, even more particular attention was paid to the accuracy of intake and collection of stool specimens.

Summary

Possible methods of supplementing intake in the burned patient were thus established. Chart 6 shows the effect of supplementation on the very unsatisfactory intakes of the three burned patients receiving ward diet alone (Chart 1). It shows that suggested levels of intake can be achieved by one of other method, but that for very high levels of intake tube feeding is probably required. It also shows that the effect of anaesthesia on intake can be eliminated to a large extent, thus providing a better average intake for the period concerned. Further, it serves to point out that encouragement to eat produces virtually no improvement in intake in the child. A great deal of time and

effort /

CHART 6



To show the result of supplementation of the ward diet by oral supplement or tube feeding, in the same patients shown in Chart 1.

effort was expended by the nursing staff, during the period of "forced" ward diet in the child presented in Chart 6 and yet the average intake over this period was virtually unchanged.

Feeding methods were studied in this detailed way because, if the nutrition of burned patients was to be maintained at all, this aspect assumed great importance. The actual method used in individual patients will be discussed as these patients are presented.

STUDIES ON BURNED PATIENTS

Having established methods of supplementing intake, it became possible to study the effect of supplementation of intake in the burned patient.

Material and Methods

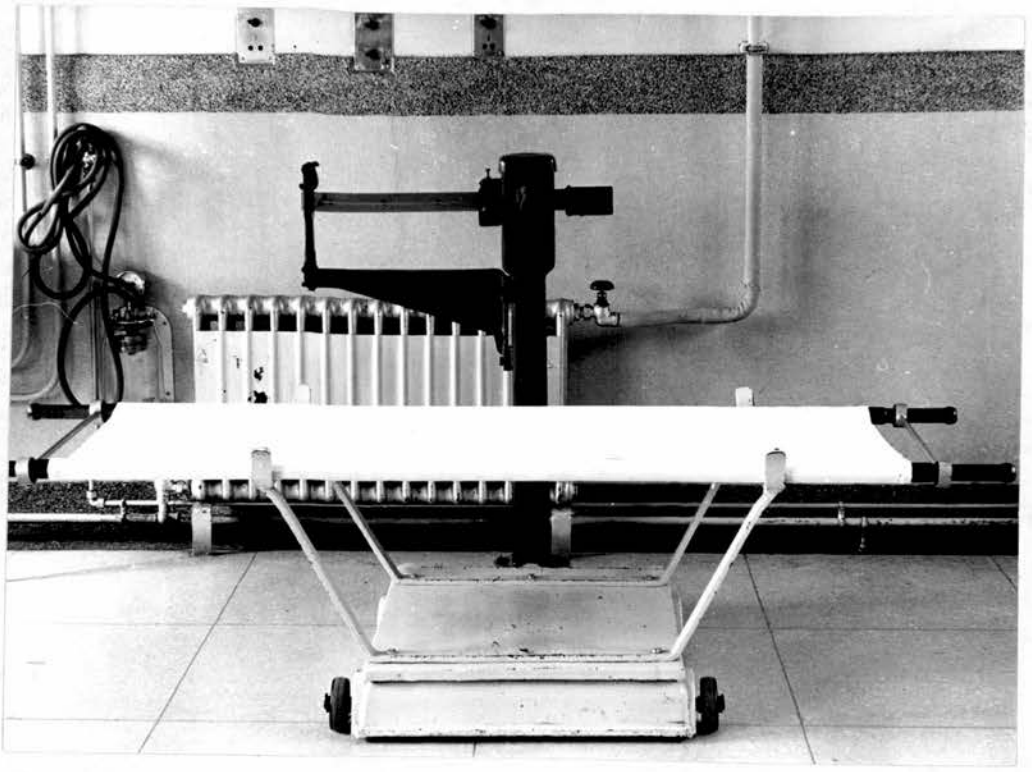
The patients included eighteen adults and seventeen children, all of whom had sustained flame burns, but in whom the extent of the injury varied. Except in one instance, all had burns involving 10 per cent or more of the body surface.

The adult patients were treated in the Plastic Surgery Unit at Bangour Hospital, and the children at the Royal Hospital for Sick Children.

As has been mentioned previously, in studies such as this, it is important to outline the routine used in the general overall care of such patients. It must be pointed out here, that while the great majority of the children were admitted directly, the adults, in some instances, were treated elsewhere initially, and transferred, usually within one week of injury. Thus, in them, detailed knowledge of intake, apart from intravenous therapy is unknown for the period prior to transfer. For the same reason, an accurate admission weight in these patients is not always obtained. Therefore, in such patients only those who could give accurate information concerning their weight immediately prior to injury were included. No patient is included in this series who was admitted after the seventh day post burn. The routine about to be described applies only to those patients admitted directly.

(1) On admission, before being placed in bed, the patient was weighed. This was considered doubly important, not only to establish /

PLATE 4



To show scale used in weighing patients

establish a base line for use throughout hospital stay, but also in estimating the fluid therapy required in resuscitation. For such a purpose, a scale was required, which allowed weight to be recorded in both ambulent and non-ambulant patients (Plate 4). The simple machine illustrated accommodates the ordinary Red Cross stretcher and weighs to an accuracy of 50 g.

(2) A rough estimate of the extent of the burn was made, using the "Rule of Nines" modification of the Berkow Table (Wallace, 1952), and a decision made as to whether or not intravenous therapy would be required. This was usually the case in adults with burns of over 20 per cent of the body surface, and in children where over 10 per cent was involved.

(3) A polythene cannula was inserted into one of the superficial veins, the antecubital fossa being the site of choice when not involved in the burn. The initial fluid infused was reconstituted dried plasma.

(4) An indwelling urinary catheter was inserted and released hourly. The volume obtained served as an additional guide to the adequacy of the resuscitative therapy.

(5) A more accurate estimation of the percentage body surface involved was made by using the method of Lund and Browder (1944).

(6) Fluid therapy was continued using as a guide the following formula:-

3 ml. Colloid solution/Kg. body weight/percentage burn.

The total amount was spread over the forty-eight hour period following injury, the rate of administration being adjusted according to the clinical state and urinary output. The solution used was plasma in superficial injuries and a combination of plasma and /

and blood in deep burns. In nearly all instances, this was the routine used in children (Batchelor, 1957). In the adults, a combination of colloid (plasma and/or blood) and electrolyte solution (normal saline, Ringer lactate) was used, but the estimated total amount of intravenous fluid was in the order of 3 ml./Kg. body weight/percentage burn.

The plasma infusion was included in the protein intake and although it may not be available in this sense, Moore (1952) suggested that it should be charted as ordinary protein intake. Whole blood, however, was not included in the protein intake, neither that used in resuscitation, nor that given subsequently in interval transfusions, again being the recommendation of Moore (1952).

Intravenous therapy, during the latter part of the second day post burn, was usually confined to 5 per cent glucose solution and the infusion was seldom required after forty-eight hours.

(7) Oral intake, during this forty-eight hour period, was confined to water or diluted fruit juices, the amount in adults not exceeding 1500 ml. and in children 30-60 ml. per hour in any twenty-four hour period.

(8) At the end of the forty-eight hour period, half strength milk was introduced into the oral intake, the volumes being increased gradually over the next three to four days.

(9) Oral intake was built up gradually through whole milk to either light solids plus supplementary feeding, or to tube feeding.

In adults with burns up to 35 per cent body surface involved and in children up to 25-30 per cent, intake was in most instances in /

in the form of ward diet plus oral supplement, in those with more severe injuries, a nasogastric feeding tube was passed on the third day post burn, and the major part of the intake given by this route.

The levels of intake aimed at in the adult (Table 13) were derived from Levenson's recommendations (1952).

The levels of intake aimed at in the child were those which were recommended for a healthy child of the same age (Table 2).

In both children and adults, an attempt was made, whenever possible, to reach the estimated required intake by the tenth day following injury, and earlier when practicable.

The local care of the wound was either by exposure, or absorptive dressings, or by a combination of the two methods (Wallace 1952). In some, deep burns were excised and grafted within seven to ten days, but this was the exception rather than the rule.

In all patients, whether admitted directly or transferred, the following routine was adopted.

(1) Naked weights were obtained twice weekly throughout the period of study. This time interval was fixed upon because the patients whose burns were dressed usually had a dressing change twice weekly. By weighback of the dressings, it was possible thus to obtain a very accurate weight. This yielded more useful information than daily weights, where the allowance for dressings must be, at best, a poor approximation, the dressings becoming progressively more moistened with exudate.

Again, the use of the simple stretcher scale made this routine of minimum inconvenience to both the patient and the attendants.

(2) Intake-output charts were kept for all patients, showing /

showing both fluid and solid intake. When possible, the solid intake was weighed on a simple Salter balance. When this was not possible, homely measures such as teaspoonful, tablespoonful were used. The weights of many foods occurring frequently on the hospital diet measured in this way had been determined previously. It was realised that this would, of course, allow less accurate estimation of total intake, but the studies had to be undertaken in a busy general surgical ward without the assistance of trained dietetic help at all times.

(3) From these charts, the daily intake of protein and calories was calculated for each patient, using standard food tables (McCance and Widdowson, 1946). It was appreciated that this method of calculating intake, as opposed to analysis, was much less inaccurate, the analysed foods differing considerably from those calculated from standard tables. More recently, Pearson et al. (1955) have shown the extent of this difference. The food value of manufactured products used - Complan, Casilan, fat emulsion (now marketed as Prosparol), Casydrol, concentrated fruit juice - was known accurately from the manufacturers' analysis of their products. From the estimations of daily intake, weekly average intakes of both protein and calories were calculated, this average probably being of more value than the actual day to day intake.

(4) With the cooperation of the senior anaesthetists in both units, the periods of starvation both before and after anaesthesia were cut to a minimum, so that feeding was continued up to four hours before anaesthesia and recommenced three to four hours after return to the ward. While it was seldom possible to include the total /

total estimated requirement on these days, there was marked improvement in intake. A reduced intake on two out of seven days, however, does tend to reduce the average weekly intake.

(5) Supplementary vitamins and iron were given as shown in Table 13, commencing on the third day post burn in those admitted directly, or from the day of admission in those transferred later.

(6) In only one or two patients was diarrhoea a feature. Vomiting was seldom encountered. The diarrhoea was easily controlled by adequate dosage of chalk and opium mixture (N.F.), the usual dosage being fluid ounce $\frac{1}{2}$ three times daily.

Vomiting was usually associated with malposition of the feeding tube. In no instance had the feed, either oral supplement or tube, to be reduced because of vomiting.

Because vomit and diarrhoeal stool were not analysed in this study, the following allowances were made. In the case of vomitus, all food consumed in the previous four hour period was disregarded and not included in the intake, this including any oral supplement or tube feed given during this time. No such allowance could be made for diarrhoeal stool and, therefore, the intake was charted as being complete and a note made that diarrhoea was present. The diarrhoea was never of such severity or duration as to assume any greater importance than this. Both complications were so infrequent that it was considered that they could have little effect on the total intake over the long periods studied.

The patients were divided into three groups according to the extent of the burn, the adults and children being considered separately.

Group 1. Up to 20 per cent involved.

Group /

Group 2. 21-30 per cent involved.

Group 3. 31-40 per cent involved.

Patients with burns of greater extent are not included in this series, as, in them, survival is frequently in doubt. Bull and Fisher (1954) have shown that a burn of 46.4 per cent is associated with a mortality of 50 per cent. Further, there are often complicating factors, which make the treatment adopted at variance with the routine described.

ADULTS - GROUP 1

8-20 per cent Body Surface Involved

Case 7.- This man, aged twenty-nine years, was injured in a pit explosion. The burns involved the face and hands, the total area being 9 per cent total body surface.

Resuscitation and dressing of the areas were carried out elsewhere, and he was transferred on the fourth day post burn.

Theatre dressing on the fifth day post burn showed fairly marked infection of all areas. Theatre dressings were repeated on the twelfth, seventeenth, and twenty-third days, by which time the face was completely healed. Theatre dressings were continued twice weekly, and razor grafts were applied to the hands on the thirty-first and thirty-ninth days post burn, with 100 per cent "take" in both instances.

All areas were healed by the forty-seventh day post burn, physiotherapy commenced, and he was discharged on the eighty-third day.

Estimated Requirement

WEIGHT : 65.0 Kg.

PROTEIN : 1.5 g./Kg. = 1.5 x 65 = 97.5 g.

CALORIES : 45/Kg. = 45 x 65 = 2925.

Oral supplementation of ward diet was commenced on the fifth day post burn, and continued until the fifty-second day.

Feed	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	30	27.0	0.3	0.3
	Glucose	20	-	-	20.0
	Lactose	15	-	-	15.0
	Whole Milk	420	13.9	15.5	20.2
	Evaporated Milk	100	7.6	8.4	12.3
	Fat Emulsion	70	-	35.0	-
			48.5	59.2	67.8

Protein 49 g.
Calories 999.

Comment (Table 15).

Weight loss continued until the end of week two, the severest drop in weight occurring between weeks one and two. The total weight lost was 1.4 Kg., a percentage loss of 2.2. From the beginning

beginning of week three, there was a slow gain, which was arrested between weeks five and six, at which time there was also a reduction in intake, mainly of calories. Despite a fall in intake at week eight, weight gain continued.

The protein intake was greater than the estimated requirement except at week eight. The calorie intake was at, or above, the estimated requirement except at week eight.

Case 8.- This man, aged thirty-seven years, was injured in a pit explosion. The burns involved both hands and forearms the total area being 10 per cent total body surface. The patient was admitted within two hours of the accident and did not require intravenous therapy. All areas were dressed.

Theatre dressing, under anaesthesia, was repeated on the fourth and ninth days post burn. Healing was complete on the twenty-first day and he was dischargedon the thirty-first day.

Estimated Requirement

WEIGHT : 70.8 Kg.

PROTEIN : 1.5 g./Kg. = 1.5 x 70.8 = 1o6 g.

CALORIES : 45 /Kg. = 45 x 70.8 = 3186.

Oral supplementation of ward diet was commenced on the second day post burn, and continued until the twehty-fourth day.

Feed	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Fat Emulsion	100	-	50.0	-
	Concentrated Fruit Juice	150	-	-	15.0
	Evaporated Milk	200	15.2	16.8	24.6
	Lactose	10	-	-	10.0
	Glucose	30	-	-	30.0
	Water	150	-	-	30.0
			15.2	66.8	79.6

Protein 15 g.
Calories 983.

Comment (Table 16).

Weight loss continued until the end of week three, with the severest drop at week one. The total weight lost was 3.6 Kg.,

a /

a percentage loss of 5.3. Weight gain occurred during Week four. Both the protein and calorie intake failed to reach the estimated requirement except at Week three.

Case 9.- This man, aged thirty-nine, was injured in a pit explosion. The burns involved the left arm and right upper arm, the total area being 10 per cent.

The patient was admitted within two hours of the accident and did not require intravenous therapy. All areas were dressed.

Theatre dressing, under anaesthesia, was carried out on fourth and ninth days post burn and healing was complete on the twenty-fourth day. He was discharged on the twenty-ninth day.

Estimated Requirement

WEIGHT : 72.0 Kg.

PROTEIN : 1.5 g./Kg. = 1.5 x 72 = 108 g.

CALORIES : 45/Kg. = 45 x 72 = 3240.

Oral supplementation of ward diet was commenced on the second day post burn and continued until discharge.

Feed 1. Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Fat Emulsion	100	-	50.0	-
Concentrated Fruit Juice	150	-	-	15.0
Evaporated Milk	200	15.2	16.8	24.6
Lactose	10	-	-	10.0
Glucose	30	-	-	30.0
Water	150	-	-	-
		15.2	66.8	79.6

Protein 15 g.
Calories 983.

Comment (Table 17)

Weight loss continued until the end of Week three, with the severest drop occurring during Week one. The total weight lost was 3.4 Kg., a percentage loss of 4.7. There was a rapid gain during Week four.

The protein intake was less than the estimated requirement during /

during weeks one and two, but above during Week four. The calories did not reach estimated requirement until Week three and were well above during Week four.

Case 10.- This man, aged twenty-nine, was injured in a pit explosion. The burns involved the face, both hands and arms, the total area being 16 per cent of the total body surface. He was admitted within two hours of the accident and did not require intravenous therapy.

All areas were dressed except the face, which was exposed.

Theatre dressing, under anaesthesia, was carried out on the fourth and ninth days post burn. Healing was complete on the fifteenth day, and he was discharged on the twenty-third day.

Estimated Requirement

WEIGHT : 60.6 Kg.

PROTEIN : 1.5 g./Kg. = 1.5 x 60.6 = 91.0 g.

CALORIES : 45/Kg. = 45 x 60.6 = 2727.

Oral supplementation of ward diet was commenced on the second day post burn, and continued until discharge.

Feed	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Fat Emulsion	100	-	50.0	-
	Concentrated Fruit Juice	150	-	-	15.0
	Evaporated Milk	200	15.2	16.8	24.6
	Lactose	10	-	-	10.0
	Glucose	30	-	-	30.0
	Water	150	-	-	-
			15.2	66.8	79.6

Protein 15 g.
Calories 983.

Comment (Table 18)

Weight loss continued until the end of Week two, with no change in weight at Week three, at which time this superficial burn had healed. The weight loss was 2.0 Kg., a percentage loss of 3.3.

The protein reached the estimated requirement at Week three only /

only, and the calories at Weeks two and three.

Case 11.- This man, aged twenty-eight, was injured in a pit explosion. The burns involved the face, chest, back, and arms, the total area being 16 per cent of the total body surface. He was admitted within two hours of injury and did not require intravenous therapy.

All areas were dressed except the face, which was exposed.

Theatre dressing, under anaesthesia, was carried out on the fourth, ninth, and sixteenth days post burn. Healing was complete on discharge on the thirty-fifth day.

Estimated Requirement

WEIGHT : 64.5 Kg.

PROTEIN : 1.5 g./Kg. = 1.5 x 64.5 = 96.7 g.

CALORIES : 45/Kg. = 45 x 64.5 = 2902

Oral supplementation of ward diet was commenced on the second day post burn and continued until the tenth day.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Fat Emulsion	100	-	50.0	-
	Concentrated Fruit Juice	150	-	-	15.0
	Evaporated Milk	200	15.2	16.8	24.6
	Lactose	10	-	-	10.0
	Glucose	30	-	-	30.0
	Water	150	-	-	-
			15.2	66.8	79.6

Protein 15 g.
Calories 983.

The patient found this supplement difficult to take and a change was made on day ten.

Feed 2	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Fat Emulsion	175	-	87.5	-
	Concentrated Fruit Juice	75	-	-	7.5
	Glucose	25	-	-	25.0
	Water	50	-	-	-
			-	87.5	32.5

Protein -
Calories 924.

This /

This supplement was continued from day ten until discharge.

Comment (Table 19)

Weight loss continued until the end of Week three, the severest drop occurring between Weeks two and three. The total weight loss was 6.6 Kg., a percentage loss of 10.2. Rapid weight gain occurred during Week four.

The protein and calorie intakes reached the estimated requirement except during Week one.

Case 12.- This man, aged twenty-five, was injured in a pit explosion. The burns involved the face, hands, and arms, the total area being 16 per cent of the total body surface. Resuscitation and dressing of all areas was carried out elsewhere and he was transferred on the fourth day post burn.

Theatre dressing on the fifth day showed infection of all areas. The hands and arms were treated by dressings, but the face was, at this point, left exposed. Theatre dressings, under anaesthesia, were repeated on the eleventh and seventeenth days and areas, which were at first thought to be deep, showed evidence of healing. Healing was complete on the twenty-ninth day, and after fairly intensive physiotherapy he was discharged on the forty-fifth day.

Estimated Requirement

WEIGHT : 61.0 Kg.

PROTEIN : 1.5 g./Kg. = 1.5 x 61 = 91.5 g.

CALORIES : 45/Kg. = 45 x 61 = 2745.

No supplementary feeding was given, apart from the ordering of a high protein, high calorie diet.

Comment (Table 20)

A slight weight gain occurred at Week one. Thereafter, weight loss continued until the end of Week three. The total weight loss was 3.8 Kg., a percentage loss of 6.2. Rapid weight gain then took place.

The protein and calorie intake did not reach the estimated requirement /

requirement during the first four weeks. The protein intake reached it during Week five, but the calories remained below.

Case 13.- This man, aged forty, was injured in a pit explosion. The burns involved the face, arms, and hands, the total area being 17 per cent of the total body surface. Resuscitation and dressing of all areas was carried out elsewhere and he was transferred on the fourth day post burn.

Theatre dressing, under anaesthesia, was carried out on the fifth day post burn. All areas were infected, and the involvement of the hands appeared to be full thickness skin loss. All areas were dressed except the face, which was exposed.

Further dressings, under anaesthesia, were carried out on the eleventh, seventeenth, twenty-third, twenty-eighth, and thirty-second days, by which time the superficial areas on the arms and face had healed, leaving a clean granulating surface on the dorsum of both hands. Dermatome grafts were applied to those areas on the thirty-ninth day with 100 per cent "take" of the grafts. After the grafts had stabilised, physiotherapy was commenced and gradually increased, and he was discharged on the seventy-third day, at which time the range of movement of the small joints of the hands was increasing rapidly.

Estimated Requirement

WEIGHT : 57.0 Kg.

PROTEIN : 1.5 g./Kg. = 1.5 x 57 = 85.5 g.

CALORIES : 45/Kg. = 45 x 57 = 2565

No supplementation was given apart from ordering a high protein, high calorie diet.

Comment (Table 21)

A very small weight loss occurred at Week one. Weight continued to fall until the end of Week four, with the severest drop between weeks one and two. The total weight loss was 3.3 Kg. a percentage loss of 5.8. Weight gain was rapid during Weeks six and seven.

The protein intake reached the estimated requirement only during Weeks six and seven, and the calories remained 10-15/Kg. below throughout.

Discussion

(Chart 7 and 8)

Of these patients studied with burns involving up to 20 per cent of the body surface, only Case 7 reached the estimated requirement at all consistently. Cases 8, 9, 10, and 11 reached it for part of the time, mainly in the later stages of the study period. Cases 12 and 13 achieved the required protein intake latterly, but their calorie intake was low throughout. These cases were the only patients in this group whose intake was not supplemented. This was done deliberately to assess again the levels of intake, which could be attained on the ward diet by patients with moderate injury. It stresses that it is virtually impossible to achieve the requirement level by ordinary means. The lack is mainly a caloric one.

In all but Case 7, weight continued to fall until the end of the third week after injury. The weight in Case 10 remained static at the third week, and it could be that this was not the end of his weight loss. This brings to light the inadequate length of the study period of those patients with superficial injuries, who heal within three to four weeks and are ready for discharge. Thus, although lost weight is not fully regained in these patients, there is no interference with healing.

In case 13, weight continued to fall until the end of the fourth week. Two factors may be responsible. Firstly, while this patient had a comparable extent of injury to Cases 10, 11, and 12, a small part of the burn was deep and required grafting. Secondly, he was one of those in whom intake was low throughout, especially in regard to calories.

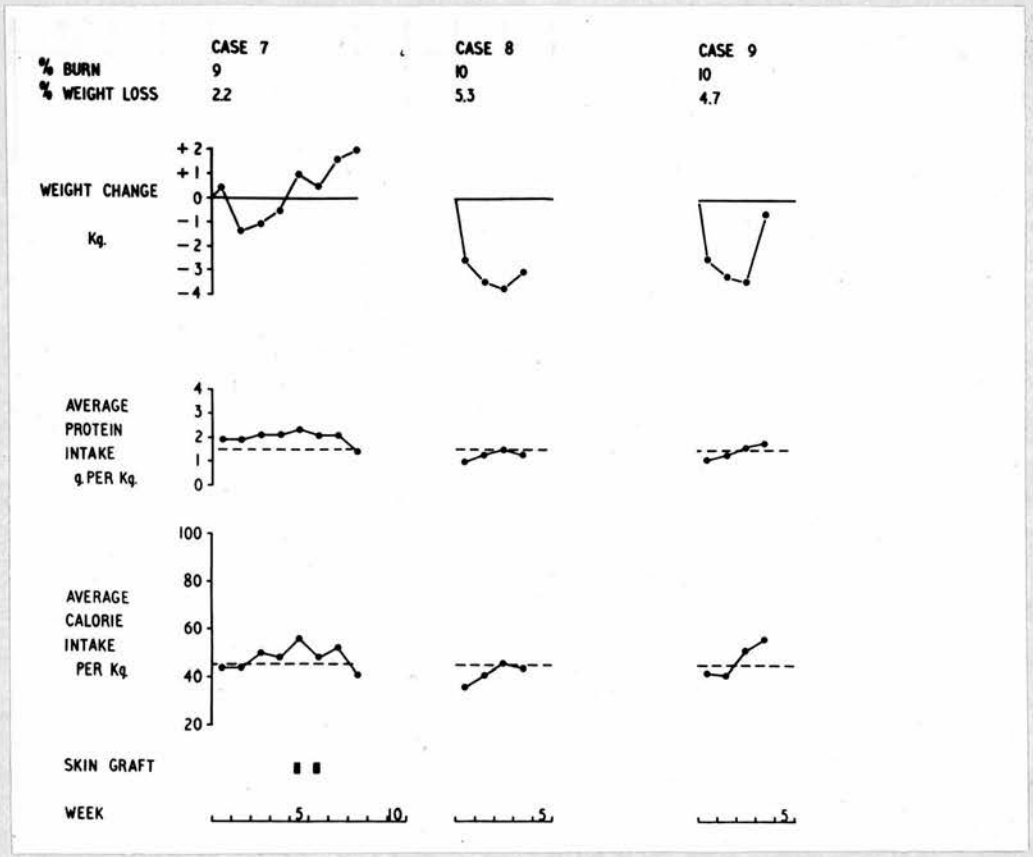
The /

The weight pattern, in those more minor injuries, where the estimated requirement is not reached consistently, appears to be one of a weight loss of around 6 per cent of total body weight, occurring in the first three weeks after injury. Weight gain thereafter is readily established and will continue at lower levels of intake, although it may be more rapid if the higher intakes are reached, as shown in Case 9.

The marked weight loss in Case 11 is difficult to explain. It would not appear to be a starvation effect, as requirement levels were virtually reached except during Week one. Surface infection of the right arm did occur during Week two and may have played some part. Another possible explanation would be in fluid shift, but it is unlikely that it would have continued in an injury of this size with no intravenous therapy, for two weeks. Clinically, no other cause for weight loss could be found and the intake figures were checked and appeared reliable.

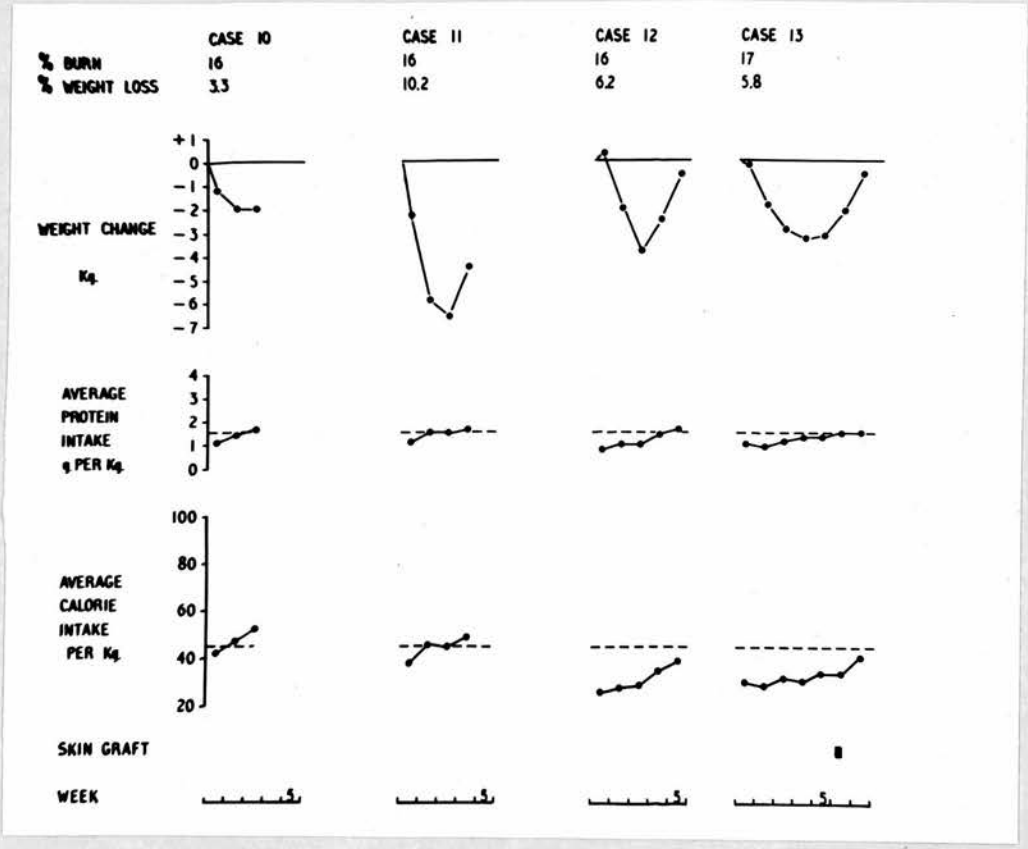
In considering the group as a whole, it is tempting to attribute much of the weight loss to a failure in achieving the recommended levels of calorie intake. The minor degree of weight loss in Case 7 is found along with the highest consistent level of calorie intake.

CHART 7



Case 7, 8, 9.- To show change in body weight and average levels of intake achieved. The interrupted line in the intake graphs shows the level of the estimated requirement.

CHART 8



Case 10, 11, 12, 13.- To show change in body weight and average levels of intake achieved. The interrupted line in the intake graphs shows the level of theestimated requirement.

ADULTS - GROUP 2

21-30 per cent Body Surface Involved

Case 14.- This man, aged twenty-seven, was injured in a pit explosion. The burn involved the face, arms, hands, and posterior trunk, the total area being 21 per cent of the total body surface.

Resuscitation and dressing of all areas was carried out elsewhere and he was transferred on the fourth day post burn.

Theatre dressing, under anaesthesia, was carried out on the fifth day, when mild infection was present in all areas. Apart from the face, which was exposed, the areas were dressed. Further dressing under anaesthesia was carried out on the twelfth and nineteenth days, at which time the upper arms were virtually healed. By the thirty-fifth day, all areas except the left hand were healed. This was healed on the forty-first day. Physiotherapy was gradually increased from the fifty-third day onwards and he was discharged on the seventy-first day.

Estimated Requirement

WEIGHT : 62.1 Kg.

PROTEIN : 1.5 g./Kg. = 1.5 x 62.1 = 93 g.

CALORIES : 45/Kg. = 45.x 62.1 = 2795

Oral supplementation of the ward diet was commenced on the sixth day post burn, and continued until the fifty-first day.

Feed	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Fat Emulsion	100	-	50.0	-
	Concentrated Fruit Juice	150	-	-	15.0
	Evaporated Milk	200	15.2	16.8	24.6
	Lactose	10	-	-	10.0
	Glucose	30	-	-	30.0
	Water	150	-	-	-
			15.2	66.8	79.6

Protein 15 g.
Calories 983.

Comment (Table 22)

There was no loss of weight recorded, but it was variable until the end of Week three. There followed rapid weight gain with /

with a very slight drop between Week four and five, at which time there was a drop in both protein and calories. Thereafter, weight gain was continuous.

The protein reached estimated requirement except during Weeks one and two, when it was slightly below. The calories were above throughout, being 10-20/Kg. higher than requirement from Week three to seven.

Case 15.- This youth, aged nineteen, sustained burns of his legs, when accidental ignition of petrol set fire to his clothing . The burns involved both legs and buttocks, the total area being 24 per cent of the total body surface. All areas appeared to be involved in full thickness skin loss.

He was admitted about three hours after the accident, and showed evidence of mild shock, and required intravenous resuscitation. During the forty-eight hour period immediately following the accident, he received :-

Plasma - 2000 ml.
Whole Blood - 1200 ml.
Normal saline with 5 per cent glucose - 2100 ml.

All areas were cleansed and dressed, under anaesthesia, on the second day. A rise of temperature to 103°F. (39.4°C.) occurred on the sixth day and because of this a further dressing, under anaesthesia, was done on that day. The temperature settled rapidly and was normal on the ninth day. On the tenth day, the loose slough was excised and 1200 ml. whole blood transfused.

Further dressings, under anaesthesia, were carried out on the sixteenth, nineteenth, twenty-third, and twenty-sixth days.

On the twenty-ninth day, dermatome grafts were applied to the anterior surface of the left leg, the other areas were dressed, and 1200 ml. whole blood transfused.

On the thirty-third day, further dermatome grafts were applied to the anterior surface of the right leg. There was a fair "take" of the grafts on the left leg. Dressing, under anaesthesia, on the thirty-seventh day, showed a good "take" of grafts and a further dressing on the forty-fourth day showed outgrowth of epithelium from all grafted areas.

On the fifty-first day, dermatome grafts were applied to the posterior surface of both legs and 1200 ml. whole blood was transfused. These grafts "took" well. Thereafter, dressings /

dressings were continued at two to three day intervals until the sixty-first day, when razor grafts were applied to the remaining raw areas on the right leg, and a further 1800 ml. whole blood was transfused. There was an excellent "take" of these grafts and dressings were continued in the ward from this point onwards. Gradually increasing physiotherapy was continued from the eighty-fourth day, when only very small areas remained unhealed. Healing was complete on the one hundred and thirty-seventh day, and he was discharged on the one hundred fifty-first day.

Estimated Requirement

WEIGHT : 58.9 Kg.

PROTEIN : 1.5 g./Kg = 1.5 x 58.9 = 88 g.

CALORIES : 45/Kg. = 45 x 58.9 = 2650.

Oral supplementation of the ward diet was commenced on the fourth day post burn.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Complan	100	31.0	16.0	42.0
	Whole Milk	450	14.8	16.6	21.6
Feed 2					
	Casilan	35	31.5	0.3	0.3
	Glucose	35	-	-	35.0
	Lactose	20	-	-	20.0
	Whole Milk	420	12.6	15.4	19.6
	Fat Emulsion	150	-	75.0	-
Feed 3					
	Casilan	35	31.5	0.3	0.3
	Glucose	35	-	-	35.0
	Lactose	20	-	-	20.0
	Evaporated Milk	200	15.2	16.8	24.6
	Whole Milk	420	13.9	15.5	20.2
			150.5	155.8	238.0

Protein 149 g.
Calories 2952.

On the forty-third day, Feed 2 was discontinued and the following feed added.

Feed 4	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Fat Emulsion	175	-	87.5	-
	Concentrated Fruit Juice	75	-	-	7.5
	Glucose	25	-	-	25.0
			-	87.5	32.5

This /

This, with Feed 1 and 3, gave a total supplement of:-

Protein 105 g.: Fat 153 g.: Carbohydrate 196 g.: Calories 2581.

On the fifty-fifth day, Feed 3 was omitted and Feed 4 doubled. This gave a total supplement of :-

Protein 46 g.: Fat 208 g.: Carbohydrate 129 g.: Calories 2572.

On the eighty-seventh day, Feed 4 was reduced to the initial quantity, the supplements then providing :-

Protein 46 g.: Fat 120 g.: Carbohydrate 96 g.: Calories 1648.

On the ninety-fifth day, all supplementation was discontinued.

Mild diarrhoea occurred on the eleventh day, but was readily controlled with chalk and opium mixture (N.F.) fluid ounce ½ three times daily. There was no other evidence of intolerance.

Comment (Table 23)

Weight gain occurred during Week one. Weight loss then continued until the end of Week six, with the severest drop between Weeks one and three. The total weight loss was 8.1 Kg., a percentage loss of 13.6. The weight remained almost static until the end of Week nine, followed by a slow and then a rapid gain. The severe weight loss occurred over a period of high intake of both protein and calories.

The protein intake was at, or above, estimated requirement except during Weeks one, nine, and ten, as were the calories except during Weeks one and eight. Between Weeks two and six, there was a marked excess of both protein and calories. This higher intake was attempted deliberately because of the depth of the burns and the age of the patient.

Case 16.- This man, aged thirty-five, was injured in a pit explosion. The burns involved the face, trunk, and upper limbs, the /

the total area being 3o per cent.

He was admitted about two hours after injury. He was not shocked and despite the extent of the burn he did not require intravenous resuscitation. He was given oral electrolyte solution and during the following forty-eight hours received in all 1000 ml. Ringer lactate solution. This was given diluted to half strength with fruit juice. Cleansing and dressing, without anaesthesia, of all areas except the face was carried out on the second day post burn. The face was exposed. Dressing, under anaesthesia was repeated on the fourth and eighth days, at which time the arms were healed. Further dressings, under anaesthesia, on the eleventh and fifteenth days showed further healing, leaving only the dorsum of both hands still to heal. Healing was complete on the twenty-first day and he was discharged on the thirty-third day.

Estimated Requirement

WEIGHT : 73.9 Kg.

PROTEIN : 2.5 g./Kg. = 2.5 x 73.9 = 185 g.

CALORIES : 55/Kg. = 55 x 73.9 = 4065.

Oral supplementation of the ward diet was commenced on the third day post burn.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	15	13.5	0.1	0.1
	Whole Milk	300	9.9	11.1	14.4
Feed 2					
	Casilan	30	27.0	0.3	0.3
	Glucose	20	-	-	20.0
	Lactose	15	-	-	15.0
	Whole Milk	420	12.6	15.4	19.6
	Evaporated Milk	100	7.6	8.4	12.3
	Fat Emulsion	70	-	35.0	-
			70.6	70.3	81.7

Protein 71 g.
Calories 1242.

Oral intake of ward diet was not satisfactory and on the eleventh day a further supplement was added.

Feed 3	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Fat Emulsion	90	-	45.0	-
	Concentrated Fruit Juice	40	-	-	4.0
	Glucose	10	-	-	10.0
			-	45.0	14.0

Protein /

Protein -
Calories 461.

This gave a total intake provided by the supplements of:

Protein 71 g.; Fat 115 g.; Carbohydrate 96 g.;
Calories 1703.

This supplementation was continued until discharge.

Comment (Table 24)

Weight loss continued until the end of Week three. The total weight loss was 3.7 Kg., a percentage loss of 5.0. Weight gain occurred at Week four.

Both the protein and calorie intake failed to reach the estimated requirement throughout.

Case 17.- This man, aged thirty-one, was injured in a fire damp explosion. He sustained burns of head and neck, arms and posterior trunk, the total area being 30 per cent of the total body surface.

He was admitted two and a half hours after injury and showed evidence of shock. During the ensuing forty-eight hours, intravenous resuscitation was required. In that time he received:

Plasma - 4000 ml.
Whole Blood - 1800 ml.
Oral water and 5 per cent glucose - 2500 ml.

On the second day, under general anaesthesia, all areas were cleansed and dressings applied. The face was exposed.

Dressings, under anaesthesia, were repeated on the eigh th and seventeenth days, dressing having been done, without anaesthesia, on the fourteenth day. Ward dressings were continued and the back was healed on the twenty-second day. On the twenty-ninth day, razor grafts were applied to the arms, with a good "take", and further razor grafts were applied on the thirty-sixth day. Again, there was a good "take", leaving only small areas to heal. A final small graft was applied to the only remaining raw area on the right upper arm on the sixtieth day.

Thereafter progress was uninterrupted and he was discharged, after intensive physiotherapy, on the ninety-eighth day.

Estimated Requirement

WEIGHT : 60.0 Kg.

PROTEIN : 2.5 g./Kg. = 2.5 x 60 = 150.0 g.

CALORIES /

CALORIES : 55/Kg. = 55 x 60 = 3300.

Oral supplementation to the ward diet was commenced on the fifth day post burn, and continued until the fifty-first day.

	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Feed 1	Complan	200	62.0	32.0	84.0
	Water	400	-	-	-
Feed 2	Casilan	20	18.0	0.2	0.2
	Glucose	20	-	-	20.0
	Lactose	20	-	-	20.0
	Milk	210	6.9	7.7	10.0
	Fat Emulsion	90	-	45.0	-
Feed 3	Fat Emulsion	175	-	87.5	-
	Concentrated Fruit Juice	75	-	-	7.5
	Glucose	25	-	-	25.0
	Water	50	-	-	-
			86.9	172.4	166.7

Protein 87 g.
Calories 2564.

All supplementation was discontinued on the fifty-first day.

Comment (Table 25)

Marked weight gain occurred during Week one. Weight fell until the end of Week two. The total weight loss was 2.3 Kg., a percentage loss of 3.8. Weight then remained almost static until the end of Week four, after which weight gain was rapid.

The protein intake reached estimated requirement at Weeks three and four, and was otherwise just below, except at Week seven. The calories were above throughout. A drop in both protein and calories at Week seven did not interfere with continuing weight gain.

Discussion

(Chart 9)

The most striking observation in this group was the great variation in the weight pattern, from Case 14 with no loss throughout to Case 15 showing a loss of 13.6 per cent of his total body weight. Case 14 /

14, however, was probably more comparable to the patients in Group 1, as his extent of injury was the smallest and, in addition, the burns were superficial. In view of the rather unusual weight picture, which he presented, the study was continued for a longer time than is usually possible in this degree of injury, in order to ensure that the weight trend was not reversed later. It was possible that there might have been previous depletion, which a weight curve of this type would suggest, but the history revealed nothing to substantiate this. He was, in fact, a healthy young man, the very type of patient in whom a near maximal response to injury and its associated weight loss might have been expected. On the other hand, his intake was at or above the estimated requirement throughout, the calories being 10-20/Kg. in excess, and the protein also being in excess except during Weeks one and two. Of further interest is the observation that the rapid weight gain continued in Week eight when the protein and calorie intake, while still above requirement level, had fallen considerably. The weight, prior to this time, was apparently sensitive to intake, a fall at Week six being associated with slight fall in weight. Readjustment obviously occurred, for with similar levels at Week seven weight gain was rapid.

The other extreme is shown in Case 15, who had an infinitely greater weight loss than any other case in this group, despite an intake over the period of maximum weight loss far in excess of estimated requirement. The onset of weight gain was also delayed, but this may be due to a fall in intake at this time, the calories especially being very low at Week eight, due mainly to the effects of grafting and subsequent dressings under anaesthesia. However, weight gain once established was rapid and maintained despite a slight /

slight reduction in intake at Week thirteen.

Almost the whole of this patient's injury was full thickness burn, and, further, the late adolescent (this patient was aged nineteen) is known to have the most severe response to injury. Both these factors probably contributed to the magnitude of the weight loss, although allowance was made for this by supplying supplements, which, in themselves, exceeded estimated requirement. Little evidence of weight gain occurred before skin grafting was completed.

The possible effect on weight of a large area of full thickness skin loss may well be demonstrated by comparing Case 15 with Case 16 and 17.

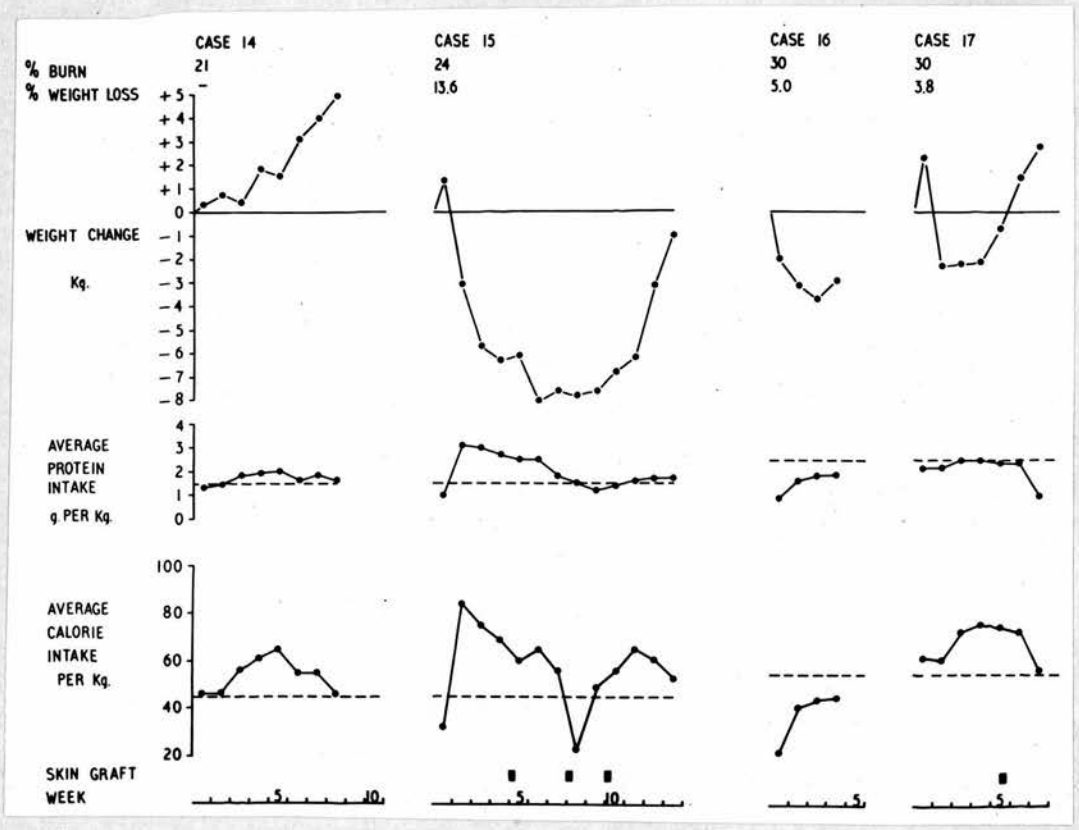
Although the total extent of injury in Case 17 was greater, there was a much smaller area of full thickness skin loss. Because of the greater extent of his injury, however, estimated requirement was set higher and virtually achieved throughout, the calories being in excess of requirement. Weight loss was minimal at 3.8 per cent of the total body weight, although definite weight gain did not occur until after the grafting procedure.

Case 16, on the other hand, had again a more extensive injury than Case 15, but the injuries were completely superficial and healed rapidly without grafting. Weight loss was only about 5 per cent of his total body weight despite an intake of protein and calories below requirement throughout. The weight pattern is reminiscent of the smaller superficial injuries.

The weight gain at Week one, as in Case 15 and 17, was noted fairly frequently in patients with more severe injury and was certainly associated with a rapid fall at Week two. It was almost certainly /

certainly due to changes in fluid, being most obvious in those requiring vigorous resuscitation on admission. These were the patients, who subsequently developed marked oedema during Week one, and who showed thereafter an increased urinary output as the oedema subsided.

CHART 9



Case 14, 15, 16, 17.- To show change in body weight and average levels of intake achieved. The interrupted line in the intake graphs shows the level of the estimated requirement.

ADULTS - GROUP 3

31-40 per cent Body Surface Involved

Case 18.- This man, aged thirty-two, was burned, when a container of molten lead broke, spilling the lead over him and setting fire to his clothes. The burns involved both legs, forearms, and face, totalling 32 per cent of the body surface.

He was admitted to hospital elsewhere in good general condition half an hour after the accident.

Intravenous therapy was instituted and continued over the next forty-eight hours.

Plasma - 3620 ml.
5 per cent glucose and oral fluids - 4500 ml.

Later, on the day of admission, under general anaesthesia, the burns were cleansed, the face exposed, and all other areas dressed.

He was transferred on the third day post burn.

Dressing and removal of loose slough was carried out on the seventh, twelfth, and eighteenth days, at which time the face was healed and the hands nearly so. Dressings were repeated on the twenty-first and twenty-fifth days. Razor grafts were applied to the right leg on the twenty-eighth and thirty-third day, the left leg being rather infected at this point with profuse exudate. The grafts on the right leg "took" well and on the fortieth day, razor grafts were applied to the left leg with resultant good "take".

Dressings were continued twice weekly and on the fifty-sixth day, razor grafts were applied to the remaining raw areas of the left thigh. The right leg was completely healed. Again, a good "take" of grafts resulted and by the sixty-seventh day all areas were virtually healed.

After intensive physiotherapy, he was discharged on the seventy-eighth day.

Estimated Requirement

WEIGHT : 51.4 Kg.

PROTEIN : 2.5 g./Kg. = 2.5 x 51.4 = 128.5 g.

CALORIES : 55/Kg. = 55 x 51.4 = 2827

Oral supplementation of the ward diet was commenced on the fifth day post burn.

Feed /

Feed 1	Constituent	Amount g.or. ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	40	36.0	0.4	0.4
	Whole Milk	600	19.8	22.2	28.8.
Feed 2					
	Casilan	35	31.5	0.3	0.3
	Glucose	35	-	-	35.0
	Lactose	20	-	-	20.0
	Whole Milk	420	13.9	15.5	20.2
	Fat Emulsion	90	-	45.0	-
			101.2	83.4	104.7

Protein 101 g.
Calories 1571.

Feed 1 was accepted well, but Feed 2 was generally only taken in part and usually about 450 ml. As intake on this regime was tending to fall short of requirement, Feed 3 was introduced on Day nineteen and was accepted well, Feed 2 being discontinued.

Feed 3	Constituent	Amount g. or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	35	31.5	0.3	0.3
	Glucose	35	-	-	35.0
	Lactose	20	-	-	20.0
	Whole Milk	420	13.9	15.5	20.2
	Evaporated Milk	200	15.2	15.8	24.6
			60.6	31.6	100.1

This feed given along with Feed 1 gave :-

Protein 116 g.; Fat 54 g.; Carbohydrate 129 g.;
Calories 1466.

provided by oral supplement.

On Day fifty-five, Feed 1 was discontinued, giving a supplementary intake of :-

Protein 61 g.; Fat 32 g. ; Carbohydrate 100 g.;
Calories 1032.

Feed 3 was discontinued on the sixtieth day.

Comment (Table 26)

Weight gain occurred at Week one. Weight then fell until the end of Week four. The total weight loss was 4.0 Kg., a percentage loss of 7.8. Rapid weight gain followed, levelling off as intake fell /

fell in Week nine.

The protein intake was at or above the estimated requirement except during Week one and nine. It almost reached the level during Week four. The calories were just below the required level except during Week six and seven, when they were 10/Kg. in excess.

Case 19.- This man, aged thirty, was injured in a pit explosion. The burns involved the face, trunk and upper limbs, the total area being 33 per cent of the total body surface. He was admitted some two hours after injury. Initially, resuscitation was attempted with oral electrolyte solution, but he showed signs of mild shock six hours after injury and intravenous therapy was instituted. During the forty-eight hours after injury he received :-

Plasma - 1500 ml.
Ringer Lactate solution - 1400 ml., of which 800 ml. was given in half strength solution orally.

The areas were cleansed and dressed, under analgesia, on the second day post burn, the face being exposed.

Theatre dressing, under anaesthesia, was carried out on the fourth, eighth, eleventh, fifteenth, and eighteenth day, at which time the only remaining raw areas were on the upper arms and were small. Razor grafts were applied to these areas on the twenty-second day with excellent "take", and he was discharged on the thirty-sixth day.

Estimated Requirement

WEIGHT : 62.0 Kg.

PROTEIN : 2.5 g./Kg. = 2.5 x 62 = 155 g.

CALORIES : 55/Kg. = 55 x 62 = 3410.

Oral supplementation of ward diet was commenced on the third day post-burn.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	15	13.5	0.1	0.1
	Whole Milk	300	9.9	11.1	14.4
Feed 2					
	Whole Milk	420	13.9	15.5	20.2
	Evaporated Milk	100	7.6	8.4	12.3
	Fat Emulsion	70	-	35.0	-
	Casilan	30	27.0	0.3	0.3
	Lactose	15	-	-	15.0
	Glucose	20	-	-	20.0
			71.9	70.4	82.3

Protein /

Protein 72 g.
Calories 1246.

On the tenth day post burn an extra feed was added.

Feed 3	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Fat Emulsion	175	-	87.5	-
	Concentrated Fruit Juice	75	-	-	7.5
	Glucose	25	-	-	25.0
			-	87.5	32.5

The total amount provided by the supplement was then :-

Protein 71 g.; Fat 159 g.; Carbohydrate 114 g.;
Calories 2171.

These supplements were continued until discharge.

Comment (Table 27)

Weight fell until the end of Week three, the most severe loss occurring between Week one and two. The total weight loss was 5.9 Kg., a percentage loss of 9.5. Rapid weight gain followed.

The protein intake failed to reach the estimated requirement except at Week five, and the calories at Week four and five only.

Case 20.- This man, aged forty-three, a male mental nurse, was injured when a patient threw a lighted match into a tin of floor polish and, in attempting to extinguish the flames, his clothing caught fire. The burns involved the head, neck, anterior trunk, left arm, and both legs. The total area was 33 per cent of the total body surface.

He was admitted within one hour of injury to a hospital elsewhere, by which time he showed evidence of shock. Intravenous therapy was instituted and over the forty-eight hour period he received :-

Plasma - 3000 ml.
Whole Blood - 600 ml.
Normal Saline - 3000 ml.
Oral water and 5 per cent glucose - 2500 ml.

On the second day, under analgesia, the areas were cleansed, the head, neck, and anterior trunk being exposed, and the remainder dressed /

dressed. He was transferred on the seventh day after injury. On admission, he appeared toxic, and was running a temperature of 103-104°F. (39.4-40°C.). On the eighth day, under anaesthesia, the dressings were removed. All areas appeared grossly infected. All except the face were redressed.

On the twelfth and sixteenth day, under anaesthesia, the loose slough was removed. The areas remained heavily infected, he continued to run a high fever, and his general condition was very poor.

Theatre dressing on the twentieth day showed the surface to be much improved, and there was marked general improvement with the fever beginning to abate - 100-101°F. (37.8 - 38.3° C.). Further dressing on the twenty-fourth day showed continued improvement and on the twenty-ninth day, electric dermatome grafts were applied to the right leg. All areas now showed a healthy granulating surface. The grafts "took" well, and on the thirty-sixth day, electric dermatome grafts were applied to the left leg again with a good "take".

On the fortieth day, he developed consolidation of the left lower lobe, but his general condition remained satisfactory, and this resolved slowly with penicillin therapy.

Dressing on the forty-third day showed the right leg to be healed, and the donor areas of the twenty-ninth day were also healed. Further razor grafts were applied to the remaining raw areas on the left leg. There was an excellent "take" of these grafts.

On the fifty-fourth day, razor grafts were applied to the left arm and to the anterior chest, again with an excellent "take" of grafts.

Thereafter, progress was rapid and after a course of intensive physiotherapy he was discharged on the ninetieth day.

Estimated Requirement

WEIGHT : 68.5 Kg.

PROTEIN : 2.5g./Kg. = 2.5 x 68.5 = 171 g.

CALORIES : 55/Kg. = 55 x 68.5 = 3768.

Oral supplementary feeding was introduced on the eighth day post burn.

Feed /

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Complan	100	31.0	16.0	42.0
	Whole Milk	450	14.8	16.6	21.6
Feed 2					
	Casilan	35	31.5	0.3	0.3
	Glucose	35	-	-	35.0
	Lactose	20	-	-	20.0
	Evaporated Milk	200	15.2	16.8	24.6
	Whole Milk	420	13.9	15.5	20.2
Feed 3					
	Fat Emulsion	175	-	87.5	-
	Concentrated Fruit Juice	75	-	-	7.5
	Glucose	25	-	-	25.0
			106.4	152.7	196.2

Protein 106 g.
Calories 2585.

On day twelve, Feeds 1 and 2 were discontinued, because the patient found them too sweet, and Feed 4 commenced.

Feed 4	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Complan	400	124.0	64.0	168.0
	Water	800	-	-	-
			124.0	64.0	168.0

This, with Feed 3, gave a total of :-

Protein 124 g.: Fat 152 g.: Carbohydrate 201 g.:
Calories 2668.

On day twenty-seven, at the patient's request to be given the original feed, Feed 4 was halved and Feed 2 reintroduced. The supplements provided then :-

Protein 121 g.: Fat 152 g.: Carbohydrate 216 g.:
Calories 2716.

This regime was continued until day fifty-five, when Feed 4 was discontinued. The intake by supplement was then :-

Protein 59 g.: Fat 120 g.: Carbohydrate 132 g.:
Calories 1844.

On day sixty-one, Feed 2 was discontinued, giving an intake of :-

Protein /

Protein -; Fat 88 g. ; Carbohydrate 33 g. ;
Calories 924.

All supplementary feeding was discontinued on Day sixty-nine.

Comment (Table 28)

A weight was not obtained during Week one, but the patient was a male nurse, who knew his pre-burn weight accurately. The weight at the end of Week two was slightly above this pre-burn level. Thereafter the weight fell rapidly until the end of Week six, the most severe drop occurring between Week two and four. The total weight loss was 7.2 Kg., a percentage loss of 8.1. There then followed immediate, rapid weight gain.

The protein intake reached the estimated requirement only at Week four and ten, but was just below otherwise, except at Week two. The calories were above requirement at Weeks three, four, five, six, and seven, and below at Weeks two, eight, nine and ten.

Case 21.- This man, aged twenty-five, was injured in a pit explosion. The burns involved the face, neck, anterior and posterior trunk, and arms. The total area was 36 per cent of the total body surface.

He was admitted in moderate shock about two hours after injury. Intravenous therapy was continued over forty-eight hours and consisted of:-

Plasma - 1800 ml.
Ringer lactate - 1200 ml.

In addition, oral electrolyte solution was given in the form of Ringer lactate diluted to half strength in fruit juice. This provided an additional 2100 ml. Ringer lactate. 300 ml. plain water was given over this forty-eight hour period.

Cleansing and dressing of the areas was carried out, under analgesia on the second day post burn, the face being left exposed.

Theatre dressings, under anaesthesia, were repeated on the fourth, eighth, twelfth, and eighteenth day, at which time the dermal slough had largely separated. His general condition throughout this period was excellent.

On /

On the twenty-fifth day, razor grafts were applied to the left hand and right arm with a resultant fair "take". Dressings were continued twice weekly and on the fortieth day, dermatome grafts were applied to both upper arms and both forearms, again with only fair "take". Dressings were again continued until the fifty-sixth day, when dermatome grafts were applied to the left shoulder area and the remaining raw areas on the arms.

These grafts "took" well and physiotherapy was started on the seventieth day, at which time all areas were healed. He was discharged on the ninety-eighth day.

Estimated Requirement

WEIGHT : 80.1 Kg.

PROTEIN : 3 g./Kg. = 3 x 80.1 = 240 g.

CALORIES : 60/Kg. = 60 x 80.1 = 4806.

Oral supplementation of the ward diet was commenced on Day three.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	15	13.5	0.1	0.1
	Whole Milk	300	9.9	11.1	14.4
Feed 2					
	Casilan	35	31.5	0.3	0.3
	Glucose	35	-	-	35.0
	Lactose	20	-	-	20.0
	Fat Emulsion	175	-	87.5	-
	Whole Milk	420	12.6	15.4	19.6
			67.5	114.4	89.4

Protein 68 g.
Calories 1654

The patient tolerated the supplements well, but took very little solid food, and refused further supplement of a similar type to Feed 1 and 2. As he was drinking fairly large amounts of milk, it was felt that the lack would be rather one of calories, and a further feed was introduced on Day eleven.

Feed 3	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Fat emulsion	175	-	87.5	-
	Concentrated Fruit Juice	75	-	-	7.5
	Water	50	-	-	-
	Glucose	25	-	-	25.0
			-	87.5	32.5

This /

This feed was introduced gradually in view of the amount of fat already being given, and the introduction was comleted on the seventeenth day, bringing the totals to:-

Protein 67.5 g.: Fat 201.9 g.; Carbohydrate 1224 g.;

The three supplements, therefore, provided 2658 calories.

This regime was continued until day thirty-nine when, in view of the persistent inadequate protein intake, the disappointing "take" of grafted skin, and the need for further grafting, Feed 1 was doubled. This increased the protein provided to 91 g. and the calories to 2825, but there was a voluntary reduction of solid food, so that little increase in intake resulted.

This was continued until Day sixty-six, when healing was well advanced. At this point, Feed 3 was omitted, and on Day seventy-five supplementation was discontinued altogether.

Comment (Table 29)

Weight fell until the end of Week five, although a slight gain was recorded at Week three. The severest drop occurred between Week one and two. The total weight loss was 7.1 Kg., a percentage loss of 8.9. Weight remained static at Week six, a slow rise followed at Week seven, and thereafter rapid gain took place.

The protein and calorie intake did not reach estimated requirement throughout, the protein being almost consistently 1 g./Kg. less, and the calories 10-15/Kg. less.

In view of the extent of his injuries and the difficulty with intake, this patient should probably have been tube fed.

Case 22.- This man, aged forty, was injured in a "flash" explosion in a pit.

The burns involved the head and neck, anterior chest, posterior trunk, upper arms, forearms, and hands, totalling 36 per cent of the body surface. In addition, there was a fracture of the 10th rib on the right side.

He was admitted some three hours after injury and showed evidence of moderate shock. Intravenous therapy was continued for forty-eight hours, during which time the following fluids were infused :-

Plasma /

Plasma - 2500 ml.
Whole Blood - 1200 ml.
Normal Saline - 2000 ml.
5 per cent Glucose - 2000 ml.

On the second day post burn, under analgesia, the areas were cleansed and dressed, except the face, which was exposed.

On the eighth day, under anaesthesia, the areas were re-dressed. There was some oedema and mild infection present.

Dressing, under anaesthesia, was repeated on the sixteenth, twenty-third, and thirtieth day, at which time only small areas remained unhealed. These areas were not considered large enough for grafting, but were slow to heal. Healing was complete on the sixty-fourth day, and he was discharged on the seventy-fifth day.

Despite frequent blood transfusion and oral iron, it was found extremely difficult to maintain his haemoglobin at satisfactory levels. It remained around 12.5 g. per cent until the fortieth day, and then slowly rose and was 14.0 g. per cent on the sixtieth day.

Estimated Requirement

WEIGHT : 67.6 Kg.

PROTEIN : 3 g./Kg. = 3 x 67.6 = 203 g.

CALORIES : 60/Kg. = 60 x 67.6 = 4056.

Oral supplementation to the ward diet was commenced on day three.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	30	27.0	0.3	0.3
	Whole Milk	600	19.8	22.2	28.8
Feed 2					
	Casilan	35	31.5	0.3	0.3
	Glucose	35	-	-	35.0
	Lactose	20	-	-	20.0
	Fat Emulsion	175	-	87.5	-
	Whole Milk	420	12.6	15.4	19.6
			90.9	125.7	104.0

Protein 91 g.
Calories 1914

The feeds were not accepted well. There was no specific complaint and no evidence of any intolerance. From Day eleven onwards, he refused Feed 2 altogether and although various other types of supplement were offered and every encouragement given by the nursing staff, he still refused all but Feed 1. At this point /

point, it was apparent that the burns were superficial and were unlikely to require grafting. Accordingly, ward diet was forced to the extreme and Feed 1 continued. Because of the continuing unsatisfactory intake and refusal of Feed 1 and weight loss, a further feed was introduced on Day thirty-six and continued until Day fifty-six. It was accepted well on occasion, but not consistently.

Feed 3	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Complan	100	31.0	16.0	42.0
	Whole Milk	450	14.8	16.6	21.6
			45.8	32.6	63.6

Protein 46 g.
Calories 737.

Comment (Table 30)

Slight weight gain occurred at Week one. Thereafter weight fell rapidly until the end of Week four, the severest loss being between Week one and three. The total weight lost was 9.2 Kg., a percentage loss of 14.2. Thereafter weight gain was rapid, but tended to level out after Week six.

The protein intake was around 1.5 g./Kg less, and the calories 20-25/Kg. less than the estimated requirement.

Case 23.- This woman, aged twenty-two, sustained burns when her dress caught fire. The burns involved the neck, anterior and posterior trunk, and left thigh, the total area being 38 per cent of the body surface.

She was admitted to hospital elsewhere in moderate shock and intravenous therapy was instituted. She was transferred on the second day. Intravenous therapy was continued over the forty-eight hour period.

Plasma - 2500 ml.
Whole Blood - 1200 ml.
Hartmann's solution - 2000 ml.
Oral water - 2000 ml.

The burns were cleansed and dressed, under analgesia, prior to transfer.

Her general condition was satisfactory during the first week after injury.

Dressing /

Dressing, under anaesthesia, was carried out on the seventh day. The burns of the arms were deep, and it was decided that these should be excised. This was done on the tenth day and the areas grafted on the sixteenth day. On the nineteenth day, razor grafts were applied to the axillae and anterior chest, and all these grafts "took" well.

Dressings, under anaesthesia, were continued twice weekly and on the thirty-third day further razor grafts were applied to the anterior chest. These also "took" well, and again dressings were repeated twice weekly, under anaesthesia, until the fifty-eighth day. At this time, both arms were healed. Razor grafts were applied to the posterior chest wall with good "take" of the grafts.

Twice weekly dressings, under anaesthesia, were continued and by the seventy-ninth day there remained only small patchy, unhealed areas on the back, right axilla, and anterior chest wall.

On the eighty-ninth day, she complained of some central abdominal pain, but this settled. It recurred on the ninety-third day, associated with vomiting, and a diagnosis of acute appendicitis was made. At operation, an acutely inflamed, gangrenous appendix was removed. She made an uninterrupted recovery.

On the one hundred and second day, the remaining small raw areas in the right axilla were grafted.

Thereafter, recovery was fairly rapid and she was discharged on the one hundred and fiftieth day, at which time all areas were soundly healed.

Estimated Requirement

WEIGHT : 56.1 Kg.

PROTEIN : 3 g./Kg. = 3 x 56.1 = 168 g.

CALORIES : 60/Kg. = 60 x 56.1 = 3366.

Oral supplementation of ward diet was commenced on the fourth day.

Feed /

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	30	27.0	0.3	0.3
	Whole Milk	600	19.8	22.2	28.8
Feed 2					
	Casilan	25	22.5	0.2	0.2
	Glucose	15	-	-	15.0
	Chocolate Powder	15	3.2	0.9	9.9
	Fat Emulsion	50	-	25.0	-
	Evaporated Milk	75	5.7	6.3	9.2
	Whole Milk	360	11.9	13.3	17.3
			90.1	68.2	80.7

Protein 90 g.
Calories 1296

This was accepted well, but it was evident that further oral supplement would be refused. Tube feeding was begun on the seventh day.

Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Hepovite	100	50.0	-	38.0
Casydrol	100	50.0	-	50.0
Dextrimaltose	50	-	-	48.5
Evaporated Milk	400	30.4	33.6	49.2
Fat Emulsion	100	-	50.0	-
Water to	1200	-	-	-
		130.4	83.6	185.7

Protein 130 g.
Calories 2020.

Vitamins and iron added in amounts shown in Table 14
Ascorbic acid given as a single daily dose.

Six feeds of 200 ml. were given at 6 a.m., 10 a.m., 2 p.m., 6 p.m., 10 p.m., and 2 a.m.

The nasogastric tube was not tolerated well and this gave rise to some difficulties during the seventh to tenth days. The feed itself, however, was tolerated well, and by the tenth day, no further trouble was encountered in the tolerance of the nasogastric tube.

Increments to the tube feed were made as follows ;-

Day 16 - Fat emulsion increased to 150 ml. Water increased to 2000 ml.
Food value - Protein 130 g.: Calories 2155.

Five /

Five feeds of 400 ml. were given at 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m.

Day 24 - Fat emulsion increased to 200 ml.
Protein 130 g.: Calories 2470.
Volume as before.

Day 30 - Fat emulsion increased to 250 ml.
Protein 130 g.: Calories 2695

Day 37 - Fat emulsion increased to 300 ml.
Protein 130 g.: Calories 2920.

Day 49 - Fat emulsion increased to 350 ml.
Protein 130 g.: Calories 3145.

On Day fifty-nine, an attempt was made to replace the fat of the fat emulsion with isocaloric amounts of olive oil, but vomiting commenced almost immediately and the attempts were abandoned on Day sixty-five, and the feed, as given on Day forty-nine, reintroduced.

On Day sixty-eight, the nasogastric tube was withdrawn and oral supplement introduced.

Feed 3 Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Casilan	30	27.0	0.3	0.3
Glucose	20	-	-	20.0
Lactose	15	-	-	15.0
Whole Milk	420	12.6	15.4	19.6
Evaporated Milk	100	7.6	8.4	12.3
Fat Emulsion	70	-	35.0	-
		47.2	59.1	67.2

Protein 47 g.
Calories 987.

This was continued, apart from the period covering the appendicectomy, until the one hundred and second day.

Comment (Table 31)

This patient was the only female included in the series. Weight gain was marked at the end of Week one. Thereafter, weight loss continued until the end of Week four. The total weight lost was 4.7 Kg., a percentage loss of 8.4. The severest drop occurred between Week one and two. Weight remained static at Week five, rapid gain occurred at Week six and seven, remaining static until Week twelve, when further gain took place.

The /

The protein intake was 1-1.5 g./Kg. less than the estimated requirement throughout and the calories reached the level only at Week eight.

It would appear that pure oil (olive oil) is not tolerated as a source of fat, in amounts comparable to isocaloric amounts of fat emulsion.

Case 24.- This man, aged forty, sustained burns when a furnace "blew back" in a foundry and ignited his clothing. The burns involved the face, arms, and legs, the total being 39 per cent of the body surface.

He was admitted to hospital within one hour of his injury in a state of moderate shock. Intravenous therapy was instituted and continued for forty-eight hours.

Plasma - 7000 ml.
Whole Blood - 1500 ml.
Normal Saline - 500 ml.
5 per cent Glucose - 1500 ml.
Water by mouth - 610 ml.

His condition was satisfactory throughout this period and on the second day, under anaesthesia, the burns were cleansed and dressed, except the face, which was exposed.

Thereafter, dressings were changed, under anaesthesia, twice weekly until the twenty-ninth day, when the remaining slough was removed from both legs. Twice weekly dressings, under anaesthesia, were carried out until the forty-seventh day, when electric dermatome grafts were applied to both lower legs with a good "take" resulting. On the fifty-fourth day, electric dermatome grafts were applied to the right anterior thigh and right forearm, and on the sixty-first day to remaining areas on the right posterior thigh. Again, a good "take" was observed, the only area remaining uncovered being a small area on the anterior aspect of the right lower leg, where the burn involved bone, the anterioraspect of the tibia being exposed. Physiotherapy was commenced on the seventieth day. A sequestrum formed in the right tibia and sequestrectomy was performed on the one hundred and twenty-fifth day and the area grafted. Thereafter, progress was uninterrupted and he was discharged on the one hundred and fifty-fifth day.

Estimated Requirement

WEIGHT : 59.0 Kg.

PROTEIN : 3 g./Kg. = 3 x 59 = 177 g.

CALORIES : 60/Kg. = 60 x 59 = 3540.

A /

A nasogastric tube was passed on Day four, and tube feeding commenced on Day six.

Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Complan	200	62.0	32.0	84.0
Casydrol	100	50.0	-	50.0
Hepovite	80	40.0	-	30.4
Evaporated Milk	400	30.4	33.6	49.2
Glucose	100	-	-	100.0
Fat Emulsion	350	-	175.0	-
Water to	2500	-	-	-
		182.4	240.6	313.6

Protein 182 g.
Calories 4153.

Vitamins and iron in amounts shown in Table 14, with the Ascorbic acid given as a single dose.

Five feeds of 500 ml. were given at 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m.

There was an episode of diarrhoea on the eighteenth and nineteenth days, which was controlled readily with chalk and opium (N.F.) ½ fluid ounce three times daily, and thereafter, no intolerance was noted.

The patient was eating well in addition and on Day twenty-eight, the tube feed was reduced.

Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Casydrol	160	80.0	-	80.0
Hepovite	80	40.0	-	30.4
Evaporated Milk	400	30.4	33.6	49.2
Glucose	100	-	-	100.0
Fat Emulsion	350	-	175.0	-
Water to	2500	-	-	-
		150.4	208.6	259.6

Protein 150 g.
Calories 3521 .

Vitamins and iron as in previous feed.

Five feeds of 500 ml. were given at 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m.

Because of the satisfactory oral intake and the cooperation of the patient, tube feeding was discontinued on the thirty-third day, and oral supplements given.

Feed /

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	15	13.5	0.1	0.1
	Whole Milk	300	9.9	11.1	14.4
Feed 2					
	Complan	200	62.0	32.0	84.0
	Fat Emulsion	100	-	50.0	-
	Water	300	-	-	-
Feed 3					
	Fat Emulsion	175	-	87.5	-
	Concentrated Fruit Juice	75	-	-	7.5
	Glucose	25	-	-	25.0
Feed 4					
	Complan	200	62.0	32.0	84.0
	Water	400	-	-	-
			147.4	212.7	215.0

Protein 147 g.
Calories 3365.

This regime was continued until Day fifty-five. Feed 2 and Feed 3 were discontinued and Feed 1 doubled, and Feed 5 commenced.

Feed 5	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Complan	100	31.0	16.0	42.0
	Fat Emulsion	100	-	50.0	-
	Water to	450	-	-	-
			31.0	66.0	42.0

Protein 31 g.
Calories 886.

This gave a total intake by supplement of 140 g. Protein and 2269 calories.

On Day sixty-four, Feed 4 was discontinued, the supplements then providing 78 g. Protein and 1397 Calories.

On Day eighty, all supplementary feeding was discontinued.

Comment (Table 32)

Marked weight gain was evident at the end of Week one. Weight then continued to fall until the end of Week three, when it appeared to have been arrested, but fell again to reach its lowest point at the /

the end of Week six. The severest loss occurred between Week one and two. The total weight loss was 3.9 Kg., a percent age loss of 6.8. Thereafter, weight gain was rapid, with a minor interruption at Week nine.

The protein and calorie intake was at or above estimated requirement until Week eight, when both fell below and continued at the lower level.

The arrest in weight gain at Week nine occurred at the same time as the fall in calorie intake, but during the rapid gain, which followed both protein and calories were below requirement level.

Discussion

(Chart 10 and 11)

The weight loss in all cases in this group, except for Case 22, was of similar magnitude -7.5-9.5 per cent of the total body weight. In all but Case 19 and 21, initial weight gain was again evident and the drop in Case 21 in Week one was small compared to the usual magnitude seen once weight loss became evident, and the ensuing loss was intense.

The duration of weight loss was variable and may well be related to the levels of intake achieved. In none did it last for less than three weeks, and in those wherethe third week marked its end, the estimated requirement was reached, or nearly so - Case 18 and 19. Case 19, while an extensive injury, had a very small area of full thickness skin loss requiring one minor grafting procedure only, and healing was completed early. Otherwise, the areas of full thickness loss were comparable. Again, little weight gain was observed until a major part of the granulating area was grafted. In those with larger areas of skin loss, in whom weight gain was delayed, the

estimated /

estimated requirement of both protein and calories was not reached - Case 21 and 23 - or grafting was delayed - Case 24.

Once weight gain was established, it continued rapidly despite intakes less than the estimated requirement - Case 20, 21, and 24. In Case 24, a drop in intake at Week nine was associated with slight weight loss, but continued rapidly thereafter despite lower intakes.

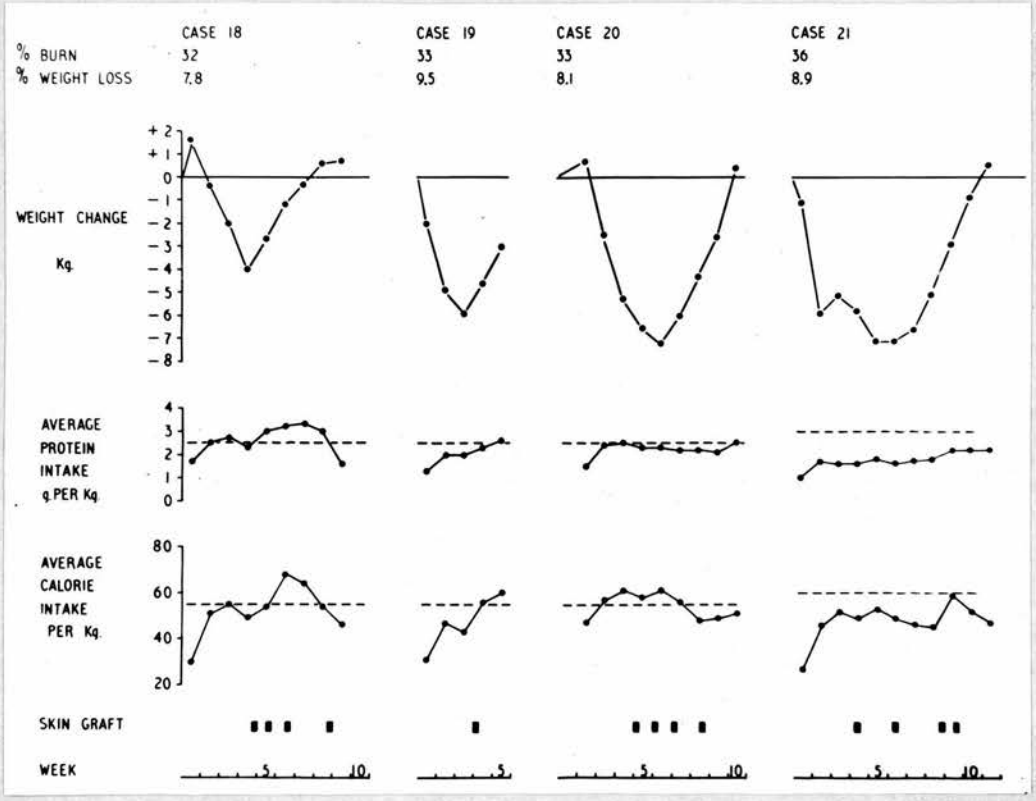
In these major injuries, the time taken for intake to reach the estimated requirement must of necessity be delayed as the high intakes required can only be introduced gradually.

Case 22 showed a severe weight loss out of proportion to all other patients in this group, and yet his injuries were completely superficial. His intake was far below estimated requirement due to complete lack of cooperation on his part. Despite this, weight loss ended at Week four and was followed by rapid gain until the sixth week, when, although still continuing, was at a much slower rate. Healing was completely satisfactory.

The only female included in the adult series is in this group - Case 23. The weight loss was of similar magnitude and duration to the male patients. Weight gain, once established, was rapid, but levelled out as intake dropped. Experience with other female patients showed similar difficulties in maintaining intake at the required levels and this patient was no exception; the estimated requirement not being achieved. Requirement may have been set too high, however, as it is thought to be less in the female. This may explain why the weight loss was not more severe.

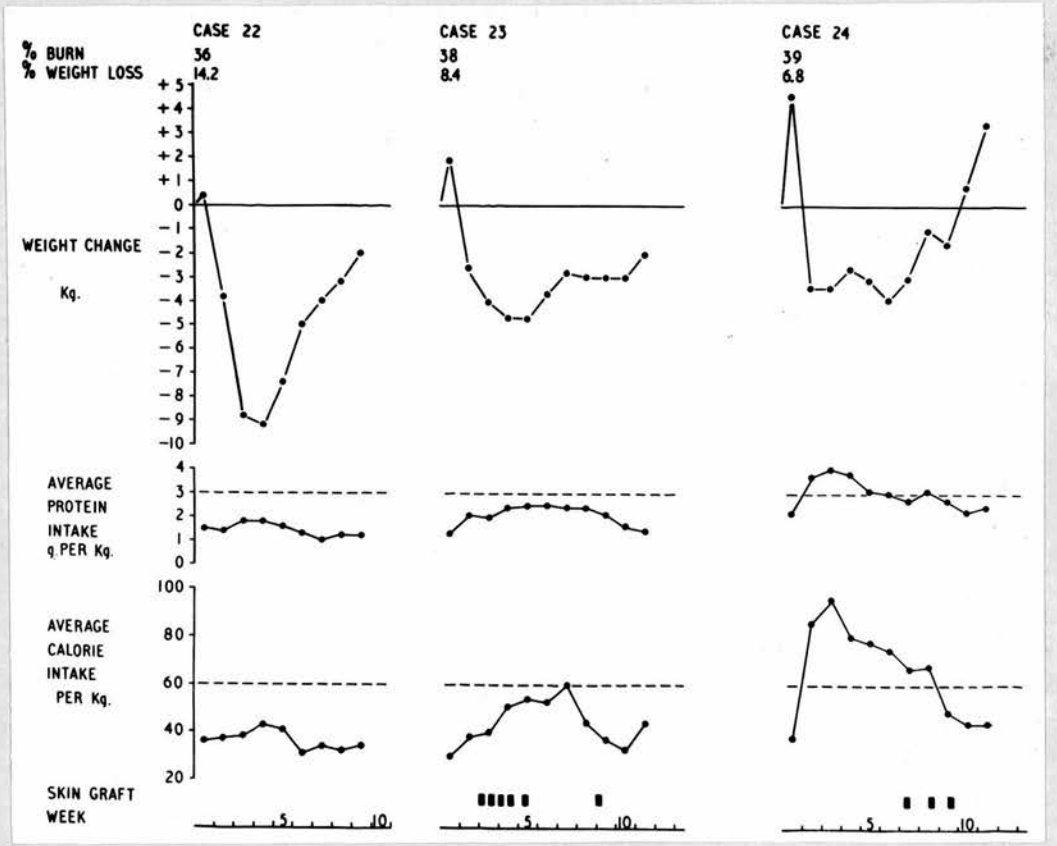
The contination of the study beyond Week twelve was interrupted by the development of acute appendicitis. As healing was virtually complete at this time, and as the effect of even a minor operation on weight at this stage was unpredictable, further study was abandoned.

CHART 10



Case 18, 19, 20, 21.- To show change in body weight and average levels of intake achieved. The interrupted line in the intake graphs shows the level of the estimated requirement.

CHART 11



Case 22, 23, 24.-To show change in body weight and average levels of intake achieved. The interrupted line in the intake graphs shows the level of the estimated requirement.

STUDIES IN CHILDREN

The following points should be noted concerning the presentation of findings in children - patients up to twelve years of age.

(1) The estimated requirement is that recommended by Levenson (1952), being the same intake as that required for a child of the same age in health. The requirements used are those recommended for children by the Committee on Nutrition of the British Medical Association (1950).

(2) The expected weights are those reported by Provis and Ellis (1955) for children over five years and by Thomson (1955) for children up to five years. These weights are preferred to national figures as most of the children came from the Edinburgh area. Where the age of the child concerned lies between the reported ages, the mean of the weights for the age above and below has been used.

(3) Requirement is calculated from age and not from "weight age".

(4) The requirement per Kg. is obtained by dividing the recommended intake for age by the expected weight for age of the child concerned.

(5) In the charts, the age is shown to the nearest year.

CHILDREN - GROUP 1

(16-20 per cent Body Surface Involved)

Case 25.- This girl, aged three years and nine months, was burned when her nightdress caught fire. The burns involved the right side of chest, abdomen, and thighs, totalling 16 per cent of the body surface. She was admitted two hours after injury in moderate shock. Intravenous therapy was instituted and continued for forty-eight hours.

Plasma - 830 ml.
Whole Blood - 250 ml.
Oral Fluids and 5 per cent dextrose - 810 ml.

Later /

Later on the same day, under general anaesthesia, the areas were cleansed and dressed.

Rise of temperature to 101°F. (38.3°C.) occurred on the sixth day and persisted until the sixteenth day, despite twice weekly dressing changes. The surface, however, was noted to be a little infected.

On the twenty-fourth day, razor grafts were applied to the thighs, but the resultant "take" was poor, with fairly profuse exudate. Twice weekly dressings were continued until the thirty-eighth day, when razor grafts were applied to the abdomen and thighs, and an excellent "take" resulted.

By the fifty-fifth day, the burns were virtually healed, and she was discharged on the seventy-first day.

Estimated Requirement

Admission weight 13.2 Kg. Expected weight 14.2 Kg.

Protein 56 g.
Calories 145o.

Supplementation of ward diet was commenced on the fourth day.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Complan	100	31.0	16.0	42.0
	Whole Milk	450	14.8	16.2	21.6
			45.8	32.2	63.6

Protein 46 g.
Calories 728.

She took this supplement readily, but was disinclined to eat solids. Accordingly, on the tenth day, a further supplement was introduced.

Feed 2	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Whole Milk	210	6.9	7.5	10.0
	Evaporated Milk	100	7.6	8.4	12.3
	Casilan	20	18.0	0.2	0.2
	Glucose	15	-	-	15.0
	Lactose	10	-	-	10.0
			32.5	16.1	47.5

Protein 33 g.
Calories 468.

This, along with Feed 1, gave a total supplementary intake of:

Protein 78 g.; Fat 48 g.: Carbohydrate 111 g.: Calories 1188.

On /

On the fifty-eighth day, Feed 2 was discontinued and all supplementary feeding was omitted on the sixty-second day.

Comment (Table 33)

The weight loss continued until the end of Week two. The total weight loss was 0.7 Kg., a percentage loss of 5.3. Thereafer, there was steady weight gain, although some levelling out occurred at Week seven.

The protein intake was greater than the estimated requirement throughout, being about 2 g./Kg. in excess. The calorie requirement was reached except in Week one and six, and was 15-20/Kg. in excess in Week three, four, and nine.

Case 26.- This female child, aged two years, was burned when her nightdress caught fire. The burns involved the abdomen, thighs and buttocks, the total area being 17 per cent.

She was admitted to hospital elsewhere. Intravenous therapy was instituted, 2000 ml. normal saline being given in the first twenty-four hours, and the infusion maintained with 600 ml. 5 per cent glucose daily for five days. She took fluids well by mouth, the amount being around 1000 ml. daily.

She was transferred on the fifth day. There was fairly marked oedema and she was running a fever of around 101°F. (38.3°C.).

The burns had been exposed initially and this form of local care was continued.

On the fourteenth day, under anaesthesia, the loose eschar was removed, and this procedure was repeated on the seventeenth and twenty-first day.

Razor grafts were applied to the thighs and abdomen on the twenty-fourth, twenty-eighth, and thirty-first day, with a resultant good "take" of the grafts.

Healing was complete on the sixty-first day and she was discharged on the sixty-eighth day.

Estimated Requirement

Admission weight 13.1 Kg. Expected weight 11.6 Kg.

Protein 56 g.
Calories 1300.

Supplementation /

Supplementation of the ward diet was not commenced until the twelfth day. Fluids were restricted initially because of oedema and intake was kept salt poor. By the twelfth day, the oedema was much less marked and a supplementary feed introduced and taken well.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Whole Milk	210	6.9	7.5	10.0
	Fat Emulsion	90	-	45.0	-
	Casilan	15	13.5	0.1	0.1
	Glucose	20	-	-	20.0
	Lactose	10	-	-	10.0
			20.4	52.6	40.1

Protein 20 g.
Calories 717.

This feed was accepted well and continued until the forty-first day.

Comment (Table 34)

No weight loss was recorded in the early stages. This was followed by fluctuation around admission weight, the lowest recording being at Week three. The total weight loss was 0.5 Kg., a percentage loss of 3.8.

The protein intake did not reach the estimated requirement at any time, and the calorie intake at Week six only.

Case 27.- This girl, aged one year and ten months, was playing with matches, which set fire to her dress. The burns involved the chest, abdomen, and thighs, a total of 20 per cent of the body surface.

She was admitted to hospital elsewhere and treated with oral electrolyte solution. She received 500 ml. during the first twenty-four hours and 750 ml. during the second twenty-four hours as a half strength solution. On the third day, she was given 300 ml. plasma and on the fourth day 240 ml. Dextran. Thereafter oral non-electrolyte fluids were given in the order of 1000 ml. daily. The burns were treated by exposure.

She was transferred on the seventh day. Her general condition was good, and treatment by exposure was continued.

On the seventeenth and twenty-first day, under anaesthesia, loose slough was removed and all areas dressed. On the twenty-fourth day, razor grafts were applied to the trunk with a resultant /

resultant good "take". The remaining areas were healing satisfactorily.

By the forty-sixth day, all areas were virtually healed and she was discharged to the convalescent home on the seventy-first day.

Estimated Requirement

Admission weight 12.7 Kg. Expected weight 11.6 Kg.

Protein 37 g.
Calories 1250.

Oral supplementation to the ward diet was commenced on the tenth day.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Complan	100	31.0	16.0	42.0
	Whole Milk	450	14.8	16.2	21.6
			45.8	32.2	63.6

Protein 46 g.
Calories 728

The supplement was accepted well, and continued until Day forty-three, when all supplementary feeding was discontinued.

Comment (Table 35)

Weight was not obtained during Week one, but the child's immediate pre injury weight was known accurately. No weight loss was recorded, except during Week five, which may be a reflection of the grafting procedure carried out at this time. The loss was 0.4 Kg., a percentage weight loss of 3.1.

The protein was in excess of the estimated requirement throughout, being 2-3 g./Kg. higher. The calories were in excess of requirement except at Week four.

Case 28.- This girl, aged five years, was burned when her nightdress caught fire. The burns involved the anterior trunk, and both legs, totalling 20 per cent of the body surface.

She was admitted one hour after the accident in mild shock.

Intravenous /

Intravenous therapy was instituted and continued over the next forty-eight hours.

Plasma - 1000 ml.
Whole Blood - 250 ml.
Oral fluids and 5 per cent glucose - 1510 ml.

Later, on the day of admission, under analgesia, the burned areas were cleansed and dressed.

Dressings and removal of loose slough were carried out on the eighth, eleventh, fourteenth, seventeenth, twenty-first, and twenty-fourth day. On the twenty-eighth day, razor grafts were applied to thighs and abdomen with a resultant excellent "take".

All areas were healed on the fifty-sixth day and she was discharged on the sixtieth day.

Estimated Requirement

Admission weight 20.8 Kg. Expected weight 17.9 Kg.

Protein 56 g.
Calories 1600.

It was decided to attempt to treat this child by intake of ward diet without supplementation, and, while it was not anti-:cipated that intake would be adequate during the first week, the continuing very low intake and rapid weight loss during the second week, led to the attempt being abandoned.

On Day seventeen, an oral supplement was introduced.

Feed 1 Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Complan	150	46.5	24.0	63.0
Fat Emulsion	50	-	25.0	-
Water	600	-	-	-
		46.5	49.0	63.0

Protein 47 g.
Calories 881.

There was a further reduction of intake of ward diet, weight continued to fall rapidly, and on the twenty-second day tube feeding was introduced.

Constituent	Amount g. or ml.	Pro. g.	Fat g.	Carbohydrate g.
Complan	200	62.0	32.0	84.0
Glucose	100	-	-	100.0
Evaporated Milk	200	15.2	16.8	24.6
Fat Emulsion	100	-	50.0	-
Water to	1200	-	-	-
		77.2	98.8	208.6

Protein /

Protein 77 g.
Calories 2035

Vitamins and iron added in amounts shown in Table 14.

Feeds of 200 ml. were given at 2 a.m., 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m.

Water and diluted fruit juices were allowed ad libitum, and the total fluid intake per day was around 2000 ml. Tolerance was excellent. Tube feeding was continued until the forty-third day.

Comment (Table 36)

The weight was at admission level at the end of Week one, although there had been weight gain recorded earlier in the week. Thereafter, the weight began to fall, reaching its lowest level at Week three, with the severest drop between Week two and three. The total weight loss was 3.8 Kg., a percentage loss of 18.3. Rapid weight gain thenoccurred with a further small fall at Week six.

The protein intake was 1-2 g./Kg. lower than the estimated requirement during the first three weeks, thereafter being at requirement level. The calorie intake was 50-60/Kg. less during Week one and two, and 10/Kg. less in Week three, only reaching requirement at Week six, although it was just short otherwise.

Case 29.- This girl, aged seven, was burned when she set her dress alight while playing with matches. The burns involved the posterior trunk, buttocks, right arm, and right chest, a total of 20 per cent of the body surface. She was admitted within one hour of the accident in mild shock.

Intravenous therapy was instituted and continued for forty-eight hours.

Plasma - 1040 ml.
Whole Blood - 670 ml.
Oral fluids and 5 per cent glucose - 2670 ml.

Later, on the day of admission, under general anaesthesia, the areas were cleansed and dressings were applied to the arm, while the back and thigh were exposed.

On the seveneeenh day, the eschar on the back was excised and razor /

razor grafts applied. Dressing, on the twenty-first day, showed a moderate "take" of grafts. On the twenty-seventh day, razor grafts were applied to the arm, and these "took" well. Dressings were continued twice weekly and by the thirty-eighth day the grafts were noted to be extending rapidly. Healing was complete on the fifty-eighth day and she was discharged to the convalescent home on the sixty-sixth day.

Estimated Requirement

Admission weight 20.6 Kg. Expected weight 22.0 Kg.

Protein 74 g.
Calories 1800.

Oral supplementation of the ward diet was commenced on Day two.

Feed 1	Constituent	Amount g.or. ml.	Pro. g.	Fat g.	Carbohydrate g.
	Complan	100	31.0	16.0	42.0
	Whole Milk	450	14.8	16.2	21.6
			45.8	32.2	63.6

Protein 46 g.
Calories 728

This was continued until Day seven, when a further supplement was introduced, as intake of solid food was poor.

Feed 2	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	20	18.0	0.2	0.2
	Glucose	20	-	-	20.0
	Lactose	20	-	-	20.0
	Whole Milk	210	6.9	7.5	10.0
	Fat Emulsion	90	-	45.0	-
			27.9	52.7	50.2

Protein 28 g.
Calories 789.

This, along with Feed 1, gave a total supplementary intake of :-

Protein 74 g.; Fat 85 g.; Carbohydrate 114 g.;
Calories 1517.

These feeds were accepted well and continued until the forty-sixth day, when both were omitted.

Comment /

Comment (Table 37)

Weight gain was recorded during Week one and two. Thereafter weight loss continued until the end of Week four, the severest loss occurring between Week two and three. The total weight loss was 1.1 Kg., a percentage loss of 5.3. Weight gain then took place and continued during Week seven despite a fall in intake.

The protein intake was in excess of requirement except at Week seven, as was also the calories except at Week one and seven.

Discussion

(Chart 12 and 13)

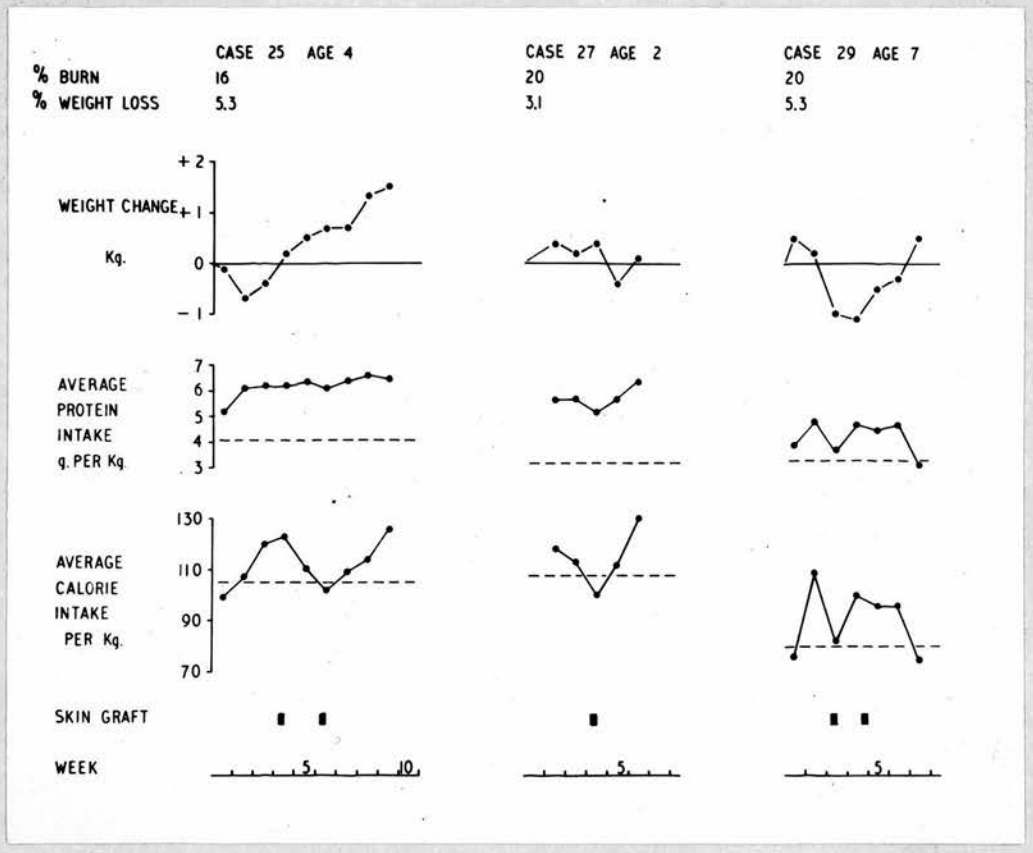
In Case 25, 27, and 29, in whom intake was maintained at or above estimated requirement, the weight loss was small. Its duration, however, varied. While the injuries were of similar size, the area of skin loss in Case 27 was minimal requiring only a minor grafting procedure. No weight loss was recorded in this patient until the fifth week, although the weight in Week one was unknown and may well have been a reflection of the lower intake in Week four, or of the grafting procedure, or of a combination of both. Case 25, whose intake was greatly in excess of requirement except in Week one and nine, showed rapid gain, but again the static weight at Week seven may be a reflection of the drop in calorie intake at Week six. Case 29 continued to show weight gain for two weeks and the fall at Week three may be associated with the fall in intake at this time, although still above requirement. In the later stages, however, a fall in intake appeared to have little effect on weight gain. In these three cases, a grafting procedure was frequently associated with /

with a fall in intake. Any weight change occurring over such a period cannot, therefore, be attributed to any one cause. That the drop in intake was probably more important was suggested by the continued gain in Case 25 at Week four when grafting was carried out but intake maintained.

In Case 26 and 27, there were periods of low intake. Despite this, in Case 26, weight loss was minimal and gain apparently established. In fact, the injury itself appears to have had little effect on weight.

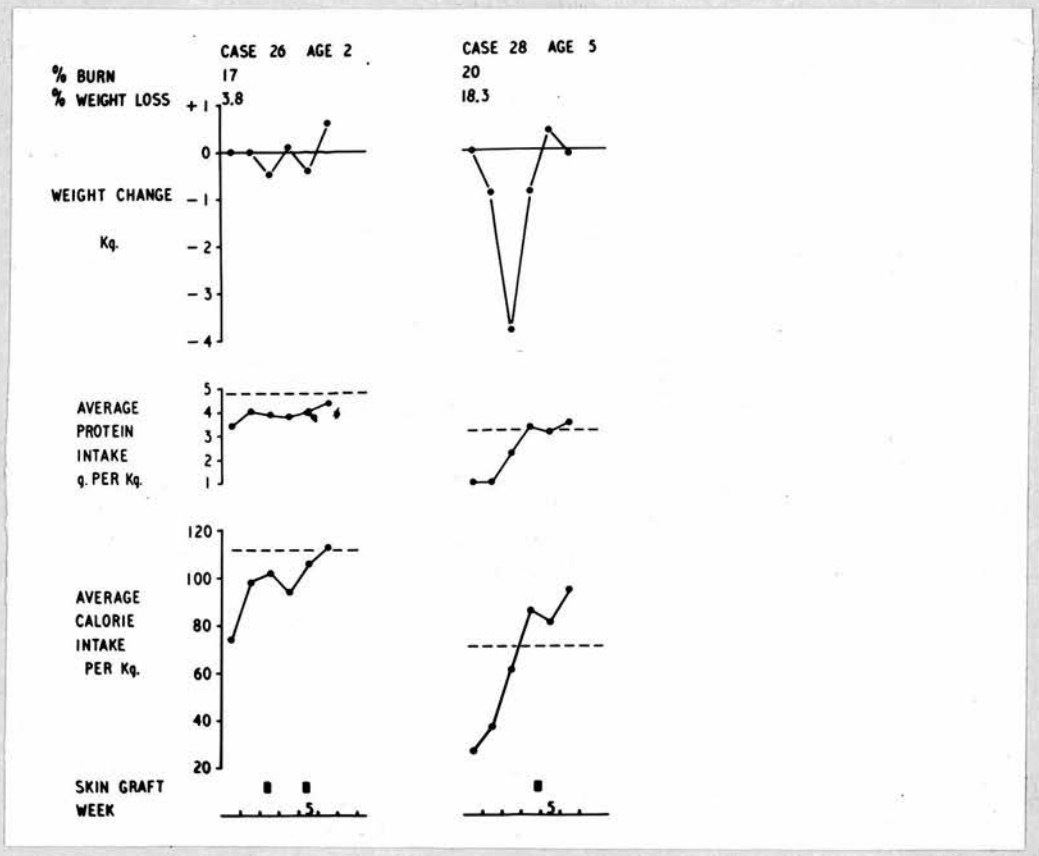
Case 22, on the other hand, shows the effects of semi-starvation, the severe loss at Week three probably being a reflection of the very low intakes of the first three weeks. It is difficult to attribute this dramatic weight loss to starvation alone. Its magnitude suggests fluid shift, but careful study of the child herself, and the fluid balance, showed no evidence to support a sudden fluid loss.

CHART 12



Case 25, 27, 29.-To show change in body weight and average levels of intake achieved. Interrupted line in the intake graphs shows the level of the estimated requirement.

CHART 13



Case 26, 28.- To show change in body weight and average levels of intake achieved. The interrupted line in the intake graphs shows the level of the estimated requirement.

CHILDREN - GROUP 2

21-30 per cent Body Surface Involved

Case 30.- This boy, aged five years, set his pyjamas on fire while playing with matches. The burns involved the anterior chest, and thighs, a total area of 22 per cent of the body surface. He was admitted within half-an-hour of the accident in moderate shock.

Intravenous therapy was instituted and over the next forty-eight hours he received:-

Plasma - 375 ml.
Whole Blood - 450 ml.
Hartmann's Solution - 450 ml.
Oral fluids and 5 per cent glucose - 1650 ml.

Later on the day of admission, under general anaesthesia, the burns were cleansed and exposed. Apart from a thrombophlebitis at the site of the "cut down" on the long saphenous vein, his general condition was satisfactory.

On the twelfth day, the edge of the eschar was noted to be infected and there was fever up to 101°F. (38.3°C.)

On the fourteenth day, under induced hypotension with Trimetaphan Camphorsulphonate (Arfonad)(Roche), the eschar was removed from the abdomen and thighs, and covered with a mixture of autografts and homografts. During the next four days, his general condition was poor. The fever persisted and he appeared toxic. Thereafter, improvement was rapid, and dressing on the twenty-first day showed a good "take" of the grafted skin. Twice weekly dressings were continued and on the thirty-first day, further razor grafts were applied to those areas previously covered with homografts. There was again a good "take" and rapid extension of the grafts themselves. Twice weekly dressings were again instituted and by the forty-ninth day only very small areas were left to heal. Progress thereafter was uninterrupted.

On the eighty-second day, he was transferred to the convalescent home.

Estimated Requirement

Admission weight 17.4 Kg. Expected weight 18.3 Kg.

Protein 56 g.
Calories 1600.

Oral supplementation of the ward diet was commenced on the sixth day.

Feed /

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Whole Milk	360	11.9	13.3	17.3
	Evaporated Milk	75	6.7	6.3	9.2
	Fat Emulsion	70	-	35.0	-
	Casilan	25	22.5	0.2	0.2
	Chocolate Powder	15	3.2	0.9	9.9
	Glucose	15	-	-	15.0
			44.3	55.7	51.6

Protein 44 g.
Calories 888.

During the period from the fourteenth day to the twentieth day, only small amounts of the supplement were accepted. This covered the period immediately after excision on the fourteenth day, when his general condition was poor. Otherwise it was accepted well. The supplement was discontinued on the fifty-third day.

Comment (Table 38)

Weight loss continued until the end of Week three, the severest drop being between Weeks two and three. The total weight loss was 3.0 Kg., a percentage loss of 17.2. Thereafter, weight gain was rapid, but was arrested at Week eight, and fall was again evident.

The protein intake fluctuated above and below the estimated requirement during the first four weeks. It was in excess of requirement during Week five, six, seven, and eight. Otherwise it was around 1 g./Kg. less than requirement. The calorie intake reached requirement at Week two, five, six, and eight. It was markedly below during Week one, three, and four.

Case 31.- This girl, aged six years and six months, was burned when her nightdress caught fire. The burns involved the anterior trunk, right arm, and both thighs, a total of 23 per cent of the body surface. She was admitted three hours after the accident in mild shock.

Intravenous therapy was instituted and continued over the next forty-eight hours:-

Plasma - 840 ml.
Whole Blood - 250 ml.
Ringer Lactate solution - 535 ml.
Oral fluids and 5 per cent Glucose - 2335 ml.

Later /

Later on the day of admission, under analgesia, the burns were cleansed and exposed.

On the twelfth day, under induced hypotension with Trimetaphan Camphorsulphonate(Arfonad)(Roche), all areas were excised and razor grafts applied. Dressing on the fifteenth day showed a good "take" of grafts. On the eighteenth day, she developed a pyrexia of 103°F. (39.4°C.). Culture from the burn surface gave a heavy growth of penicillin resistant Staphylococcus aureus. A seven day course of Erythromycin was given to cover a further grafting procedure on the nineteenth day. Again, there was a good "take", and dressings were continued twice weekly until the thirty-second day, when it was noted that the grafts were spreading rapidly, apart from an area on the anterior chest wall. This area remained infected with B. haemolytic streptococcus until the forty-sixth day. On the forty-seventh day, razor grafts were applied and "took" moderately well. Thereafter, healing was rapid and recovery uninterrupted, and she was discharged on the seventy-sixth day.

Estimated Requirement

Admission weight 17.9 Kg. Expected weight 20.8 Kg.

Protein 56 g.
Calories 1750.

Oral supplementation of the ward diet was commenced on the third day.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	40	36.0	0.4	0.4
	Whole Milk	600	19.8	22.2	28.8
Feed 2					
	Casilan	15	13.5	0.1	0.1
	Glucose	20	-	-	20.0
	Lactose	10	-	-	10.0
	Chocolate Powder	10	0.6	2.1	6.6
	Whole Milk	210	6.9	7.7	10.0
	Fat Emulsion	90	-	45.0	-
			76.8	77.5	75.9

Protein 77 g.
Calories 1324.

These supplements were tolerated well, but on the eighteenth day, she began to have occasional small vomits. This coincided with the onset of fever and surface infection treated with Erythromycin. On the twenty-fourth day, Feed 2 was omitted, and Feed 1 doubled. This gave a supplementary intake of :-

Protein /

Protein 112 g.; Fat 45 g.; Carbohydrate 98 g.;
Calories 1245.

On Day thirty, Feed 1 was again reduced to its original value, and continued until Day forty-four, when all supplementary feeding was discontinued.

Comment (Table 38)

The weight remained around the admission level throughout, the only obvious loss occurring late, at Week eight. This loss of 0.4 Kg. represented a percentage loss of 2.2.

The protein intake was in excess of the estimated requirement throughout, being 3-5 g./Kg. greater from Week two to six. The calorie intake was greater than requirement except during Week one, being 20/Kg. in excess from Week two to five.

Case 32.- This girl, aged six years, sustained burns when her clothes caught fire. The areas involved were the anterior and posterior trunk, and thighs, totalling 25 per cent of the body surface.

She was admitted within one hour of injury in good general condition.

Intravenous therapy was instituted and continued over the next forty-eight hours :-

Plasma - 2260 ml.
Whole Blood - 250 ml.
Oral fluids and 5 per cent glucose - 2355 ml.

On the second day, under general anaesthesia, the areas were cleansed and dressed.

On the seventh day, her temperature rose to 104°F. (40°C.) and there were signs of congestion at the left lung base. X-ray showed generalised congestive changes, but no evidence of consolidation. Dressing on the eighth day showed some infection of all areas of burn.

The temperature settled with crystalline penicillin 250,000 units six hourly, and repeat X-ray on the fifteenth day was negative.

Twice weekly dressing was continued with the removal of loose slough. Razor grafts were applied to the chest and thighs on the twenty-fourth day with a resultant good "take". Further razor grafts were applied to the anterior and posterior trunk on the thirty-first and thirty-eighth day, again with good "take" of the grafts. Dressings were continued twice weekly and at the forty-first /

first day there was marked extension of the grafts. Some infection of the unhealed areas on the back was noted on the forty-fifth day, but this cleared up rapidly and by the fifty-fifth day all the anterior areas were healed and only small granulating areas remained on the back. These areas were slow to heal, pinch grafts applied on the ninety-seventh day failing to "take". She was transferred to the convalescent home on the one hundred and twenty-ninth day.

Estimated Requirement

Admission weight 20.6 Kg. Expected weight 19.3 Kg.

Protein 56 g.
Calories 1700.

Oral supplementation of the ward diet was commenced on Day three.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	45	40.5	0.4	0.4
	Whole Milk	300	29.7	33.3	43.2
Feed 2					
	Casilan	15	13.5	0.1	0.1
	Glucose	20	-	-	20.0
	Lactose	10	-	-	10.0
	Chocolate Powder	10	0.6	2.1	6.6
	Whole Milk	210	6.9	7.7	10.0
	Fat Emulsion	90	-	45.0	-
			91.2	88.6	90.3

Protein 91 g.
Calories 1615.

Towards the end of the third week, she became very difficult with all feeding, probably a result of the fever and chest infection, and only constant forcing by the nursing staff permitted intake to be maintained. On the eighteenth day, tube feeding was instituted.

Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Casydrol	60	30.0	-	30.0
Hepovite	60	30.0	-	22.8
Evaporated Milk	400	30.4	33.6	49.2
Glucose	100	-	-	100.0
Fat Emulsion	180	-	90.0	-
Water to	1500	-	-	-
		90.4	123.6	202.0

Protein 90 g.
Calories 2284.

Vitamins and iron added in amounts shown in Table 14.

Feeds /

Feeds of 300 ml. were given at 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m.

Water and diluted fruit juices were allowed ad libitum to maintain total fluid intake at around 2000 ml. per day.

The tube feeding was tolerated well and continued until Day sixty-one. It was reduced by one-fifth on the four succeeding days, and discontinued on the sixty-fifth day.

Comment (Table 40)

Weight gain occurred during Week one, followed by weight loss until the end of Week three, the degree of weight loss being similar in Week two and three. The total weight loss was 3.0 Kg., a percentage loss of 14.5. A slow gain took place during Week four and five, and continued rapidly during Week six and seven. Arrest of weight gain occurred at Week eight, followed by a rise thereafter.

The protein intake was in excess of the estimated requirement except at Week nine. The calories were 20-25/Kg. greater except during Week one.

Case 33.- This girl, aged five years and six months, sustained burns when her nightdress caught fire. The burns involved the anterior trunk, thighs, and hands, totalling 25 per cent of the body surface. She was admitted within one hour of injury in good general condition.

Intravenous therapy was instituted and continued over the next forty-eight hours:-

Plasma - 1125 ml.
Whole Blood - 300 ml.
Hartmann's solution - 540 ml.
Oral fluids and 5 per cent glucose - 1590 ml.

Later on the day of admission, the burns were cleansed, the hands were dressed, and all other areas exposed.

On the eighth day, haemolytic streptococci were isolated from the surface of the burn, and she was running a fever of 101-102°F. (38.3-38.9°C.). Chloromycetin was given, 125 mg. six hourly for six days.

On the tenth day, under induced hypotension with Trimetaphan Camphorsulphonate (Arfonad) (Roche), the areas on the anterior trunk /

trunk and thighs were excised and razor grafts applied.

Her temperature remained elevated, but the grafts "took" well, except on the right thigh. Dressings were continued twice weekly. Infection of the raw areas with Staphylococcus aureus and B. haemolytic streptococcus persisted, despite a five day course of Erythromycin 100 mg. six hourly. By the twenty-first day, digestion of the grafts was evident, although the donor areas were healed by the twenty-fourth day. Some local improvement was noted on the twenty-eighth day, and further razor grafts were applied to the right leg and hands on the thirty-first day. A poor "take" resulted and B. haemolytic streptococcus was again isolated from all the raw areas.

Razor grafts were applied to the remaining raw areas on the trunk and legs on the thirty-eighth day with resultant good "take". Dressings were continued but healing was slow, and the temperature did not settle until the fifty-fifth day. Healing was complete by the seventy-ninth day, and after a period of rehabilitation she was discharged on the one hundred and thirty-first day.

Estimated Requirement

Admission weight 22.7 Kg. Expected weight 18.9 Kg.

Protein 56 g.
Calories 1650.

Oral supplementation of the ward diet was commenced on the fifth day.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	40	36.0	0.4	0.4
	Whole Milk	600	19.8	22.2	28.8
Feed 2					
	Casilan	15	13.5	0.1	0.1
	Glucose	20	-	-	20.0
	Lactose	10	-	-	10.0
	Chocolate Powder	10	0.6	2.1	6.6
	Whole Milk	210	6.9	7.7	10.0
	Fat Emulsion	90	-	45.0	-
			76.8	77.5	75.9

Protein 77 g.
Calories 1314.

On the forty-fifth day, Feed 1 was halved. This reduced the supplementary intake to :-

Protein 49 g.: Fat 66 g.: Carbohydrate 61 g.:
Calories 1034.

On /

On the sixty-sixth day, Feed 1 was discontinued, reducing the supplementary intake to:-

Protein 21 g.: Fat 55 g.: Carbohydrate 47 g. :
Calories 767.

Feed 2 was discontinued on the seventy-first day. The feeds were tolerated well throughout.

Comment (Table 41)

Weight gain occurred during Week one. Weight then continued to fall until the end of Week four, the severest fall being during Week two to three. The total weight loss was 1.7 Kg., a percentage loss of 7.5. Weight then rose rapidly, levelling out at Week six to seven, which may have been due to the grafting procedures at this time. Weight gain continued until Week twelve, at which time intake also fell.

The protein intake was in excess of estimated requirement by 1.5-2 g./Kg. from admission until Week ten. It then fell below requirement level. The calorie intake was 20-30/Kg. above requirement until Week ten, thereafter being 20-30/Kg. below.

Case 34.- This girl, aged six years, was burned when her clothes caught fire. The burns involved the anterior and posterior trunk, and thighs, totalling 26 per cent of the body surface. She was admitted two hours after injury in a state of moderate shock.

Intravenous therapy was instituted and continued for forty-eight hours :-

Plasma - 1350 ml.
Whole Blood - 585 ml.
Normal Saline - 150 ml .
Oral fluids and 5 per cent glucose - 1300 ml.

Later on the day of admission, under general anaesthesia, the burns were cleansed and dressed.

Dressings, under anaesthesia, were carried out on the sixth and ninth day, and removal of loose slough on the thirteenth and sixteenth day. On the thirteenth day, the serum sodium was reported as 150 mEq./l, which persisted, despite no clinical evidence of sodium excess. On the seventeenth day, however, sodium /

sodium intake was reduced and the serum sodium gradually fell to normal levels by the twenty-fourth day. Throughout this period, her general condition remained excellent. Dressings were continued twice weekly and on the thirtieth day, razor grafts were applied to the groins and anterior abdomen and to the thighs on the thirty-fourth day. There was a very good "take" of these grafts. Further grafts were applied on the forty-first and forty-eighth day, again with good "take". Donor sites healed rapidly and dressings were continued twice weekly to the remaining raw areas. Razor grafts were applied to the posterior trunk on the sixty-second day, using the previous early donor areas for a second time. The remaining small raw areas were grafted on the sixty-ninth day. Extension of all grafts was marked by Day seventy-nine, and all areas were virtually healed on the ninety-third day. She was discharged on the one hundred and eighteenth day.

Estimated Requirement

Admission weight 20.5 Kg. Expected weight 19.3 Kg.

Protein 56 g.
Calories 1700.

Oral supplementation of the ward diet was commenced on Day four.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Complan	200	62.0	32.0	84.0
	Fat Emulsion	40	-	20.0	-
	Water to	600	-	-	-
			62.0	52.0	84.0

Protein 62 g.
Calories 1052
Sodium 34 mEq.

During the period of sodium restriction, the following feeds were given instead of Feed 1, beginning on the seventeenth day.

Feed 2	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	20	18.0	0.2	0.2
	Whole Milk	300	9.9	11.1	14.4
	Water	150	-	-	-
Feed 3					
	Fat Emulsion	175	-	87.5	-
	Concentrated Fruit Juice	150	-	-	15.0
	Glucose	75	-	-	75.0
			27.9	98.8	104.6

Protein /

Protein 28 g.
Calories 1423
Sodium 6 mEq.

These feeds were continued until Day thirty-two, when Feed 4 was substituted.

Feed 4 Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Complan	100	31.0	16.0	42.0
Glucose	15	-	-	15.0
Lactose	15	-	-	15.0
Evaporated Milk	60	4.5	5.0	7.3
Whole Milk	300	9.9	11.1	14.4
Fat Emulsion	90	-	45.0	-
		45.4	77.1	93.7

Protein 45 g.
Calories 1249

This was accepted only reasonably well and on the thirty-ninth day was discontinued and Feed 5 commenced.

Feed 5 Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Casilan	30	27.0	0.3	0.3
Glucose	40	-	-	40.0
Lactose	20	-	-	20.0
Whole Milk	360	11.9	13.3	17.3
Fat Emulsion	150	-	75.0	-
		38.9	88.6	77.6

Protein 39 g.
Calories 1269.

This feed was accepted well and continued until Day eighty-five, when all supplementary feeding was discontinued.

Comment (Table 42)

Weight gain occurred during Week one. Weight then continued to fall until the end of Week four. The total weight loss was 3.2 Kg., a percentage loss of 15.6. There followed a rapid weight gain until Week six, after which time the weight fluctuated at a lower level.

The protein intake was in excess of the estimated requirement except at Week four, and the calories except at Week one, seven and eleven/

eleven.

The fall in weight at Week seven and eleven occurred at the same time as a fall in calorie level to below the estimated requirement.

Case 35.- This girl, aged six years and five months, was burned when her nightdress caught fire. The burn involved the anterior trunk, and both legs, totalling 30 per cent of the body surface. She was admitted two hours after the accident in moderate shock.

Intravenous therapy was instituted and was continued over the next fifty-six hours :-

Plasma - 2580 ml.
Whole Blood - 425 ml.
Normal Saline - 200 ml.
Oral fluids and 5 per cent glucose - 2280ml.

Later on the day of admission, under general anaesthesia, the areas were cleansed. Dressings were applied to the legs, and the trunk was exposed.

On the seventh day, she was restless and disorientated and the serum sodium was reported at 165 mEq./l. She also ran a tachycardia of 130 per minute with a temperature of 95°F.(35°C.). With warming, the temperature rose to normal and the pulse rate fell to 90 per minute. Water intake was increased and the serum sodium was normal by the tenth day.

On the fourteenth day, the eschar was excised from the left thigh and razor grafts applied. These "took" fairly well, and the procedure was repeated on the right thigh on the seventeenth day. On the twenty-first day, there was marked digestion of all grafts and B-haemolytic streptococcus was cultured from the surface. This infection persisted, despite twice weekly dressings and, while initially there was little general effect, on the thirty-sixth day, she began to run a fever of 101-102°F. (38.3 - 38.9°C.), and vomited frequently. By the forty-second day, there was considerable general and local improvement and, at this point, stored razor grafts, taken on the twenty-first day, were applied to the anterior chest wall. The resultant "take" was poor and B-haemolytic streptococcal infection of the surface was again marked. On the fifty-second day, a course of Terramycin, 125 mg. six hourly, was begun, and the B-haemolytic streptococcus was absent from the surface for the first time by the fifty-sixth day. Twice weekly dressing was continued and there was slow improvement of the local state.

On the seventy-first day, a rise of temperature to 101-102°F. (38.3-38.9°C.) again occurred and culture of urine showed a heavy growth of B. coli and B. proteus. This was treated with a course of sulphadimidine, 0.5 g. six hourly and Streptomycin 0.5 g. twice daily. The infection cleared and on the seventy-third day trial grafts to the thighs resulted in a good "take" and further grafts were applied on the seventy-seventh day with a good result. By the eighty /

eighty-seventh day, there was fairly marked extension of grafts but, on the ninety-fourth day, a further episode of urinary infection occurred, B. coli and Staphylococcus Aureus being cultured. A further course of streptomycin 0.5 g. twice daily caused some improvement but, from this point onwards, the urinary infection persisted.

On the ninety-eighth day, razor grafts were applied to the chest with a resultant good "take" and thereafter there was continuous slow improvement of the local state. On the one hundred and sixth day, healing of the anterior trunk was almost complete, and further grafts to the left thigh on the one hundred and twenty-ninth day "took" well. The remaining small raw areas healed slowly and healing was virtually complete on the one hundred and fifty-second day.

The urinary infection persisted, however, and on the one hundred and seventy-second day, a severe attack of renal colic occurred. X-ray showed diffuse calcification of the right kidney and an intravenous pyelogram on the one hundred and eightieth day showed no evidence of excretion of the dye on the right side. The appearances were suggestive of tuberculous disease.

On the one hundred and eighty-second day, a right nephro-ureterectomy was performed. The kidney showed a severe acute pyelonephritis with abscess formation, but no evidence of tuberculosis.

Recovery from operation was uneventful, the urine was sterile on culture, and she was discharged on the two hundred and eleventh day.

Estimated Requirement

Admission weight 21.4 Kg. Expected weight 20.8 Kg.

Protein 56 g.
Calories 1750.

Oral supplementation of the ward diet was commenced on Day four.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Complan	100	31.0	16.0	42.0
	Whole Milk	450	14.8	16.2	21.6
			45.8	32.2	63.6

Protein 46 g.
Calories 728.
Sodium 27 mEq.

In /

In view of the high serum sodium level reported on the seventh day, the feed was discontinued and clear fluids containing no sodium given until the tenth day, when with a fall in the serum sodium to normal, Feed 1 was again introduced. Intake was increased on Day eleven with the introduction of Feed 2.

Feed 2	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	35	31.5	0.3	0.3
	Glucose	35	-	-	35.0
	Lactose	20	-	-	20.0
	Whole Milk	420	13.9	15.5	20.2
	Evaporated Milk	200	15.2	16.8	24.6
			60.6	32.6	100.1

This, along with Feed 1, gave a total supplementary intake of

Protein 106 g.: Fat 65.g.: Carbohydrate 164 g.: Calories 1665.

These feeds were tolerated well until the deterioration in general condition due to surface infection on the thirty-fifth day, when she vomited frequently. For two days, all feeding was withdrawn except half strength milk, which was tolerated well. Supplementary feeding, with Feeds 1 and 2, was resumed on the thirty-eighth day and thereafter tolerated well.

On the ninety-sixth day, when the surface loss was much reduced, Feed 1 was discontinued. Supplementary feeding, by Feed 2 only, then provided:-

Protein 61 g.: Fat 33 g.: Carbohydrate 100 g.: Calories 941.

Feed 2 was discontinued on the one hundred and forty-fourth day.

Comment (Table 43)

Weight loss continued until the end of Week six, although it was arrested at Week two. The severest drop occurred between Week one and two. The total weight loss was 2.2 Kg., a percentage loss of 10.3. Weight remained static until Week eight, followed by rapid weight gain. The weight fluctuated around admission level from Week twelve to eighteen, with further gain until Week twenty-one /

one, when it levelled off.

The protein intake was in excess of the estimated requirement by 1-4 g./Kg. throughout. The calorie intake was also in excess, except during Week one, two, six, and fourteen to seventeen. The loss of weight between Week sixteen and seventeen occurred at the same time as a major fall in calorie intake.

This case illustrates a long, complicated convalescence.

The development of renal calculus in this case, emphasises one of the possible dangers of increased intakes. Reiss et al. (1956) reported that in the burned patient there was no evidence to suggest that calcium losses were much greater than those expected with prolonger immobilisation, but the urinary calcium excretion was unusually high with an accompanying high phosphorus excretion. This gives ideal conditions for urinary calculus formation, and while this complication is rare, it could be aggravated by high intakes of these elements. The supplements used in this case were rich in calcium and phosphorus.

Discussion

(Chart 14, 15, 16)

Case 30, 32, and 34, were considered together, as their weight loss was comparable. It continued for three to four weeks.

In Case 30, it was difficult to separate the weight loss from the severe fall in intake, which occurred at the same time, although no similar reason can be given for the weight drop at Week six. Throughout the course, intake did not consistently reach requirement level, and the falling intake in Week nine and ten was associated with weight loss.

In /

In Case 32, the intake was at or above the estimated requirement except in Week one, when the calorie level was low. Despite maintenance of intake, fall in weight occurred and continued until the end of Week three, remaining static for a further week. Thereafter, rapid gain occurred, but was interrupted at Week eight, at which time there was also a fall in calorie intake.

In Case 34, weight loss continued until the end of the fourth week, and, while the protein intake was at or above estimated requirement throughout this time, the calorie intake was just at requirement level, being well below in Week one. The continued rather steep fall in weight at Week four may thus have been associated with lower intake, supported by the fact that weight gain in the fifth and sixth weeks was rapid, the intake at this time being well above requirement levels. Similarly, the weight loss in Week seven was associated with a fall in calorie level to below requirement, and the arrest of weight gain at Week eleven again coincided with reduced calorie intake.

The weight gain in these three cases was not so obviously related to the achievement of skin cover, and they regained admission weight in the period studied.

The weight loss in Case 31 and 33 was very much less. Case 31 was interesting in that the weight fluctuated around admission level throughout the period of study. In fact, the greatest weight loss was recorded at Week eight and may well be merely a reflection of reduction in intake at Week seven, for gain was readily established when intake was increased. The levels of intake reached in this child were the highest of any in the whole series. Another factor, which may have played a part in this rather unusual weight pattern, was /

was the early commencement of grafting, a major part of the burn being excised and grafted during the second week. On the other hand, the final major grafting procedure did not take place until Week seven and the "take" of the grafts was not altogether satisfactory, so that it is probable that the effect of the high intakes was more important.

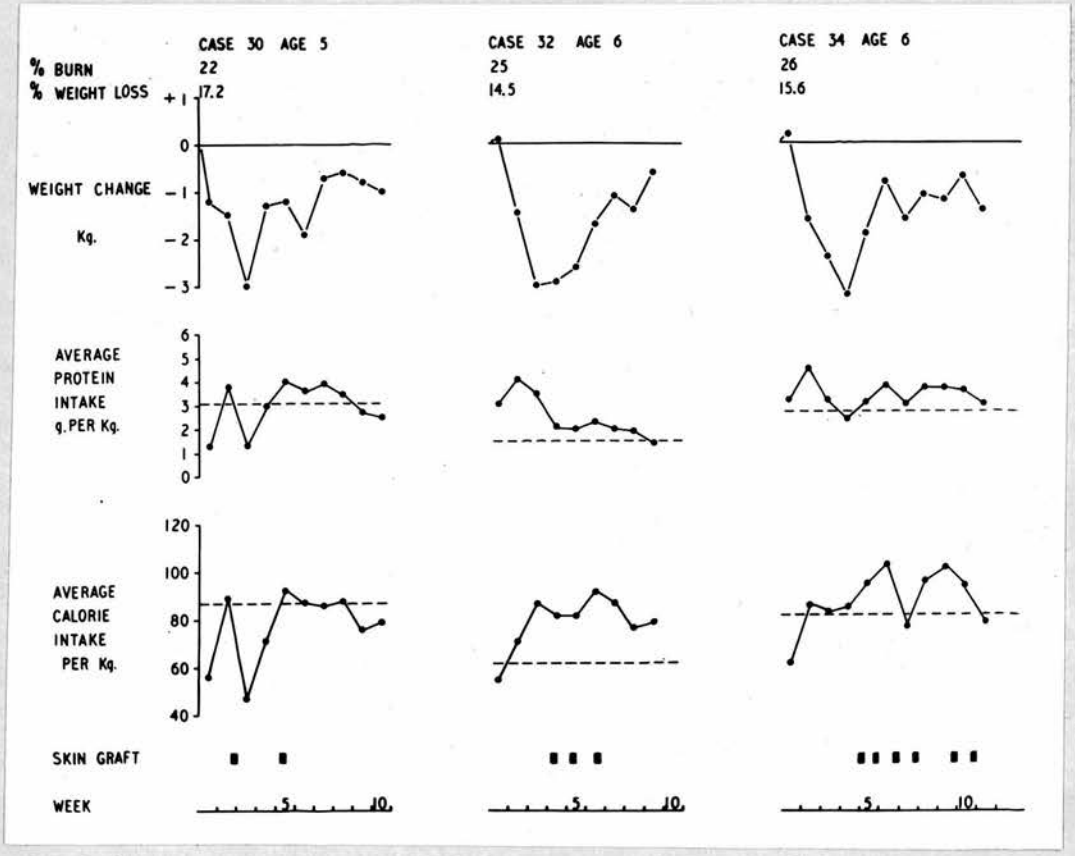
Case 33, also, while showing a greater weight loss than Case 31, had only about 50 per cent of the weight loss of Case,30, 32, and 34. Again the intake was much in excess of requirement. Despite this, weight loss continued until the end of Week four and weight gain was arrested at Week seven. When the intake was reduced at Week nine, weight levelled out and began to fall, although this was long after the final grafting procedure and the areas were virtually healed. Apparently, therefore, this reduction was premature. Case 31 to 34 all showed weight gain in Week one.

Case 35 was considered separately, for, while falling into this group by virtue of extent of injury, the amount of full thickness skin loss was greater and the course prolonged. Until the end of Week eight, the surface was consistently infected with B.-haemolytic streptococci and the loss of some of the early grafts was due to this. Infection continued sporadically until the seventeenth week with fairly profuse exudate and final grafting was not possible until the nineteenth week. In addition, there was a persistent heavy urinary infection from the tenth week onwards. The main weight loss appeared to be over at the end of the second week, but a further drop in weight occurred at the sixth week associated with a fall in intake, especially of calories, although still above requirement level. Intake was well maintained until Week fourteen, although a slight drop /

drop at Week eight was coincident with weight remaining static. After Week fourteen, weight fluctuated around the admission level, the calories at this period being below requirement level. With an increase in calorie intake at Week eighteen, weight gain again became evident.

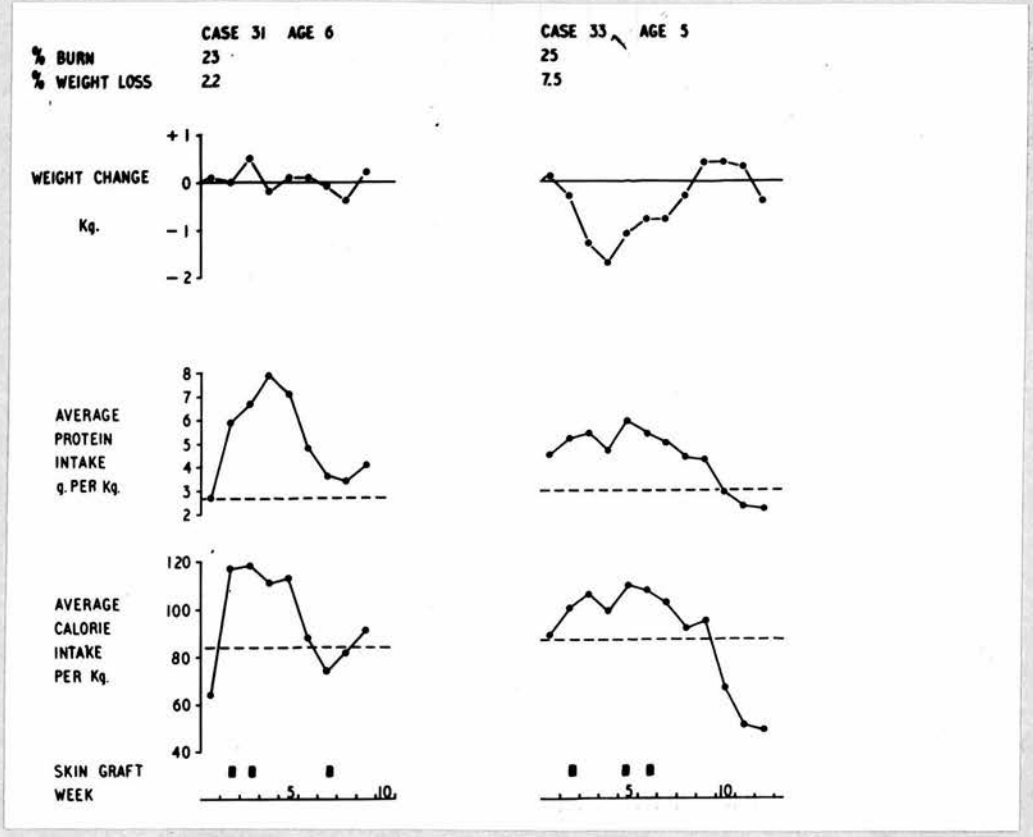
Thus, despite the extent of the injury and the complicated course, weight loss was not excessive. This may well be associated with maintenance of intake.

CHART 14



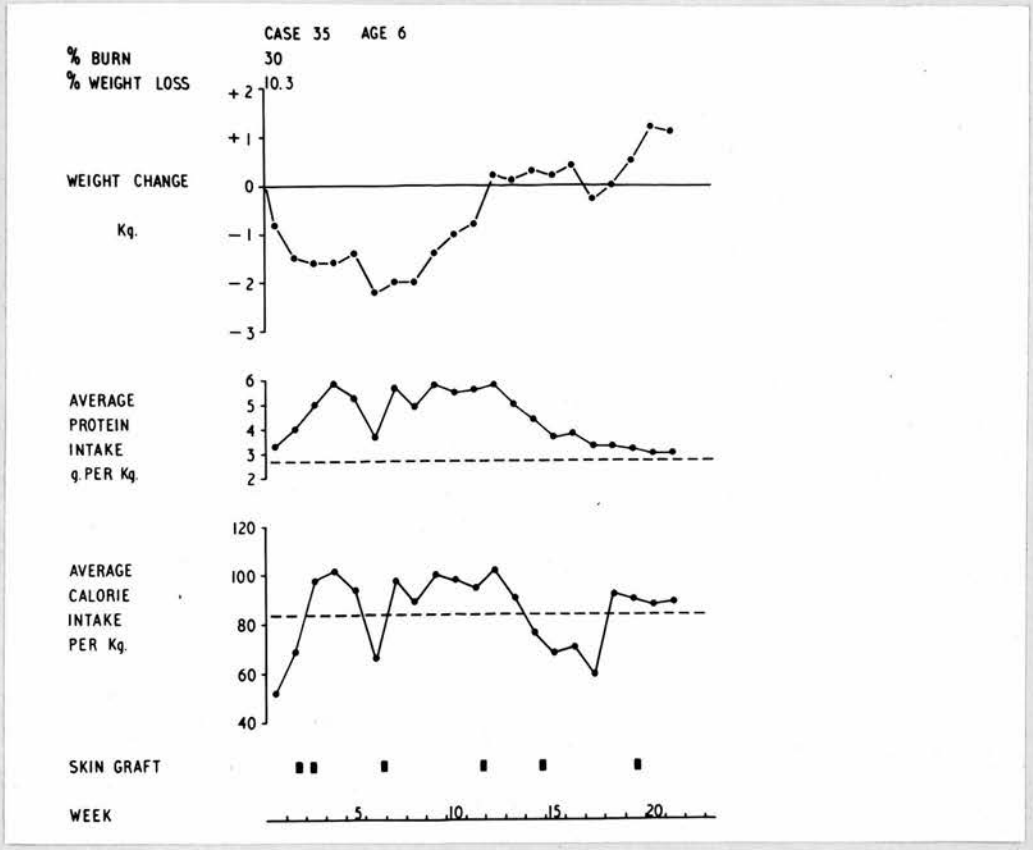
Case 30, 32, 34.-To show change in body weight and average levels of intake achieved. The interrupted line in the intake graphs shows the level of estimated requirement.

CHART 15



Case 31, 33.- To show change in body weight and average levels of intake achieved. The interrupted line in the intake graphs shows the level of the estimated requirement.

CHART 16



Case 35.-To show change in body weight and average levels of intake achieved. The interrupted line in the intake graphs shows the level of the estimated requirement.

CHILDREN - GROUP 3

31-40 per cent Body Surface Involved

Case 36.- This girl, aged six years and six months, was burned when her clothes caught fire. The burn involved both thighs, lower legs, lower abdomen, buttocks, face, and neck, totalling 32 per cent of the body surface. She was admitted three hours later in fairly severe shock.

Intravenous therapy was instituted and continued over the next forty-eight hours:-

Plasma - 1440 ml.
Whole Blood - 440 ml.
Oral fluids and 5 per cent glucose - 2145 ml.

On the second day, under analgesia, the areas were cleansed and dressed. The face and neck were exposed. The dressings were changed on Day six, and on Day nine the eschar on the thighs was excised. The following day, the temperature rose to 102°F. (38.9°C.), and persisted at this level. On the thirteenth day, razor grafts were applied to the right thigh with good "take", but culture from the other areas showed the presence of B. haemolytic streptococcus. Razor grafts were applied to the face and neck on the sixteenth day, with only partial success. Despite frequent dressing change, the B. haemolytic streptococcus persisted and she remained pyrexial. Razor grafts to the thighs and fingers were applied on the twenty-seventh day, again with poor "take" of the grafts and digestion of the grafts, which had "taken" previously.

The temperature continued around 102-103°F. (38.9-39.4°C.), with an occasional rise to 104°F. (40°C.), and her general condition, which had previously remained good, began to deteriorate slowly. Staphylococcus aureus, in addition to B. haemolytic streptococcus, was cultured from the surface, and on the thirty-fourth day, Chloromycetin 125 mg. eight hourly was given and continued for five days. Despite the reported sensitivity of the organisms to this antibiotic, the temperature remained elevated and the bacterial growth from the granulating areas remained unchanged.

On the forty-first day, razor grafts were again applied to the abdomen and left thigh with a resultant good "take". Dressing change was continued twice weekly and on the fifty-fifth day, although the B. haemolytic streptococcus was still present, there was an overall general improvement locally. Her general condition, too, was much better.

On the sixty-second day, dermatome grafts were applied to the thighs with fairly good result and on the seventy-fourth day, the B. haemolytic streptococcus was no longer present on the surface and /

and her temperature settled for the first time. Further razor grafts were applied to the thighs on the seventy-sixth day with subsequent good "take", but there was no evidence of outgrowth of any of the previous grafts. Twice weekly dressings were continued and razor grafts were applied to the buttocks on the ninetieth day. These "took" well and extension of previous grafts was first noted on the ninety-ninth day.

Thereafter, the local and the general state improved, the last dressing, under anaesthesia, being on the one hundred and fourth day. She was discharged to the convalescent home on the one hundred and thirty-second day.

Estimated Requirement

Admission weight 18.9 Kg. Expected weight 20.8 Kg.

Protein 56 g.
Calories 1750.

Oral supplementation of the ward diet was commenced on Day four.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	400	46.0	0.4	0.4
	Whole Milk	600	19.8	22.2	28.8.
Feed 2					
	Casilan	20	18.0	0.2	0.2
	Glucose	20	-	-	20.0
	Lactose	10	-	-	10.0
	Whole Milk	210	6.9	7.7	10.0
	Fat Emulsion	90	-	45.0	-
			80.7	75.5	69.4

Protein 81 g.
Calories 1284.

These feeds were accepted well initially, but with the onset of infection and fever, feeding became progressively more difficult. On the eighteenth day, tube feeding was commenced.

Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Casydrol	60	30.0	-	30.0
Hepovite	60	30.0	-	28.8
Glucose	60	-	-	60.0
Evaporated Milk	400	30.4	33.6	49.2
Fat Emulsion	150	-	75.0	-
Water to	1250	-	-	-
		90.4	108.6	168.0

Protein /

Protein 90 g.
Calories 1813.

Vitamins and iron added in amounts shown in Table 14.

Feeds of 250 ml. were given at 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m. Water and fruit juices were allowed ad libitum and satisfactory fluid intake of around 2000 ml. total was obtained.

There was occasional vomiting between the twentieth and twenty-sixth day, but otherwise the feeding was tolerated well.

On the thirty-eighth day, the fat emulsion in the feed was increased to 200 ml., raising the total fat to 134 g. and the calorie value to 2238. On this feed, vomiting was frequent and, on the forty-sixth day, was cut back to its original form. Tolerance improved, although vomiting still occurred occasionally.

Tube feeding was continued until the one hundred and seventh day, when it was reduced to four-fifths of the amount, over the next four days was reduced further, and was discontinued altogether on the one hundred and eleventh day.

Comment (Table 44)

Weight gain occurred during Week one, and then continued to fall until the end of Week four. Established weight gain was arrested at this time, and weight fell further until the end of Week seven. The weight loss was 2.5 Kg., a percentage loss of 13.2. Thereafter, weight gain was rapid.

The protein intake was in excess of the estimated requirement by 1.3-1.5 g./Kg. throughout. The calorie intake was also in excess by 20-30 /Kg., except during Week one and seven.

The secondary fall in weight occurred at the same time as a fall in calorie intake. Weight gain at Week sixteen and seventeen continued despite of a fall in calorie intake, which was still, however, above requirement.

Case 37.- This girl, aged five years, and nine months, was burned when her clothes caught fire. The burns involved the anterior and posterior trunk, and the left arm, totalling 33 per cent of the body surface. In addition, she was recovering from measles.

She /

She was admitted in fairly marked shock, three hours after the accident.

Intravenous therapy was instituted and continued for forty-eight hours :-

Plasma - 1970 ml.
Whole Blood - 310 ml.
Oral fluids and 5 per cent glucose - 1785 ml.

Later on the day of admission, under analgesia, the areas were cleansed and dressed.

Dressings, under anaesthesia, on the ninth and sixteenth days showed good evidence of healing of the superficial burn, about 1.25 to 2.5 centimetres inwards from the edge of all involved areas. The slough on the deep areas of the burn separated rapidly and on the twentieth day razor grafts were applied to the left arm. Skin taken at this procedure was stored and applied to the anterior chest on the twenty-third day. The graft "take" on both occasions was excellent. Further grafts were applied to the trunk and thighs on the thirtieth day, again with good result and by the thirty-eighth day there was marked epithelial outgrowth from all grafted areas. Twice weekly dressings were continued and by the forty-fifth day only two areas, one on the left arm and the other on the left thigh, remained unhealed. With rapid outgrowth of the existing grafts, no further grafting procedures were required.

On the sixty-fourth day, she developed mumps, but, in view of the care required of the recent skin grafts and donor sites, she was nursed in isolation in the hospital and not transferred. By the seventy-fifth day, healing was virtually complete.

After a period of physiotherapy, she was discharged to the convalescent home on the one hundred and eighth day.

Estimated Requirement

Admission weight 18.1 Kg. Expected weight 18.9 Kg.

Protein 56 g.
Calories 1650.

A nasogastric feeding tube was passed on the third day and tube feeding instituted on the seventh day.

Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Complan	200	62.0	32.0	84.0
Glucose	100	-	-	100.0
Evaporated Milk	200	15.2	16.8	24.6
Fat Emulsion	100	-	50.0	-
Water to	1200	-	-	-
		77.2	98.8	208.6

Protein /

Protein 77 g.
Calories 2035.

Vitamins and iron added in amounts shown in Table 14.

Feeds of 300 ml. were given at 6 a.m., 10 a.m., 2 p.m., 6 p.m., and an additional 300 ml. water given at 10 p.m. This, with clear fluids ad libitum ensured a total fluid intake of around 2000 ml. per day. There was some vomiting on the eighth and ninth day, but thereafter the feeds were tolerated well. Tube feeding was discontinued on the forty-second day, when it became apparent that no further grafting would be required, and her weight was slowly increasing. With the development of mumps, her intake fell off rapidly and she refused all food and fluids. A nasogastric tube was passed on the sixty-ninth day, and continued until the seventy-ninth day.

Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Complan	150	46.5	24.0	63.0
Glucose	50	-	-	50.0
Evaporated Milk	200	15.2	16.8	24.6
Fat Emulsion	80	-	40.0	-
Water to	1200	-	-	-
		61.7	80.8	137.6

Protein 62 g.
Calories 1529.

Vitamins and iron added as in previous feed.

Feeds of 300 ml. were given at 6 a.m., 10 a.m., 2 p.m., 6 p.m., and an additional 300 ml. water at 10 p.m. Reduction in the food value of the feed was made, as there was no longer an anaesthetic twice weekly, and only tiny raw areas remained.

From the seventy-ninth day onwards, all supplementary feeding was discontinued.

Comment (Table 45)

The only real weight loss occurred between Week one and the beginning of Week three. The weight loss was 0.4 Kg., a percentage loss of 2.2. Thereafter, the weight fluctuated around admission level.

The protein intake was in excess of the estimated requirement by 1 g./Kg., except during Week ten.

The /

The calorie intake was 20-30/Kg. in excess during Week two to seven. Otherwise it was less. Weight was apparently uninfluenced by this lower level of calorie intake.

Case 38.- This girl, aged five years, was burned when her nightdress caught fire. The burns involved the anterior trunk, and both legs, totalling 33 per cent of the body surface.

She was admitted within one hour of the accident in moderate shock.

Intravenous therapy was instituted and continued for forty-eight hours :-

Plasma - 1550 ml.
Whole Blood - 290 ml.
Oral fluids and 5 per cent glucose - 2510 ml.

On the second day, under analgesia, the burns were cleansed and dressed.

On the eighth day, the eschar was excised from the anterior trunk and the right anterior thigh, and razor grafts were applied with subsequent poor "take". Dressings were continued twice weekly and on the eighteenth day, the donor sites of Day eight were healed. Loose slough was removed on the twenty-second day, the twenty-fifth day, and on the twenty-ninth day, razor grafts were applied to the abdomen and right thigh with subsequent good "take". By the thirty-ninth day, the donor areas of this procedure were healed. On the forty-third day, razor grafts were applied to the left thigh, but these grafts were lost completely, the surface being heavily infected with B. proteus. Twice weekly dressings were continued, and further razor grafts applied to the thighs on the sixty-seventh day. These grafts "took" only moderately well, but the remaining raw areas were small. Healing was virtually complete on the eighty-ninth day, and she was discharged on the ninety-sixth day.

Estimated Requirement

Admission weight 17.3 Kg. Expected weight 17.9 Kg.

Protein 56 g.
Calories 1600.

Oral supplementation of the ward diet was commenced on Day four.

Feed /

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	20	18.0	0.2	0.2
	Whole Milk	300	9.9	11.1	14.4
Feed 2					
	Casilan	20	18.0	0.2	0.2
	Glucose	20	-	-	20.0
	Lactose	10	-	-	10.0
	Whole Milk	210	6.9	7.7	10.0
	Fat Emulsion	90	-	45.0	-
			52.8	64.2	54.8

Protein 53 g.
Calories 1008.

These feeds were accepted well initially, but during the fifth week feeding became extremely difficult. She began to refuse all solid food and took fluids only under pressure. Tube feeding was instituted on the thirty-fourth day.

Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Casydrol	60	30.0	-	30.0
Hepovite	30	15.0	-	14.4
Glucose	100	-	-	100.0
Evaporated Milk	400	30.4	33.6	49.2
Fat Emulsion	120	-	60.0	-
Water to	1250	-	-	-
		75.4	93.6	193.6

Protein 75 g.
Calories 1922.

Vitamins and iron added in amounts shown in Table 14.

Feeds of 250 ml. were given at 6 a.m., 10 a.m., 2 p.m., 6 p.m, and 10 p.m.

Water and diluted fruit juice were allowed ad libitum. Initially, total fluid intake was around 1500 ml., and this was increased by giving an extra 500 ml. of water daily by the naso-gastric tube. After seven to ten days, oral fluid intake was satisfactory, and the extra fluid by tube was discontinued.

Because of the profuse exudate from the surface due to B. proteus infection on the forty-sixth day, the feed was increased on the forty-eighth day.

Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
Casydrol	90	45.0	-	45.0
Hepovite	30	15.0	-	14.4
Glucose	100	-	-	100.0
Evaporated Milk	600	45.6	50.4	73.8
Fat Emulsion	120	-	60.0	-
Water to	1250	-	-	-
		105.6	111.4	233.2

Protein 106 g.
Calories 2355

Vitamins and iron added as in previous feed.

This increase was tolerated well. An attempt was made to reduce the tube feeding with a view to discontinuing it on the seventy-sixth day, but again solids were rejected almost completely so the attempt was abandoned until the eighty-third day, when three-fifths of the feed was given, and gradually reduced as satisfactory oral feeding was resumed, and discontinued completely on the eighty-ninth day.

Comment (Table 46)

No weight was available from admission weight until the beginning of Week two. The fall apparent then continued until the end of Week three. The weight loss was 1.6 Kg., a percentage loss of 9.2. Weight then rose until the end of Week five, after which it fluctuated until Week nine. Rapid gain followed.

The protein intake was in excess of the estimated requirement by 1-3 g./Kg. throughout. The calorie intake was also in excess by 20-30/Kg., except during Week one and thirteen.

Case 39.- This girl, aged five years, was burned when her nightdress caught fire. The burns involved the anterior and posterior chest, thighs, buttocks, and hands, totalling 34 per cent of the body surface.

She was admitted within one hour of the accident in good general condition.

Intravenous therapy was instituted and continued for forty-eight hours :-

Plasma - 1240 ml.
Whole Blood - 200 ml.
Oral fluids and 5 per cent glucose - 1445 ml.

Later /

Later on the day of admission, under general anaesthesia, the burns were cleansed and dressed. Dressings were carried out on the sixth and eleventh day, when the involved areas on the anterior trunk were noted to be superficial and healing satisfactorily.

On the eighteenth day, the eschar on the arms and axillae was excised and razor grafts applied. These grafts "took" well. Further grafts were applied to the posterior chest and thighs on the twenty-seventh, thirty-fifth, and thirty-eighth day, by which time the original donor sites were well healed. The "take" of grafts on both occasions was excellent. Dressings were continued twice weekly, and on the fifty-second day razor grafts were applied to the remaining small areas. These failed almost completely and were regrafted on the sixty-sixth day with resultant good "take". By the seventy-third day, all areas were healing well, apart from a few small chronic granulating areas, which remained unhealed until the ninetieth day. She was discharged on the one hundred and nineteenth day.

Estimated Requirement

Admission weight 22.6 Kg. Expected weight 17.9 Kg.

Protein 56 g.
Calories 1600.

Oral supplementation of the ward diet was commenced on Day three.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	30	27.0	0.3	0.3
	Whole Milk	600	19.8	22.2	28.8
Feed 2					
	Casilan	20	18.0	0.2	0.2
	Glucose	20	-	-	20.0
	Lactose	10	-	-	10.0
	Chocolate Powder	10	0.6	2.1	6.6
	Whole Milk	210	6.9	7.7	10.0
	Fat Emulsion	90	-	45.0	-
			72.3	77.5	75.9

Protein 72 g.
Calories 1294.

The feeds were accepted well until Day forty-four and dietary intake was satisfactory. From then onwards, feeding of both liquids and solids was difficult and time consuming, but as, by this point, the great majority of the areas were grafted, the original regime was continued until the seventy-second day, when all supplementary feeding was discontinued.

Comment /

Comment (Table 47)

Weight loss continued, slowly during Week one and two, until the end of Week three. Loss was then apparently arrested, but further fall continued thereafter until the end of Week eight. The weight loss was 4.0 Kg., a percentage loss of 17.7. Weight then rose rapidly.

The protein intake was in excess of the estimated requirement from Week two to seven. Otherwise it was below.

The calorie intake was less than requirement except during Week three and four.

Case 40.- This boy, aged eight years and nine months, was burned when his clothes caught fire. The burns involved the face, neck, anterior and posterior chest, arms, and right thigh, totalling 35 per cent of the body surface. He was admitted in moderate shock two hours after the accident.

Intravenous therapy was instituted and continued for forty-eight hours :-

Plasma - 2350 ml.
Whole Blood - 450 ml.
Oral fluids and 5 per cent glucose - 1545 ml.

Later on the day of admission, under analgesia, the burned areas were cleansed and dressed, except the face which was exposed. Because of a deep circumferential burn of the right arm, release incisions from axilla to wrist were required to relieve severe venous congestion in the right hand.

On the eighth day, his temperature rose to 104°F. (40°C.), and he complained of frequency and dysuria. The urine was loaded with pus cells. This infection was presumably related to a urinary catheter, which was in position throughout the period of resuscitation. It responded rapidly to sulphadimidine 0.5 g. six hourly.

Twice weekly dressings, and excision of loose slough, were continued until the twenty-eighth day, when razor grafts were applied to the neck, right shoulder, and axilla. Immediately following this procedure, he began to run a temperature of 103-104°F. (39.4-40°C.). The urine was clear, but culture from the raw areas showed a heavy growth of Staphylococcus aureus, sensitive only to Erythromycin. There was only a fair "take" of the grafts, and the temperature remained high.

On /

On the thirty-second day, Erythromycin, 150 mg. six hourly, was commenced, and continued for six days. This had little effect on the temperature, and the surface continued to show a heavy infection with Staphylococcus aureus.

Razor grafts, applied on the thirty-fifth day to the right arm and chest "took" well, and with continued twice weekly dressings, the infection of the surface gradually decreased. On the forty-ninth day, razor grafts were applied to the shoulder with subsequent good "take" and evidence of outgrowth of the previous grafts. On the sixty-third day, razor grafts were applied to the posterior trunk and "took" well.

Thereafter, there was gradual surface improvement and coalescence of grafts so that healing was virtually complete on the ninety-sixth day.

He was discharged to the convalescent home on the one hundred and twenty-third day.

Estimated Requirement

Admission weight 27.3 Kg. Expected weight 25.2 Kg.

Protein 74 g.
Calories 2000.

Oral supplementation of the ward diet was commenced on Day three.

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	30	27.0	0.3	0.3
	Glucose	40	-	-	40.0
	Lactose	20	-	-	20.0
	Whole Milk	360	11.9	13.3	17.3
	Fat Emulsion	150	-	75.0	-
			38.9	88.6	77.6

Protein 39 g.
Calories 1269.

This was accepted well and on Day six a further supplement was added.

Feed 2	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casilan	40	36.0	0.4	0.4
	Whole Milk	600	19.8	22.2	28.8
			55.8	22.6	29.2

This /

This, along with Feed 1, gave a total supplementary intake of :-

Protein 95 g.: Fat 111 g.: Carbohydrate 107 g.: Calories 1807.

Both feeds were accepted and tolerated well, and were continued until Day eighty-one, when all supplementary feeding was omitted.

Comment (Table 48)

Weight loss occurred during Week one, was apparently arrested at Week two, and then continued to fall until the end of Week four. The weight loss was 1.9 Kg., a percentage loss of 5.9. There was then a slow rise, with a slight fall at Week nine, followed by further gain.

The protein intake was in excess of the estimated requirement by about 1 g./Kg. throughout, except at Week one. The calories were also greater than requirement except at Week one.

Case 41.- This boy, aged ten years and ten months, was burned when his clothes caught fire. The burns involved the neck, both legs and buttocks, and patchy areas on the trunk, totalling 36 per cent of the body surface.

He was admitted four and a half hours after the accident in moderate shock.

Intravenous therapy was instituted. The initial catheter specimen of urine revealed gross haemoglobinuria. This was treated by a rapid infusion of polyvinylpyrrolidine (plasmosan) and the urine became free of visible pigment in the next two hours. Intravenous infusion was continued over the next seventy-two hours :-

Plasma - 1660 ml.
Whole Blood - 825 ml.
Oral fluids and 5 per cent glucose - 5815 ml.

On the second day, under general anaesthesia, the burns were cleansed and all areas were dressed except the neck, which was exposed.

The dressing was changed on the fourth day, and on the eighth day the eschar on the neck, adjoining chest, thighs, and legs was excised. Razor grafts were taken and stored.

On /

On the twelfth day, upper abdominal distension developed with gastric dilatation. Aspiration of the stomach produced 600 ml. of gastric contents. Bowel sounds were present. Fluids by mouth were restricted for twenty-four hours and no further dilatation occurred.

On the fifteenth day, the stored razor grafts were applied to the neck, and on the eighteenth day further razor grafts were taken and placed on the thighs. All these grafts "took" moderately well.

On the twenty-ninth day, dermatome grafts were applied to the left lower leg and both popliteal fossae. There was subsequent good "take" of these grafts and extension of those applied previously noted.

On the thirty-sixth day, culture from the raw areas revealed a profuse growth of B. haemolytic streptococcus. While the infection persisted, no further grafting was attempted, and dressings were continued twice weekly. There was little general upset.

On the fifty-third, sixty-fourth, and seventy-third day, razor grafts were applied to the thighs and these "took" well, and on the eighty-first day outgrowth from all of these grafts was marked.

On the eighty-fourth day, he complained of dysuria, and bladder distension was noted. Examination revealed that the fossa navicularis was crammed with gritty debris. Its removal relieved his symptoms and the distension. Culture revealed a sterile urine.

On the eighty-eighth day, razor grafts were applied to the buttocks and thighs with resultant good "take". Dressings were continued and on the one hundred and fourth day, razor grafts were applied to the remaining raw areas.

Rehabilitation was slow, and after a period of intensive physiotherapy, he was discharged to the convalescent home on the one hundred and sixty-sixth day.

Estimated Requirement

Admission weight 33.6 Kg. Expected weight 31.7 Kg.

Protein 102 g.
Calories 2450.

Tube feeding was commenced on Day four.

Feed /

Feed 1	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casydrol	90	45.0	-	45.0
	Hepovite	90	45.0	-	34.2
	Glucose	60	-	-	60.0
	Whole Milk	420	13.9	15.5	20.2
	Evaporated Milk	600	45.6	50.4	73.8
	Fat Emulsion	140	-	70.0	-
	Water to	1500	-	-	-
			149.5	135.9	233.2

Protein 150 g.
Calories 2756.

Vitamins and iron added in amounts shown in Table 14.

Feeds of 300 ml. were given at 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m. An additional 500 ml. water were given at 2 a.m., which, along with oral fluids, gave a total fluid intake of around 2500 ml. daily.

The above feeding was introduced gradually from Day four, commencing with two feeds of 500 ml. and working up to the full amount by day nine. All tube feeding was stopped from Day twelve to thirteen during the period of abdominal distension, and reintroduced gradually over the fourteenth to the eighteenth day to the full amount. On the nineteenth day, an additional 40 ml. Fat Emulsion was included increasing the calorie content to 2936. On the fortieth day, a further 40 ml. Fat Emulsion was added, giving a total calorie value of 3116.

This feeding was tolerated well, no vomiting or diarrhoea occurring, and was continued until the sixty-eighth day. The loss from the surface had decreased considerably at this point with the amount of skin cover achieved, and a reduction was made in the protein content of the feeds, while continuing to provide a high calorie intake.

Feed 2 (day sixty-eight)	Constituent	Amount g.or ml.	Pro. g.	Fat g.	Carbohydrate g.
	Casydrol	90	45.0	-	45.0
	Hepovite	90	45.0	-	34.2
	Glucose	100	-	-	100.0
	Evaporated Milk	400	3o.4	33.6	49.2
	Fat Emulsion	270	-	135.0	-
	Water to	1500	-	-	-
			120.4	168.6	228.4

Protein 120 g.
Calories 2913.

Vitamins and iron added as in previous feed.

The /

The same regime as to volume and timing was maintained, as that used for Feed 1.

On the eighty-first day, a further reduction was made by omitting one 500 ml. feed at 10 p.m., and giving 500 ml. water in its place. The tube feeds then provided :-

Protein 96 g.; Fat 135 g.; Carbohydrate 183 g.; Calories 2331.

This regime was followed until tube feeding was discontinued on the one hundred and thirteenth day.

Comment (Table 49)

Weight gain occurred at Week one. There followed a rapid severe weight loss until the end of Week four. The total loss was 5.2 Kg., a percentage loss of 15.2. The weight then remained static until Week six, after which there was a rapid continuous weight gain, apart from Week thirteen when no gain was recorded.

The protein intake was at or above the estimated requirement except during Week one and seventeen, as was also the calorie intake, which was 10-20/Kg. in excess.

Discussion

(Charts 17, 18, 19).

Case 36 and 39 again demonstrated weight loss associated with reduction in calorie intake.

In case 36, weight loss continued for four weeks and then appeared to have been arrested, with good evidence of weight gain. A fall in intake at Week seven, with calories below requirement level, was associated with further weight loss, weight reaching the lowest level previously recorded. The protein level over this period was in excess of requirement. Thereafter, with intake well above requirement level, weight gain was continuous and rapid, apart from slight loss at Week thirteen.

In /

In Case 39, the weight loss was apparently arrested at the end of the third week. A fall in intake at Week five and six, with the calories below requirement level, was associated with the reappearance of weight loss, the lowest weight recorded coinciding with the period of lowest intake, at Week eight. However, despite only a relatively small increase in intake, weight gain occurred and was maintained.

Case 37 and 38, in comparison, showed a different weight picture.

In Case 37, the very small weight changes were striking, the lowest recorded weight occurring at Week two, the weight thereafter fluctuating around admission level. Intake was maintained at an almost constant high level from Week two to seven, covering the period of grafting, which was complete at Week five. The marked drop in calorie intake at Week eight was not associated with weight loss, but may be reflected in the weight drop which occurred at Week nine, and which continued until intake was increased at Week eleven.

Case 38 also showed less loss of weight than Case 36 and 39, although there was little difference in the injury. Weight loss ceased at the end of Week three, although definite continuous gain was not established until Week nine, despite a high intake throughout this period. The weight gain phase coincided with marked surface improvement, allowing final grafting to take place.

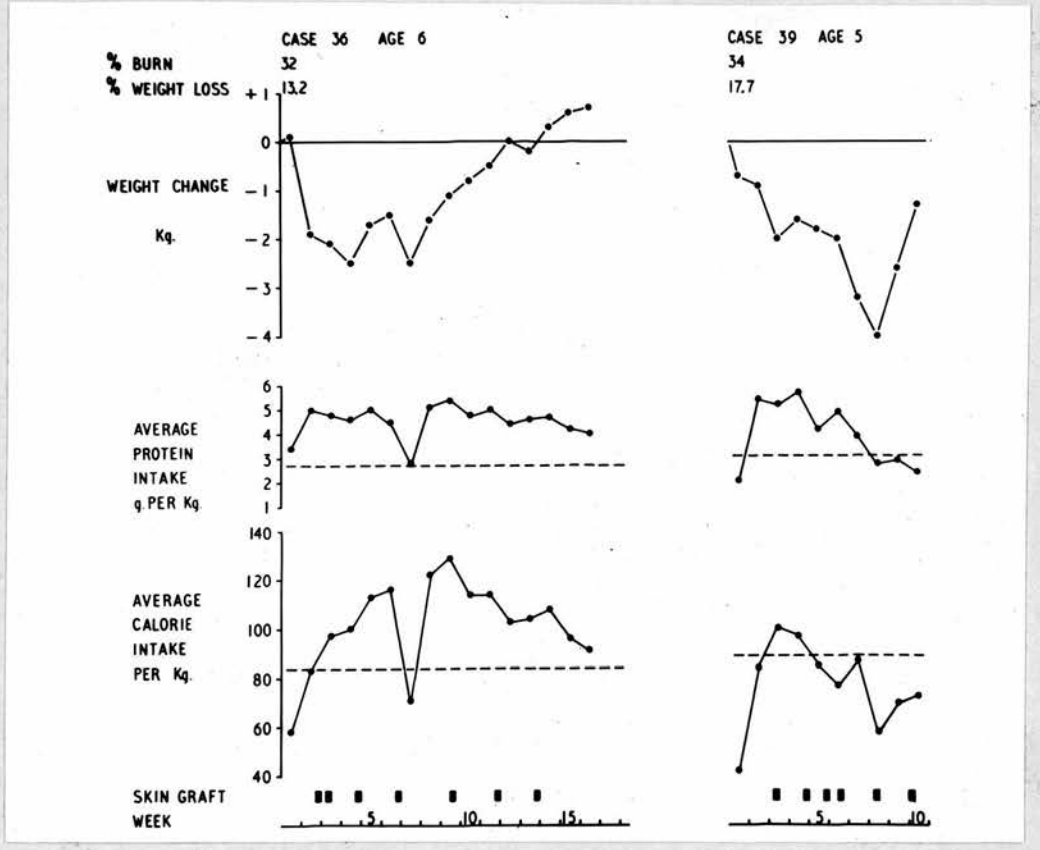
Case 40 and 41 were both male children in an older age group. There was, however, a marked difference in the extent of full thickness skin loss, the injury in Case 41 being almost entirely a deep burn.

In Case 40, the weight loss was apparently arrested at the end of Week one, but there was loss again at Week three and four, so that the /

the true end of weight loss probably occurred at this time. Apart from Week one, intake of both protein and calories was at or above requirement level throughout. The arrest of weight gain, and the fall at Week nine, occurred despite little change in intake, but skin grafting was carried out during both these weeks. On the other hand, no grafting took place during Week eleven, when weight was again static. This would seem to indicate that in this case, requirement was only just being met at this level of intake. This is further substantiated by the fact that the highest single weight gains occurred at Week ten and twelve at the same time as an increase in calorie intake took place.

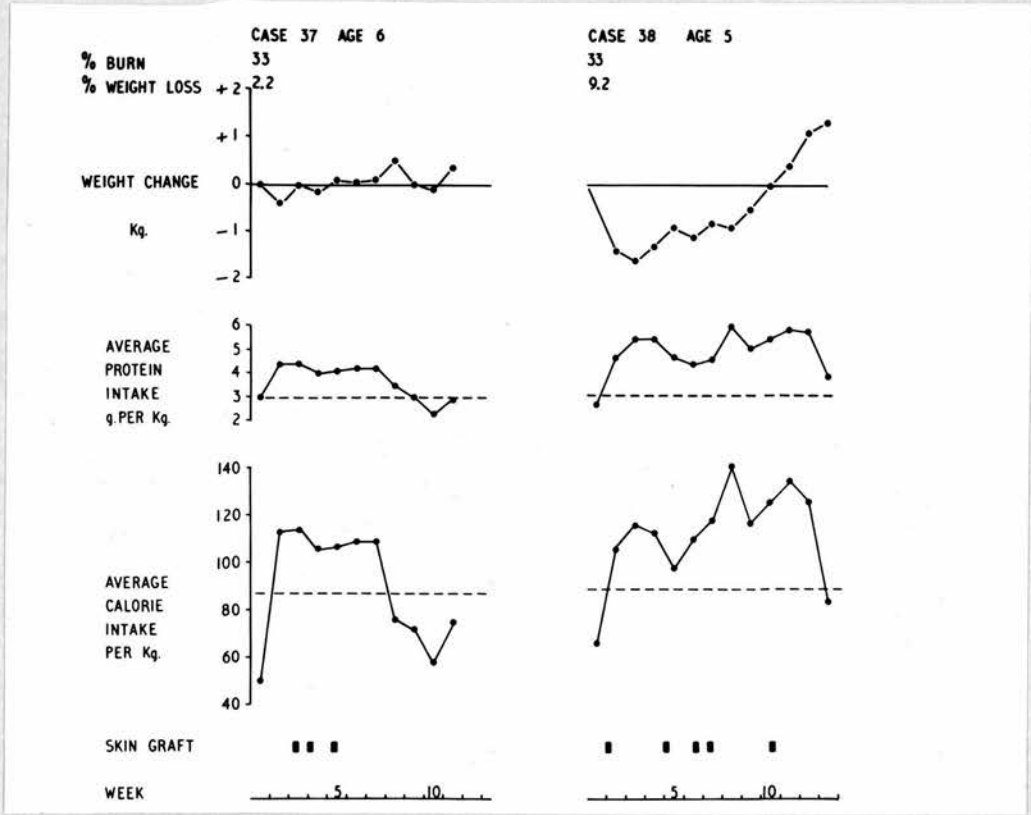
At first sight, Case 41 would appear to have suffered the most severe weight loss of any of the children studied. While this was true when Kg. weight loss was considered, there was little difference in percentage weightloss from Case 30, 32, and 34. However, apart from Week one and seventeen, intake was maintained at or above the requirement level throughout. As with Case 40, it appeared that the recommended levels were only just reaching requirement, the static weight at Week thirteen, during the period of rapid weight gain, being associated with a drop in intake to just on requirement level. By Week seventeen, however, weight gain continued despite a dramatic fall in intake, but, at this time, grafting had been completed and only very small areas were left to heal.

CHART 17



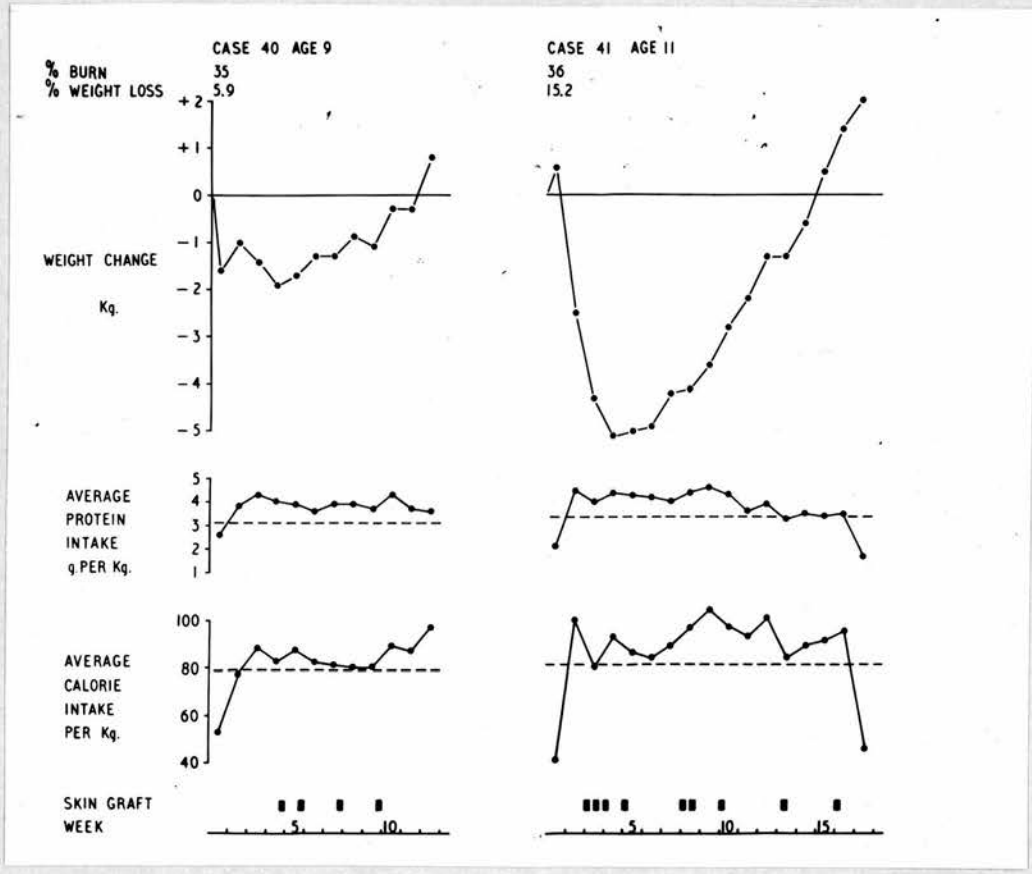
Case 36, 39.- To show change in body weight and average levels of intake achieved. The interrupted line in the intake graphs shows the level of estimated requirement.

CHART 18



Case 37, 38.- To show change in body weight and average levels of intake achieved. The interrupted line in the intake graphs shows the level of estimated requirement.

CHART 19



Case 40, 41.- To show change in body weight and average levels of intake achieved. The interrupted line in the intake graphs shows the level of estimated requirement .

GENERAL COMMENT AND DISCUSSION

In the first instance, it will be noted, as might be expected, that there was a fair measure of individual variation. In some, although every effort was made to achieve the recommended intakes consistently, this was not always possible. It was always easier to reach requirement level in the child, and there are two possible reasons for this. The child accepts without question, for the most part, and also the nutrition of every child, well or ill, is accepted as being of extreme importance. Apart from this, however, it is found that if the average levels of intake are to reach those recommended, higher daily levels are required. The main reason for this is that, despite much improved intakes on days of anaesthesia, the intake on these days remains lower than requirement.

A further practical point is of interest. By and large, the recommended levels of intake are achieved more consistently by the patients with the more severe injuries, although in them the required levels are higher. This, at first, may seem to be a paradox. However, all members of the staff, especially the nursing staff, are, perhaps, more acutely aware of the nutritional needs of the more severely injured patients, and make a real effort to obtain the higher levels of intake. Again, many of the more severely injured patients are fed by nasogastric tube supplying, in most cases, the full requirement. The variation in solid food intake is, therefore, not present in such patients. Thus, the patients, in whom it is most difficult to achieve the required levels, are those with minor injuries, up to 20 per cent of the body surface involved, and those with more major injuries in whom the maximum effort is made with oral supplement /

supplement, and in whom perhaps, nasogastric tube feeding would be preferable.

The studies of individual patients also vary in length. This is dictated in many ways, being dependent to a large extent upon healing time, which is an uncontrollable variable.

It would obviously be ideal to have all patients on relatively similar constant intakes for identical periods of time, but this is almost impossible because of the nature of the injury.

Bearing these reservations in mind, the results can be considered more fully.

The Weight Pattern

In the adult, the weight follows, for the most part, one of two patterns and this appears to be related to the nature of the injury. Thus, the patients with areas of full thickness skin loss requiring subsequent grafting are those who show weight gain at the end of the first week, or as in Case 13, and 21, slight loss. The only patient with superficial injuries, who shows weight gain is Case 14, in whom no weight loss was recorded at any time. Otherwise all patients with superficial injuries show a rapid fall in weight during Week one, independent of the extent of their injuries and the resuscitative therapy required.

In the children, all of whom had injuries which required subsequent grafting, nine showed weight gain, three slight loss, and five rapid weight loss. There is no evident reason for this difference, either in the nature of the injury or in the intravenous therapy employed.

After this first week, the most common pattern, apart from the children with minor injury, is of a period of rapid weight loss, which /

which continued for three to four weeks, usually being shorter in the less severely injured. Over and above the varying duration of the weight loss, there is also variation in its degree. In this connection, the percentage of the total body weight lost from admission level is considered to be much more important than the actual number of Kg. lost. This is well illustrated by Case 21 and 41. While inspection of the weight curve suggests a much more severe degree of loss than in other patients, this impression is false when related to admission body weight.

By using a percentage figure, the weight loss of individual patients may be compared. Considered for the present, independent of intake, there is wide variation, as is shown below.

Extent of Burn	Range of Percentage Weight Loss	
	Adults	Children
- 10 per cent	2.2 - 5.3	-
11 - 20 per cent	5.8 - 10.2	3.1 - 18.3
21 - 30 per cent	0 - 13.6	2.2 - 17.2
31 - 40 per cent	6.8 - 14.2	2.2 - 17.7

In no patient is the percentsge weight loss greater than 18.3, but there is wide variation within groups, although the range is similar between groups in the children. The magnitude of the weight loss in many of the children is of particular importance as the growing healthy child is in a state of anabolism. Weight loss such as that recorded in these burned children, whatever its cause, is, therefore, of extreme importance.

Following upon the period of weight loss, the weight either remains /

remains static for one to two weeks, with subsequent rapid gain, or rapid gain begins as soon as the phase of maximal loss is over. Weight gain, once established, is rapid and in the later stages may continue even when intake is reduced.

The rapid gain, without the intervening period of static weight, is noted most frequently in those with superficial injuries, provided intake approaches the recommended levels at this time. Those showing a period of static weight, or very slowly increasing weight for one to three weeks after the end of the period of loss, are most commonly those with major deep burns, or those in whom intake does not reach the recommended levels over this period.

Almost without exception in the major deep burn, rapid weight gain does not occur until grafting is well advanced, while in superficial injury gain is not evident until healing is nearing completion. These observations offer a possible explanation for the varying onset of weight gain, for the onset coincides with reduced surface loss in both instances. In the superficial injury, the surface loss occurs early - soakage of dressings during the first one to two weeks is a noticeable occurrence in these patients. The opposite occurs in the deep burn, where the involved area remains dry until the eschar begins to slough around the second or third week after injury. With the development of a large granulating area, the surface loss is correspondingly increased. Thus, in the superficial burn, the greatest loss occurs early, while in the deep burn it occurs much later in the post burn course.

The time at which increased intake is required should, therefore, vary in the two types of injury. In those with superficial injury, it should be given early; in those with deep injury, it should be assured /

assured certainly over the period of maximal loss, which will vary within one to two weeks depending on the rate of sloughing. This may well help to explain the exceptions to the general weight pattern. For example, Case 14, in whom no loss of weight was recorded, reached the recommended levels of intake early and maintained them, whereas in the other superficial injuries, the recommended levels were not achieved until much later, probably after their maximal needs were over. In Case 31, where the weight remained virtually static, excision of the eschar was carried out during the second week with some immediate skin cover. The remaining raw area, resulting from the excision, thus provided a source of early maximal loss and intake was maintained at a high level over this period. In Case 37, sloughing occurred very rapidly so that skin cover was virtually achieved by Week five. The maximal loss, therefore, occurred early and, again, intake was well maintained over this period.

Similarly, it can be argued that the severe early weight loss in Case 22 occurred at the period of maximal surface loss. Intake should, therefore, have been maximal over this period, while in fact it fell far short of requirement.

The importance of surface loss may also offer an explanation for the continued weight gain which takes place in the later stages of convalescence in the deep burn, despite reduction in intake. At this period, surface loss is negligible as healing nears completion.

By the same token, nutritional states, such as those shown by Case 1, 2, and 3, occur in patients with large granulating areas. They have never been reported, here or elsewhere, in a patient with superficial injuries.

It must be emphasised, however, that the patient with extensive burns, in many instances, shows a mixture of superficial and deep burns, and when such is the case, there will be increased surface loss both in the early period and later on as well.

Attractive as this argument for the importance of surface loss is, it cannot explain the severe early weight loss so characteristic of the extensive deep burn. It would seem more probable that two different states are produced and that two different responses to the trauma occur, this not being only a matter of degree.

It would appear that the superficial injury, independent of its extent, provokes but a mild response, which may even be reversible provided the patient is not "starved", starvation in this instance being present if the surface loss of protein is not made good, or if the protein provided to replace the loss is not covered by a sufficient calorie intake.

True starvation, on the other hand, can be excluded in all the patients presented. If it is present at all, it is relative to the needs of the patient. Occasionally, the effects of true semi-starvation are seen. In Case 22 and 28, the extreme falls in weight coincide with the periods of very low levels of intake. Otherwise, all the adult patients received more than many observers have recommended for the average adult at rest. For example, Cole et al. (1955) quoted figures of 1 g. protein per Kg. body weight per day, and 1850 calories per day as being adequate. Similarly, except in isolated instances, all of the children received the necessary intake for the same child in health. On these findings, starvation can be ruled out absolutely.

There is little doubt that the introduction of a deep burn of any /

any significant extent appears to alter the picture. While the wound itself may not be wholly responsible, it apparently has a profound influence. Thus, Cope et al. (1953), in studying the basal metabolic rate, could find no explanation for its increase in the burned patient other than the influence of the wound. The increase was greater as the size of the area of full thickness loss increased and receded as the wound healed. If only the increased metabolic rate were responsible for the weight loss, however, it should be reversible by increasing the calorie intake. While this may be possible sometimes after Week four or five, early high calorie intake prevents the weight loss only in rare instances. It may be that the recommended calorie intakes are not high enough. In support of this, it is noted frequently, during the weight gain phase, that the weight is highly sensitive to changes in calorie intake. This sensitivity is perhaps most noticeable in the child. Thus, when a drop in calorie intake occurs at this time, it may be associated either with a concurrent fall in weight, or an arrest of weight gain with static weight. In a few instances, the weight drop apparently occurs the week following the drop in calorie intake. It would appear, therefore, that calorie requirement is only just being met in these cases, even although in many instances, it is well above recommended intake. Further, this is occurring at a time when the demand for increased intake should be diminishing - as raw areas are grafted and wounds heal. If calorie needs are only just being met met with these high levels at this period, it is unlikely that they are being reached in the earlier stages.

One other factor may be of importance here. If the increased protein provided is to be utilised adequately, calorie intake must also /

also be increased. It is here that the calorie nitrogen ratio may be of some value. Moore (1952, 1953) stated that when a sustained positive nitrogen balance is achieved, it cannot be increased beyond a certain level with forced feeding. He suggested, however, that the ratio of total calories to nitrogen should be at least 150 : 1. With a ratio of less than 100 : 1, larger quantities of nitrogen will be excreted, the belief being that, at these lower ratios the protein is utilised as an energy source. Blocker (1955) in suggesting a requirement in the burned patient of 2-4 g. Protein/Kg. body weight and 35-85 calories/Kg. per day, stated that good results were obtained with calorie nitrogen ratios of 85-130.

It must be borne in mind that the value of the calorie nitrogen ratio is in assessing the utilisation of recommended levels of protein intake. As an illustration, Case 30 in this series, shows a calorie nitrogen ratio in the first week of 289 : 1. The total nitrogen intake, however, only averaged 3.4 g. with 981 calories. Obviously, this is an unsatisfactory intake despite the high calorie nitrogen ratio.

However, where high levels of intake are reached, it can give valuable information. Thus, in Case 31, where very high intakes are obtained, ratios of 88 : 1, and 98 : 1 were obtained in Weeks 4 and 5. While the ideal calorie nitrogen ratio for children is not known, the recommended intakes in health all have ratios of over 140 : 1. The ratios noted in Case 31, therefore, indicate a wastage of protein.

In all other patients presented, the ratio, with intakes at or near estimated requirement levels were over 100 : 1, and in the majority over 150 : 1.

It /

It was noted previously that the weight, during the period of weight gain, is apparently sensitive to changes in calorie intake, even when this does not fall below requirement level. It is probably significant that the calorie nitrogen ratio obtained at such times is little different from that in the weeks before or after. This would imply that the weight loss, or static weight, is due to a true calorie lack, rather than insufficient protein intake, for the calories provided are thus shown to be adequate for full utilisation of the protein to occur.

In the extensive deep burn increased intake of both protein and calories to recommended levels in the later stages, after the third and fourth week, does appear to hasten weight gain, and perhaps allows convalescence to proceed more rapidly. The benefits conferred in the early stages are moredifficult to assess the effect on weight not being consistent. In only a very few instances, mainly in the smaller injuries, can the weight loss be prevented. Where the recommended intake is achieved early, and this is shown to be difficult in the more severely injured, itmay influence the severity and perhaps the duration of the weight loss.

This obviously raises the question as to whether or not an attempt should be made to force these high intakes during the first two to three weeks after injury. It has been found, however, that it is easier to establish tolerance to high intakes if forced feeding is begun early. The high levels can seldom be attained during the first week, but if the attempt is delayed until the third week, or the fourth week, it is difficult to introduce the high intakes required, and, in the adult, to convince the patient of the need for the increase at this later stage.

Only /

Only one patient, with major injury, has been treated by delaying the introduction of supplementary intake until the middle of the third week. The result was highly unsatisfactory. The higher levels of intake were tolerated fairly well, but there was some diarrhoea and vomiting when the supplement was first given, and this persisted during the next two weeks. Loss of weight was severe, 22.5 per cent, and continued for five weeks. Thereafter, it remained static with a slight tendency to further fall, despite maintenance of intake at recommended levels. Grafted skin "took" well, but the remaining small raw areas were extremely slow to heal, and the donor sites broke down repeatedly. General condition and morale were very poor for long periods, and rehabilitation was extremely slow. No weight gain was recorded until the twenty-eighth week with the introduction of tube feeding at this time.

However, it is probable that early high intakes are themselves not without danger. Moyer (1955) describes a "protein overload syndrome" with ileus, diarrhoea, nausea, and vomiting occurring as minor difficulties, and a full blown picture manifested by uraemia, hypernatraemia, hyperchloraemia, hyperpyrexia, and disorientation. Protein overload may well have been the reason for the gastric dilatation, which occurred in Case 41 on the twelfth day. Selye (1950) also suggests that overfeeding may produce what he terms "food shock" manifested by acute gastric dilatation, which can be prevented by gradually increasing food intake. This suggests that the increment in Case 41 was too great and too rapid.

Evans and Butterfield (1951) describe another complication of early forced feeding. This syndrome they call "burn stress pseudodiabetes" with hyperglycaemia and glycosuria, but no acetonuria /

acetonuria. They describe three cases, and in two the outcome was rapidly fatal. The condition is an insidious one, and, because of the absence of ketosis, is often missed until dehydration is extreme. One similar case occurred and is reported briefly.

Case 42.- A mentally defective boy, aged nine years, sustained flame burns involving 41 per cent of his body surface, when his clothes caught fire. He was admitted in severe shock and the burns were noted to be almost entirely deep. Resuscitation was uneventful.

Estimated Requirement

Admission weight 19.3 Kg. Expected weight 26.3 Kg.

Protein 74 g.
Calories 2100.

A nasogastric tube was passed on the third day and increments to intake were made as follows : -

	Protein g.	Fat g.	Carbohydrate g.	Calories
Day 3	62.0	32.0	134.0	1072
Day 4	62.0	77.0	134.0	1487
Day 5	77.5	107.5	180.0	2004
Day 8	93.0	138.0	226.0	2518

Intake was given entirely by nasogastric tube, 300 ml. of feed being given at 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m., with 500 ml. water given at 2 a.m. from Day ten onwards. The feeding regime was tolerated very well, with no vomiting or diarrhoea.

Urinalysis on admission was negative for sugar and remained so although the specific gravity was occasionally as high as 1.030.

On the twelfth day, he became disorientated and the urinary output increased dramatically to 100 ml./hour from a previous level of around 30-50 ml./hour. The urine was loaded with sugar, and the blood sugar was 270 mg. per cent.

In view of the severity of the burn, intake was reduced only to the level of Day five and soluble insulin given as required. A blood sugar curve on the eighteenth day after 20 g. of glucose gave the following result:-

Fasting /

Fasting	74 mg. per cent.	
1 hour	160 mg. per cent.	Urine sugar +++
1½ hours	160 mg. per cent.	
2½ hours	153 mg. per cent.	

In the specimens taken, the blood sugar did not exceed the renal threshold level, although the omission of the half-hour specimens is unfortunate for the urinalysis at one hour suggests that it may have been higher. The main abnormality noted, however, was the failure of the blood sugar to fall in the usual manner at two and a half hours.

By the twenty-third day, despite maintenance of intake, insulin was no longer required.

The local condition progressed satisfactorily until the thirty-first day, when a conspicuous absence of any granulation was noted, and on the same day the blood sugar, which had remained normal, rose to 385 mg. per cent. Despite insulin therapy, it rose to 586 mg. per cent on the thirty-third day, but was again normal on the thirty-fourth day. The local surface showed further deterioration and the need for insulin continued. A percentage body weight loss of 8.8 had occurred up to this time.

Death occurred suddenly on the thirty-sixth day, and post-mortem revealed no obvious cause. The pancreas showed possible diabetic changes, but it was the opinion of the Pathologist that "if these changes were caused by the burn, a more acute type of lesion might be expected".

In retrospect, while this intake could not be considered excessive for a child of nine years, it should have been noted that he was 7 Kg. underweight for his age. Intake should probably have been estimated for a child of about five and a half years, giving a protein requirement of 56 g. and calorie requirement of 1600. Viewed in this way, intake was excessive and prebably introduced too rapidly.

This syndrome has never been reported in any patient whose intake has not been increased over normal levels.

Evans and Butterfield (1951) suggest that it is probably related to the effect of the glucocorticoids reducing carbohydrate tolerance and to high carbohydrate, high calorie diets and frequent feeding. While the carbohydrate level was not excessive in Case 42, the /

the calories were high and the régime was one of frequent feeding.

Other patients have developed rarely a mild, transient glycosuria, but the syndrome has not developed.

While neither of these complications is a contra-indication to early feeding, the fact that they have both been observed in a relatively small series, is a sufficient warning and certainly suggests that, if higher intakes than those already attempted were given, both complications might occur more frequently.

It would appear that the most satisfactory régime in the extensive deep burn is to introduce the recommended levels of intake gradually over the first two weeks, so that they are consistently achieved from the third week onwards and continued over the period of maximal surface loss and through the major grafting procedures. It may well be that they should be reduced in a stepwise fashion, as the extent of the raw area decreases. This suggestion is supported by the fact that many patients continue to show rapid weight gain even with reduced intake, once skin cover is nearing completion.

It can, of course, be argued that changes in body weight are too complex and their measurement too crude to be of real value, but it is felt that not enough use had been made previously of accurate serial weight recordings. It must be emphasised again that weights which include dressings can be of little value and that a naked weight obtained less frequently is of much more importance, showing whether or not a weight trend is being maintained.

In using weight as a nutritional index, weight loss or gain can represent one, or a combination of three changes.

(1) Change in the distribution of body fluids.

(2) Change in lean body mass, catabolism being associated with weight /

weight loss and anabolism with weight gain.

(3) Change in body fat, breakdown being associated with weight loss and storage with weight gain.

In the burned patient, it is probable that all three processes are involved. Initially, weight gain is of frequent occurrence due to wound oedema and adequate resuscitative therapy. Moore (1955) states that the severely burned patient adequately treated, shows an almost constant weight gain of 10 per cent of his initial body weight during the first forty-eight to ninety-six hours after injury, followed thereafter by a sharp decline as diuresis occurs. This early weight pattern is illustrated in many of the patients presented. Many still show evidence of weight gain at Day seven and there is obviously individual variation in the rate at which diuresis occurs. It is, therefore, of importance to record the admission weight before commencing intravenous therapy, as weight measured during the first week will give a false high value in the majority of cases.

After this period of weight gain and return to admission level, any loss of weight must be associated with catabolism of lean body tissue and/or breakdown of body fat. In many of the detailed studies of nitrogen balance following thermal injury, it is noted that the negative nitrogen balance does not always correlate well with the changes in weight using the factor recommended by Moore and Ball (1952) of 30 g. whole body tissue per gram of nitrogen. Thus, Reiss et al (1956), in what is probably the most comprehensive study of the metabolic response following burns, consider that the difference between the actual weight loss and that predicted from the nitrogen balance, which is less, can only be explained by postulating /

postulating a coincident loss of body fat. Their studies elaborate those of Moore (1953), who emphasises that this lack of correlation is an early manifestation and that in the later period of negative nitrogen balance the correlation is closer, as it is also in the early anabolic period. Late in anabolism, the values again become divergent, which both investigators suggest must represent fat gain, the degree of positive balance at this time representing less weight gain than that actually observed. Until a reliable method is developed for the direct measurement of body fat in the burned patient, the fat loss can only be inferred from studies such as those. Starving man, however, will lose body fat, and it is for this reason that weight studies should always be associated with knowledge of intake of both protein and calories during the period concerned. Another factor, which may influence body weight, is immobilisation, which in the burned patient is often prolonged, and subsequent ambulation. Dietrick et al. (1948), however, state that the changes in body weight which occur during such states are small, and, while his experiments were carried out in healthy volunteers, it is unlikely that the burned patient will react differently.

If the aim is to prevent body weight loss, then obviously the same arguments arise as to whether this is, in fact, desirable, in much the same way as the controversy over the desirability of attempting to reverse the negative nitrogen balance. It can be argued that a certain weight loss is obligatory, as it must be if the negative nitrogen is obligatory, and is not in itself harmful. The great difficulty arises in assessing the advantages or disadvantages of such weight loss and such assessment can be probably only clinical. As such, it will vary from observer to observer, those /

those who believe that adequate nutrition is important tending to see local and general improvements which may not exist, and those who believe that it has little effect tending to see no improvement from nutritional care.

Attempting to avoid the extreme view, the following observations are noted in patients presented in this study (and in many others not included) whose nutrition has been maintained and whose weight loss has not been excessive.

(1) They remain in better general health throughout their course.

(2) They show a better morale.

(3) They become more quickly ambulant.

(4) They withstand complications, especially of the local wound, better.

(5) They do not necessarily show more rapid healing or better graft "take". This would be in keeping with the relation of the clinical findings to nitrogen balance of Reiss et al. (1956), who state that grafts "take" and donor sites heal in the face of negative nitrogen balance and that positive nitrogen balance per se does not ensure good healing. Levenson (1952), however, feels reasonably certain that if patients are maintained in good nutritional state, the granulations are healthy, infection can be controlled, skin grafts "take" well, and donor sites heal uneventfully. Harkins (1954) considers general nutritional care is important in the intermediate stage of burn convalescence, from Day three, and considers it should be planned to counteract burn anaemia, burn hypoprotemaemia, and burn sepsis. Blocker (1955) states that malnutrition in patients with severe burns occurs frequently /

frequently. Artz et al (1956) believes that convalescence may be shortened by optimal nutrition.

By what index can "good nutritional state", "general nutritional care", "malnutrition", and "optimal nutrition" be gauged?

The laboratory can offer only partial assistance with such measurements as haemoglobin level, plasma protein level, and nitrogen balance studies. The number of blood transfusions required to maintain the haemoglobin level might, at first thought, appear to offer a fair measure of adequate nutrition. The maintenance of haemoglobin level is, however, dependent on so many factors. Of these, one of the most important is blood loss which will occur constantly in the burned patient after the eschar has sloughed, or been removed, and there will be a further loss from donor sites. These losses alone will influence the need for and the number of blood transfusions. If the surface becomes infected, the infection per se may also increase the need for transfusion. While in the ordinary surgical patient as Cole (1955) shows, the maintenance of haemoglobin takes precedence over all other protein regeneration, Moore et al (1946) suggest that the altered liver function in the burned patient may well interfere with haemoglobin synthesis, again influencing the number and frequency of the transfusions required.

Similarly, the unreliability of plasma protein measurement, as a nutritional index, has been stressed. In fasting man, Keys (1950) reports that even with a 25 per cent weight loss, there is not necessarily a reduction in the plasma protein level. In the surgical patient, Spence et al. (1946) state that the plasma protein concentration and the haemoglobin level per se do not reflect plasma protein and haemoglobin regeneration. Cole et al. (1955) emphasise that /

that the body protein reservoirs undergo depletion in order to maintain the plasma proteins, and also that their measurement is unreliable because of the fallacies produced by over and under-hydration. This last point applies also to haemoglobin level. While nitrogen balance studies give much information about the response of an individual patient to his injury, they do not give information about the nutritional state as a whole. They can be a guide in the nutritional requirements of the patient, only if exudate nitrogen loss is measured. This is a time consuming investigation, which cannot be carried out on every patient and because the loss is so variable (Reiss et al.(1956)), a standard allowance cannot be made for every patient.

Again, it may be argued that, from a clinical point of view, the number of grafting procedures required, the "take" of grafted skin, and the time required to reach complete healing, would, when reviewed together, provide a good index of nutritional state. While these observations may supply additional information, they are dependent upon so many other factors that their usefulness as an index becomes unreliable. Thus, the number of grafting procedures required will depend on the extent of the skin loss and not on the total extent of the burn. It will also depend upon the distribution of the burn, some areas of the body being very much more accessible than others as donor sites. Thus, the amount of donor site skin available, at any one time, may be limited, the same sites having to be used more than once with only small amounts of skin cover achieved at any one time. The reasons for failure of graft "take" are many - infection of the surface, difficulty in immobilisation, and soilage if the grafted area be around the perineum. The same area may, therefore, require /

require to be grafted more than once. Time to healing will be subject to similar interference and here, perhaps, the presence or absence of local infection at any point up to the achievement of complete skin cover will be the most important single factor. Healing time will also be influenced by the nature and distribution of the burn, and may be hastened by excision and immediate grafting of the areas of the deep burn.

On the other hand, it is probably generally accepted that any patient, not only the burned patient, who is losing weight or failing to regain lost weight, is not progressing satisfactorily (unless it be the obese patient in whom weight loss is being deliberately sought) Weight is, therefore, the best guide available regarding the nutritional status of any patient. If weight is being maintained at the patient's usual weight, or if he is gaining steadily after a period of weight loss, then intake must of necessity be adequate for that patient. Conversely, malnutrition in its development must be associated inevitably with weight loss, gain only occurring in the late stages as nutritional oedema develops.

Of all the rather crude indices discussed, therefore, a careful continued study of the body weight of the burned patient probably gives the best single estimate of nutritional state.

RECOMMENDATIONS

(1) The levels of intake recommended in adults are probably necessary, at least in the patient whose burn involves any significant extent of full thickness skin loss. Whether these levels are required in the extensive superficial burn is questionable.

(2) To base requirement on body weight alone, appears to be an unsatisfactory method of assessment. The extent, and more particularly the depth of the burn, appear to be the factors which cause increase in requirement. It would appear more rational to provide basal requirements of both protein and calories for each individual patient, and then to provide additional amounts of each, depending upon the extent of the injury and especially on the extent of full thickness loss. Unfortunately, there is at present no reliable method for estimating this with any degree of accuracy, in the early stages. With experience, it is reasonably easy to assess pure superficial and pure deep burn. The areas between these two, which frequently comprise the major extent of the burn, present real difficulty. If assessment were made on total extent initially, and intake allowed accordingly, it could be modified later should areas, at first thought to be deep, heal spontaneously.

(3) It remains to be shown, in those in whom high intakes are required, whether these should be given from the earliest possible time, or whether the intake should be kept at a lower level initially, although increased from normal, and increased to full requirement over the period of maximal loss.

(4) In children, the recommended levels appear to be less than that required, especially in the more severe injury, which is not surprising /

surprising when it is considered that the burn must impose an additional requirement over the normal intake of the same child in health. Again, the suggestion is to provide basal quantities of protein and calories, and prescribe additional amounts depending upon the extent and the depth of the burn.

(5) With the present method, difficulty arises in assessing the required intake for the child whose admission weight is above or below the normal for age. Expected weight has been used throughout in the children presented, as intake for age was prescribed. The dangers of such a method are shown by the child who developed "stress pseudodiabetes". "Weight age" should, therefore, probably be used in preference. It would tend to lower the intake in the underweight child which might have its own drawbacks, and increase the intake in the overweight child. As actual weights in the vast majority are around expected weights, it is only very occasionally that such a problem arises.

(6) Formulae, such as the following, should be put to test and would take into account body weight and extent of burn, and would allow for more individual variation.

	Adults			Children		
	Basal		Burn	Basal		Burn
Protein	1 g./Kg	+	3 g./per cent.	3 g./Kg	+	1.5g./per cent.
Calories	20/Kg.	+	70/per cent.	60/Kg	+	35/per cent.

SUMMARY AND CONCLUSIONS

(1) Following upon extensive thermal injury, patients who do not receive additional intake of protein and calories show severe uncontrolled weight loss, which certainly contributes to morbidity and may influence mortality.

(2) Such patients are unable to eat sufficient amounts of ordinary diet to meet the increased requirement for protein and calories, not necessarily because the hospital diets are inadequate, but because of the bulk of such diets and of anorexia.

(3) The recommended intakes can be met by the use of fortified fluids supplying either the whole, or part, of the daily intake. Such fluids may be given as an oral supplement to solid diet, or may be used to provide the entire intake by nasogastric tube.

(4) Various formulae for such fluids have been devised and an effort made to keep these as simple as possible. In the first instance, they were given to patients other than those with thermal injury to assess tolerance, acceptance, and suitability. The development of an oral fat emulsion was a major advance, allowing for provision and tolerance of the high calorie intakes required. The formulae finally selected were found to satisfy the requirements and covered a wide range of protein and calorie intake.

(5) The requirement of the individual burned patient was calculated from presently accepted recommendations, and a régime evolved which, it was hoped, would meet this requirement.

(6) The oral supplement to the ward diet was found to be the method of choice in the less severely injured; children with injuries involving up to 25 per cent of the body surface, and adults with /

with up to 30 per cent involved. Those with more extensive injuries than these were treated more satisfactorily by nasogastric tube feeding.

(7) Tolerance to both types of feeding was good in all patients. The complications to be anticipated are the "protein overload syndrome", and "burn stress pseudodiabetes".

(8) The intake was introduced gradually from the third day after injury and, while attainment of the recommended intakes early may not confer real benefit, delay is associated with greater difficulty in establishing tolerance. Whenever possible, the recommended levels of intake should be achieved, at the latest by the tenth to fourteenth day.

(9) With few exceptions, all patients lost weight, the period of weight loss varying from the second to the fourth weeks. This weight loss occurred despite intakes which, in many instances, met the estimated requirement, and were certainly above starvation level. The degree of weight loss was also variable, tending to be greater in those with extensive areas of full thickness skin loss. The most important single factor, therefore, appears to be the depth of burn.

(10) Weight, during the period of rapid weight gain, appeared sensitive to calorie intake, especially in children, and, as the calorie nitrogen ratios obtained over such periods seem to be satisfactory, it is concluded that calorie requirement is only just being met.

(11) The contribution of the exudate from the involved area is of importance. The loss from this source is early in the superficial burn, but does not occur until the third to fourth week in the deep burn /

burn. It is, therefore, suggested that the periods when increased requirement is of most importance may well be different in the two types of injury, the superficial burn requiring high intakes early, while the deep burn may have the greatest need much later in the post burn course.

(12) It would appear to be more rational to base requirement on the extent of the burn, as well as on body weight. Formulae are suggested which might be more satisfactory in assessing requirement.

(13) The patient, who has sustained thermal injury, presents a complex nutritional problem, requiring individual treatment. In the routine day-to-day treatment of such patients, an accurate frequent recording of body weight gives the most reliable information concerning nutritional state and the adequacy of intake.

REFERENCES

Artz, C .P., Soroff, H.S., Pearson, E., and Hummel, R.P. (1956), Amer. J. Clin. Nutr., 4, 642

Barron, J., and Fallis, L.S. (1953), Amer. Coll. Surg., Surgical Forum, 4, 519.

Batchelor, A.D.R. (1957), Arch. Dis. Childhood, 32, 502.

Blocker, T.G., jun., Levin, W.C., Nowinski, W.W., Lewis, S.R., and Blocker, V. (1955), Ann. Surg., 141, 589

Bull, J.P., and Fisher, A.J., (1954), Ann. Surg., 139, 269.

Co Tui, Wright, A.M., Mulholland, J.H., Breed, E.S .? Barcham, I., and Gould, D. (1945), Ann. Surg., 121, 223.

Co Tui (1953), Amer. J. Clin. Nutr., 1, 232.

Cole, W.H., Schneewind, J.H., and Canham, R., (1955), Surgery, 37, 683.

Cope, O., Nathanson, I.T., Rourke, G.M., and Wilson, H. (1943), Ann. Surg., 117, 937.

Cope, O., Nardi, G.L., Quijano, M., Rovit, R.L., Stanbury, J.B., and Wight, A.,(1953), Ann. Surg., 137, 165.

Crandon, J.H., Mikal, S., and Landeau, R., (1953), Proc. Nutr. Soc., 12, 273.

Cuthbertson, D.P., (1930), Biochem. J., 24, 1244.

Cuthbertson, D.P., (1934), Glasg. Med. J., 121, 41.

Cuthbertson, D.P., (1954), Brit. Med. Bull., 10, 33.

Dietrick, J.E., Whedon, G.D., and Shorr, E. (1948), Amer. J. Med., 4, 3.

Elman, R. (1954), Surgery, 36, 1175.

Evans, E.I., and Butterfield, W.J.H. (1951), Ann. Surg., 134, 588.

Forbes, E.B., and Swift, R.W.,(1944), J. Nutr., 27, 453

Grossman, C.M., Sappington, T.S., Burrows, B.A., Lavietes, P.H., and Peters, J.P. (1945), J. Clin. Invest, 24, 523

Harkins, H.N., (1954), Surg. Clin. N. Amer., 34, 1313.

Howard, J.E., (1944), Trans. Ass. Amer. Phycns., 58, 162

Hirschfield, J.W., Williams, H.H., Abbott, W.E., Heller, C.G., and Pilling, M.A. (1944), Surgery, 15, 766.

Kark /

Kark, R.M., (1953), Proc. Nutr. Soc., 12, 279

Keeton, R., Cole, W.H., Calloway, N., Glickmann, N., Mitchell, H.H., Dyniewicz, J., and Howes, D. (1948), Ann. Intern. Med. 28, 521.

Keys, A. (1950), "The Biology of Human Starvation", University of Minnesota Press.

Keyser, J.W. (1948), Ann. Surg., 127, 605.

Levenson, S.M., Green, R.W., Taylor, F.H.L., Robinson, P., Page, R.C., Johnson, R.E., and Lund, C.C. (1946), Ann. Surg., 124, 840.

Levenson, S.M., Loundes, E.A., and Morris, R., (1952), Ann. N.Y. Acad. Sci., 56, 37.

Levenson, S.M. (1957), Ann. Surg., 146, 357.

Lucido, J. (1940), Ann. Surg., 111, 640.

Lund, C.C., and Browder, N.C., (1944), Surg. Gynec. Obstet., 79, 352.

Lund, C.C., Levenson, S.M., Green, R.W., Page, R.C., Robinson, P.E., Adams, M.A., MacDonald, A.H., Taylor, F.H.L., and Johnson, R.E. (1947), Arch. Surg., 55, 557.

McCance, R.A., and Widdowson, E.M. (1946), "The Chemical Composition of Foods", Med. Res. Counc. Spec. Rep. Series, No. 235, 2nd edn.

Meyer, F.L., Joseph, S., Hirschfield, J.W., and Abbott, W.E. (1945), J. Clin. Invest., 24, 579.

Mindrum, G.M. (1953), Amer. J. Clin. Nutr., 1, 503.

Moore, F.D., Wendell, P.C., Blakely, E., and Cope, O. (1946), Ann. Surg., 124, 811

Moore, F.D., Langohr, J.L., Ingebretsen, M., and Cope, O. (1950), Ann. Surg., 132, 1

Moore, F.D., and Ball, M.R. (1952), "The Metabolic Response to Surgery", Charles C. Thomas, Springfield, Illinois.

Moore, F.D. (1953), Ann. Surg., 137, 289.

Moore, F.D. (1955), Ann. Surg., 141, 141.

Moyer, C.A. (1955), Surgery, 38, 806.

Pareira /

Pareira, M.D., Conrad, E.J., Hicks, W., and Elman, R. (1954), Arch. Int. Med., 156, 180.

Pearson, E., Balikov, B., and Reiss, E. (1955), Metabolism, 4, 29.

Peters, J.P., (1948), Amer. J. Med., 5, 100.

Peters, J.P., (1952), Ann. N.Y. Acad. Sci., 56, 127.

Provis, H.S. and Ellis, R.W.B., (1955), Arch. Dis. Childhood, 30, 328.

Reigal, C., Koop, C.E., Drew, J., Stevens, L.W., and Rhoades, J.E., (1947), J. Clin. Invest., 26, 18.

Reiss, E., Pearson, E., and Artz, C.P. (1956), J. Clin. Invest., 35, 62.

Report of the Committee on Nutrition , (1950), British Medical Association.

Selye, H., (1950), "The Physiology and Pathology of Exposure to Stress", Acta Inc., Montreal.

Shoskes, M., Van Itallie, T.B., Geyer, R., and Stare, F.J. (1951), J. Amer. Diet. Ass., 27, 197.

Shoskes, M., (1952), Ann. N.Y. Acad. Sci., 56, 22.

Smith, E.B., and Wollaeger, E.E. (1953), Arch. Int. Med., 91, 721

Spence, H.Y., Evans, E.I., and Forbes, J.C. (1946), Ann. Surg. 124, 131.

Stein, I.F., jun., Kubl, W.J., Goldberg, E.M., Grossman, M.I., and Myer, K.A. (1952), J. Amer. Med. Ass., 150, 1665.

Sub.-Committee on Radiation and Thermal Burns of the National Research Council. Committee on Therapeutic Nutrition. (1951) Food and Nutrition Board.

Taylor, W.H., (1955), Amer. J. Clin. Nutr., 3, 181.

Thomson, J. (1955), Med. Offr., 93., 317.

Thomson, J. (1955), Hlth. Bull. Edinb., 13/1, 16.

Thomson, J. (1955), Hlth. Bull. Edinb., 13/4, 62.

Van /

Van Itallie, T.B., Moore, F.B., and Stare, F.J., (1952), Ann. N.Y. Acad. Sci., 56, 28.

Van Itallie, T.B., Logan, W.B., Smythe, R.L., Geyer, R.P., and Stare, F.J. (1952), Metabolism, 1, 80.

Wallace, A.B. (1952), "Surgical Progress", Butterworth & Co., London.

Werner, S.C., Habif, D.V., Randall, H.T., and Lockwood, J.S. (1949), Ann. Surg., 130, 688.

Wilkinson, A.W., Billing, B.H., Nagy, G., and Stewart, CP. (1950), Lancet, 1, 533.

TABLE 1

Vitamin	Recommended Intake (Lund)	Recommended Intake in Health
Ascorbic Acid	1 - 2 g	20 mg.
Thiamine	10 - 20 mg.	0.6 - 2 mg.
Riboflavin	10 - 20 mg.	1 - 3 mg.
Nicotinamide	150 - 250 mg	7 -20 mg.

TABLE 2

RECOMMENDED DAILY ALLOWANCES

Age Years	Protein g.	Calories	Iron mg.	Calcium g.	Vitamin "A" ✱	Vitamin "D" ✱	Thiamine mg.	Riboflavine mg.	Niacin mg.	Ascorbic Acid mg.
1	37	1150	6.5	1.0	3000	800	0.4	0.6	4.0	10.0
2	56	1300	7.5	1.0	3000	400	0.6	0.9	6.0	15.0
3	56	1400	7.5	1.0	3000	400	0.6	0.9	6.0	15.0
4	56	1500	7.5	1.0	3000	400	0.6	0.9	6.0	15.0
5	56	1600	7.5	1.0	3000	400	0.6	0.9	6.0	15.0
6	56	1700	7.5	1.0	3000	400	0.6	0.9	6.0	15.0
7	74	1800	10.5	1.0	3000	400	0.8	1.2	8.0	20.0
8	74	1900	10.5	1.0	3000	400	0.8.	1.2	8.0	20.0
9	74	2100	10.5	1.0	3000	400	0.8	1.2	8.0	20.0
10	74	2250	10.5	1.0	3000	400	0.8	1.2	8.0	20.0
11	102	2450	13.5	1.3 ♂ 1.2 ♀	3000	400	1.1	1.6	11.0	30.0
12	102	2650	13.5	1.3 ♂ 1.2 ♀	3000	400	1.1	1.6	11.0	30.0

✱ - International Units ♂ - Male ♀ - Female

TABLE 3

DAILY INTAKE ON WARD DIET (MINOR INJURIES)

Day*		1		2		3		4		5		6		7	
		Protein g.	Cals. **	Protein	Cals. **	Protein g.	Cals. **	Protein g.	Cals. **	Protein g.	Cals. **	Protein g.	Cals. **	Protein g.	Cals. **
Patient (M)	1	42	1400	87	2130	50	1920	69	1910	65	1990	67	2020	75	2100
(M)	2	60	1560	62	1810	75	1960	64	1850	71	2120	65	1980	68	1920
(M)	3	78	1980	68	1990	65	1830	58	1770	72	1980	64	2250	63	1970
(M)	4	68	1910	69	2110	65	1950	55	1680	78	2020	62	1850	67	2210
(F)	5	50	1630	54	1760	63	1890	56	1690	71	2020	48	1550	65	1920
(F)	6	48	1510	45	1580	53	1610	51	1690	48	1620	56	1830	49	1780
Age 2 (Average 3 cases)	7	60	1200	58	1120	66	1210	40	980	47	975	59	1180	40	990
Age 4 (Average 2 cases)	8	50	1180	55	1230	45	1190	60	1480	58	1350	50	1220	56	1380
Age 6 (Average 4 cases)	9	55	1230	62	1420	48	1280	58	1310	53	1290	45	1080	61	1450
Age 8 (Average 2 cases)	10	60	1800	50	1250	45	1140	60	1820	58	1290	56	1310	65	1480
Age 10 (Average 2 cases)	11	50	1480	62	1810	58	1680	65	1650	56	1570	70	1920	64	1720

** - All Calorie Levels taken to the nearest 10. * - Periods chosen to avoid days of anaesthesia.

TABLE 4

ORAL SUPPLEMENTS

Feed 1 - Protein and Calories

Constituent	Amount g. or ml.	Protein g.	Fat g.	Carbohydrate g.
Whole Milk	420	13.9	15.5	20.2
Evaporated Milk	90	6.8	7.6	11.1
Fat Emulsion	70	-	35.0	-
Casilan (Glaxo)	30	27.0	0.3	0.3
Dextrimaltose	20	-	-	19.8
Lactose	15	-	-	14.9
TOTAL		47.7	58.4	66.3
Calories - 978				

Feed 2 - Calories

Constituent	Amount g. or ml.	Protein g.	Fat g.	Carbohydrate g.
Fat Emulsion	175	-	87.5	-
Concentrated Fruit Juice	75	-	-	32.0
Water	50	-	-	-
TOTAL		-	87.5	32.0
Calories - 920				

Feed 3 - Protein and Calories
No Emulsion

Constituent	Amount g. or ml.	Protein g.	Fat g.	Carbohydrate g.
Whole Milk	420	13.9	15.5	20.2
Evaporated Milk	200	15.2	16.8	24.6
Casilan (Glaxo)	35	31.5	0.3	0.3
Glucose	35	-	-	35.0
Lactose	20	-	-	19.8
TOTAL		60.6	32.6	99.9
Calories - 941				

Flavouring in Feed 1 and 3 as desired.

TABLE 4a

FOOD VALUES
(g. per 100 g.)

Substance	Protein g.	Fat g.	Carbohydrate g.
Fat Emulsion (Prosparol, Duncan Flockhart)	-	50.0	-
Fruit Juice (Concentrated)	-	-	10.0
Milk (Evaporated)	7.6	8.4	12.3
Milk (Whole)	3.3	3.7	4.8
Casilan (Glaxo)	90.0	1.0	1.0
Casydrol (Bengers)	50.0	-	50.0
ChocolatePowder	21.3	6.0	66.0
Complan (Glaxo)	32.0	16.0	42.0

TABLE 5

PATIENTS WITH FRACTURED MANDIBLE

WARD FLUID DIET

Patient	Age	Admission Weight Kg.	Average/Kg./Day		Weight at Day 10	Weight Gain Or Loss Kg.
			Protein g.	Calories		
1	43	60.5	1.0	40	59.5	-1.0
3	30	67.5	1.4	32	67.1	-0.4
5	17	76.5	0.5	22	75.3	-1.2
7	39	68.0	1.0	25	65.0	-3.0
9	17	51.5	1.5	26	50.0	-1.5

PATIENTS WITH FRACTURED MANDIBLE

SUPPLEMENT GIVEN

Patient	Age	Admission Weight Kg.	Average/Kg./Day		Weight at Day 10	Weight Gain or Loss Kg.
			Protein g.	Calories		
2	21	63.8	1.5	68	65.0	+1.2
4	53	51.5	2.2	45	54.5	+3.0
6	33	63.0	2.3	62	64.8	+1.8
8	17	55.7	1.3	41	56.5	+0.8
10	45	61.0	2.0	56	62.0	+1.0

TABLE 6

ORAL FLUID SUPPLEMENTS FOR CHILDREN

Feed 1

Constituent	Amount g. or ml.	Protein g.	Fat g.	Carbohydrate g.
Whole Milk	210	6.9	7.8	10.1
Fat Emulsion	90	-	45.0	-
Casilan (Glaxo)	20	18.0	0.2	0.2
Glucose	20	-	-	20.0
Lactose	20	-	-	19.8
Cocoa	10	2.0	2.6	3.5
TOTAL		26.9	55.6	53.6
Calories - 828				

Feed 2 - Protein and Calories
No emulsion

Constituent	Amount g.or ml.	Protein g.	Fat g.	Carbohydrate g.
Whole Milk	360	11.9	13.3	17.3
Evaporated Milk	100	7.6	8.4	12.3
Casilan (Glaxo)	25	22.5	0.2	0.2
Glucose	20	-	-	20.0
Lactose	30	-	-	29.8
Cocoa	10	2.0	2.6	3.5
TOTAL		44.0	24.5	83.1
Calories - 733.				

TABLE 7

FORMULAE USING COMPLAN (GLAXO)

1. **Adults**

Constituent	Amount g.or ml.	Protein g.	Fat g.	Carbohydrate g.
Complan	150	46.5	24.0	63.0
Fat Emulsion	100	-	50.0	-
Water	600	-	-	-
(Flavouring)	-	-	-	-
TOTAL		46.5	74.0	63.0
Calories - 1106				

2. **Children**

Constituent	Amount g.or ml.	Protein g.	Fat g.	Carbohydrate g.
Complan	100	31.0	16.0	42.0
Fat Emulsion	70	-	35.0	-
Water	300	-	-	-
(Flavouring)	-	-	-	-
TOTAL		31.0	51.0	42.0
Calories - 751				

TABLE 8

FORMULAE FOR TUBE FEEDS

Case 4.- Male, aged forty-six. Weight 62 Kg.

Diagnosis 1: Lupus carcinoma of cheek.
2: Buccal fistula.

Intake - Protein 2.0 g./Kg./Day = 2 x 62 = 124 g.
Calories 50/Kg./Day = 50 x 62 = 3100

Feed 1

Constituent	Amount g.or ml.	Protein g.	Fat g.	Carbohydrate g.
Hepovite (Evans)	100	50.0	-	38.0
Glucose	150	-	-	150.0
Evaporated Milk	1000	76.0	84.0	123.0
Fat Emulsion	130	-	65.0	-
Water to	2500	-	-	-
TOTAL		126.0 16%	149.0 43%	311.0 41%
Calories - 3089				

Intake - Protein 2.5 g./Kg./Day = 2.5 x 62 = 155 g.
Calories 60/Kg./Day = 60 x 62 = 3720

Feed 2

Constituent	Amount g.or ml.	Protein g.	Fat g.	Carbohydrate g.
Hepovite (Evans)	100	50.0	-	38.0
Glucose	150	-	-	150.0
Casydrol (Bengers)	50	25.0	-	25.0
Evaporated Milk	1000	76.0	84.0	123.0
Fat Emulsion	200	-	100.0	-
Water to	2500	-	-	-
TOTAL		151.0 17%	184.0 46%	336.0 37%
Calories - 3604				

To both feeds were added :-

Thiamine	:	2 mg.
Riboflavine	:	4 mg.
Nicotinamide	:	20 mg.
Iron	:	1.2 g.
Ascorbic Acid	:	300 mg. given separately as one dose.

TABLE 9

FORMULAE FOR TUBE FEED

Case 5.- Female, aged thirty-nine. Weight 50 Kg.

Diagnosis 1: Lupus carcinoma of cheek.
2: Buccal fistula (post-operative)

Intake - Protein 25 g./Kg.
Calories 65/Kg.

Constituent	Amount g. or ml.	Protein g.	Fat g.	Carbohydrate g.
Evaporated Milk	400	30.4	33.6	49.2
Hepovite (Evans)	100	50.0	-	38.0
Casydrol (Bengers)	100	50.0	-	50.0
Fat Emulsion	150	-	75.0	-
Glucose	50	-	-	50.0
Water to	2000	-	-	-
Calories - 2249		130.4	108.6	187.2
Percentage of total calories		23%	44%	33%
1st Increase - Emulsion 200		130.4	133.6	187.2.
Total calories = 2474				
Percentage of total calories		21%	49%	30%
2nd Increase - Emulsion 250		130.4	158.6	187.2
Total calories = 2699				
Percentage of total calories		19.5%	53%	17.5%
3rd Increase - Emulsion 300		130.4	183.6	187.2
Total calories = 2924				
Percentage of total calories		18%	56.5%	25.5%
4th Increase - Emulsion 350		130.4	208.6	187.4
Total calories = 3149				
Percentage of total calories		16.5%	60%	23.5%

Added Vitamins :-

Thiamine : 2 mg.
Riboflavin : 4 mg.
Nicotinamide : 20 mg.
Iron : 1.2 g.
Ascorbic Acid : 300 mg. daily given separately in one dose.

TABLE 10

FORMULAE FOR TUBE FEED

Case 6.- Usual Weight = 45 Kg.

Estimated Requirement

Protein : 2.5 g./Kg. = 2.5 x 45 = 112.5 g.
Calories : 60/Kg. = 60 x 45 = 2700

Feed 1: Day 1 - 11, and 29 - 40

Constituent	Amount g.or ml.	Protein g.	Fat g.	Carbohydrate g.
Casydrol (Bengers)	80	40.0	-	40.0
Hepovite (Evans)	80	40.0	-	30.4
Glucose	100	-	-	100.0
Evaporated Milk	400	30.4	33.6	49.2
Fat Emulsion	120	-	60.0	-
Water to	2000	-	-	-
TOTAL		110.4	93.6	219.6
Calories - 2166				

Feed 2: Day 12-18.

Feed 1 + 50 ml. Fat Emulsion.

Protein 110 g.: Fat 119 g.: Carbohydrate 220 g.:
Calories 2391.

Feed 3: Day 19-28

Constituent	Amount g.or ml.	Protein g.	Fat g.	Carbohydrate g.
Casydrol (Bengers)	40	20.0	-	20.0
Hepovite (Evans)	40	20.0	-	15.2
Glucose	180	-	-	180.0
Evaporated Milk	200	15.2	16.8	24.6
Fat Emulsion	320	-	160.0	-
Water to	2000	-	-	-
TOTAL		55.2	176.8	239.8
Calories 2773				

Feed 4: Day 41 -

Constituent	Amount g.or ml.	Protein g.	Fat g.	Carbohydrate g.
CASYDROL (Bengers)	80	40.0	-	40.0
Hepovite (Evans)	80	40.0	-	30.4
Glucose	100	-	-	100.0
Evaporated Milk	500	30.4	33.6	49.2
Fat Emulsion	320	-	160.0	-
Water to	2000	-	-	-
TOTAL		110.4	193.6	219.6

TABLE 11

TUBE FEEDING FORMULAE USING COMPLAN

Feed 1

Constituent	Amount g.or ml.	Protein g.	Fat g.	Carbohydrate g.
Complan	200	62.0	32.0	84.0
Evaporated Milk	400	30.4	33.6	49.2
Glucose	100	-	-	100.0
Fat Emulsion	150	-	75.0	-
Water to	2500	-	-	-
TOTAL		92.4 14%	140.6 49%	233.2 37%
Calories - 2569				

Feed 2

Constituent	Amount g.or ml.	Protein g.	Fat g.	Carbohydrate g.
Complan	400	124.0	64.0	168.0
Evaporated Milk	400	30.4	33.6	49.2
Glucose	150	-	-	150.0
Fat Emulsion	250	-	125.0.	-
Water to	3000	-	-	-
TOTAL		154.4 15%	222.6 49%	367.2 36%
Calories - 4091				

TABLE 12

FORMULAE FOR TUBE FEEDING IN CHILDREN AGE 5 - 6

Feed 1

Constituent	Amount g.or ml.	Protein g.	Fat g.	Carbohydrate g.
Evaporated Milk	400	30.4	33.6	49.2
Hepovite (Evans)	30	15.0	-	11.4
Casydrol (Bengers)	60	30.0	-	30.0
Glucose	100	-	-	100.0
Fat Emulsion	120	-	60.0	-
Water to	1000	-	-	-
TOTAL		75.4 16%	93.6 44%	190.6 40%
Calories - 1910				

Feed 2

Constituent	Amount g.or ml.	Protein g.	Fat g.	Carbohydrate g.
Complan (Glaxo)	200	62.0	32.0	84.0
Evaporated Milk	200	15.2	16.8	24.6
Fat Emulsion	100	-	50.0	-
Glucose	100	-	-	100.0
Water to	1200	-	-	-
TOTAL		77.2 15%	98.8 44%	208.6 41%
Calories - 2035				

TABLE 13

ESTIMATED INTAKE REQUIREMENTS - ADULTS

Percentage Burn	Protein g./Kg.	Calories per Kg.
10-20	1.5	45
25	2.0	50
30	2.5	55
35	3.0	60
40	3.5	65
50+	4.0	70

TABLE 14

	Adults	Children
Vitamin 'A' (International Units)	-	2500
Vitamin 'D' (International Units)	-	500
Thiamine mg.	11	4
Riboflavine mg.	5	4
Nicotinamide mg.	55	20
Ascorbic Acid mg.	500	400
Iron mg.	1600	1350

TABLE 15

Case 7.- Admission weight - 65 Kg.

Estimated Requirement

Protein : 1.5 g./Kg. = 1.5 x 65 = 97.5 g.
Calories : 45/Kg. = 45 x 65 = 2925.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	123	1.9	2878	44	146 : 1	66.8 ✱ / 65.4
2	123	1.9	2870	44	146 : 1	63.9 / 63.6
3	139	2.1	3330	50	150 : 1	63.0 / 63.9
4	136	2.1	3127	48	143 : 1	64.5 / 64.9
5	152	2.3	3515	56	145 : 1	- / 65.1
6	134	2.1	3118	48	146 : 1	65.1 / 65.5
7	135	2.1	3353	52	155 : 1	65.8 / 66.1
8	92	1.4	2675	41	178 : 1	- / 67.0

✱ On transfer

TABLE 16

Case 8.- Admission Weight 70.8 Kg.

Estimated Requirement

Protein : 1.5 g./Kg. = 1.5 x 70.8 = 106.2 g.
Calories : 45/Kg. = 45.x 70.8 = 3186

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	70	1.0	2572	36	229 : 1	71.2 68.2
2	89	1.3	2888	41	203 : 1	67.7 67.3
3	105	1.5	3285	46	195 : 1	67.2 67.2
4	92	1.3	3005	44	147 : 1	67.9 67.7

TABLE 17

Case 9.- Admission Weight 72 Kg.

Estimated Requirement

Protein : 1.5 g./Kg. = 1.5 x 72 = 108 g.
Calories : 45/Kg. = 45 x 72 = 3240

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	80	1.1	3002	42	234 : 1	72.6 69.5
2	93	1.3	2985	41	200 : 1	69.1 68.8
3	113	1.6	3676	51	203 : 1	- 68.6
4	126	1.8	4062	56	201 : 1	71.0 71.4

TABLE 18

Case 10.- Admission Weight 60.6 Kg.

Estimated Requirement

Protein : 1.5 g./Kg. = 1.5 x 60.6 = 91.0 g.
Calories : 45/Kg. = 45 x 60.6 = 2727

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	66	1.1	2526	42	238 : 1	62.3 59.4
2	86	1.4	2864	47	208 : 1	58.6 58.6
3	98	1.6	3129	52	136 : 1	- 58.6

TABLE 19

Case 11.- Admission Weight 64.5 Kg.

Estimated Requirement

Protein : 1.5 g./Kg. = 1.5 x 64.5 = 97 g.
Calories : 45/Kg. = 45 x 64.5 = 2902

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ration	Weight Kg.
1	72	1.1	2464	38	214 : 1	65.2 62.2
2	96	1.5	2938	46	191 : 1	59.7 58.6
3	98	1.5	2874	45	187 : 1	57.5 57.9
4	100	1.6	3148	49	197 : 1	58.4 60.0

TABLE 20

Case 12.- Admission Weight 61.0 Kg.

Estimated Requirement

Protein : 1.5 g./Kg. = 1.5 x 61 = 91.5 g.
Calories : 45/Kg. = 45 x 61 = 2745

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	51	0.8	1613	26	198 : 1	61.6 ✱ 61.3
2	59	1.0	1689	28	180 : 1	61.0 59.0
3	59	1.0	1762	29	187 : 1	57.3 57.2
4	85	1.4	2137	35	157 : 1	57.2 58.5
5	96	1.6	2360	39	152 : 1	60.2 60.4

✱ On transfer

TABLE 21

Case 13.- Admission Weight 57.0 Kg.

Estimated Requirement

Protein : 1.5 g./Kg. = 1.5 x 57 = 85.5 g.
Calories : 45/Kg. = 45 x 57 = 2565

Week	Average Protein Intake g.	Average Protein Intake g./Kg	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	57	1.0	1717	30	188 : 1	- 56.8
2	55	0.9	1632	29	185 : 1	55.9 55.1
3	63	1.1	1848	32	183 : 1	54.3 54.1
4	74	1.3	1777	31	151 : 1	54.1 53.7
5	76	1.3	1956	34	160 : 1	- 53.8
6	84	1.5	1941	34	145 : 1	53.9 54.9
7	88	1.5	2314	41	164 : 1	- 56.4

TABLE 22

Case 14.- Admission Weight 62.1 Kg.

Estimated Requirement

Protein : 1.5 g./Kg. = 1.5 x 62.1 = 93 g.
Calories : 45/Kg. = 45 x 62.1 = 2795

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	83	1.3	2878	46	216 : 1	62.0 62.3
2	85	1.4	2851	46	210 : 1	- 62.7
3	112	1.8	3481	56	194 : 1	62.7 62.4
4	120	1.9	3770	61	196 : 1	62.3 63.8
5	124	2.0	4028	65	209 : 1	63.2 63.5
6	98	1.6	3392	55	216 : 1	- 65.1
7	111	1.8	3401	55	191 : 1	- 66.0
8	102	1.6	2882	46	177 : 1	- 67.0

TABLE 23

Case 15.- Admission Weight 58.9 Kg.

Estimated Requirement

Protein : 1.5 g./Kg. = 1.5 x 58.9 = 88 g.
Calories : 45/KG. = 45 x 58.9 = 2650

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	60	1.0	1898	32	198 : 1	60.8 60.2
2	182	3.1	4967	84	171 : 1	59.4 55.8
3	178	3.0	4431	75	155 : 1	54.1 53.2
4	158	2.7	4049	69	160 : 1	52.8 52.6
5	147	2.5	3557	60	151 : 1	52.9 52.8
6	149	2.5	3808	65	160 : 1	52.7 50.8
7	104	1.8	3316	56	200 : 1	51.9 51.3
8	85	1.5	1381	23	102 : 1	51.4 51.1
9	70	1.2	2882	49	257 : 1	50.4 51.3
10	81	1.4	3292	56	253 : 1	51.8 52.1
11	94	1.6	3820	65	255 : 1	52.9 53.7
12	102	1.7	3610	61	221 : 1	55.8
13	98	1.7	3085	53	196 : 1	57.9

TABLE 24

Case 16.- Admission weight - 73.9 Kg.

Estimated Requirement

Protein : 2.5 g./Kg. = 2.5 x 73.9 = 185 g.
Calories : 55/Kg. = 55 x 73.9 = 4065

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio.	Weight Kg.
1	67	0.9	1698	22	159 : 1	74.5 71.9
2	121	1.6	3018	41	155 : 1	70.5 70.8
3	134	1.8	3219	44	214 : 1	70.0 70.2
4	139	1.9	3307	45	149 : 1	70.4 71.0

TABLE 25

Case 17.- Admission Weight - 60.0 Kg.

Estimated Requirement

Protein : 2.5 g./Kg. = 2.5 x 60 = 150 g.
Calories : 55/Kg. = 55 x 60 = 3300

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	132	2.2	3708	62	175 : 1	64.8 62.3
2	130	2.2	3643	61	175 : 1	- 57.7
3	150	2.5	4398	73	179 : 1	- 57.8
4	151	2.5	4562	76	188 : 1	57.8 57.9
5	145	2.4	4507	75	194 : 1	58.0 59.3
6	144	2.4	4354	73	189 : 1	61.0 61.5
7	61	1.0	3406	57	347 : 1	62.0 62.8

TABLE 26

Case 18.- Admission Weight - 51.4 Kg.

Estimated Requirement

Protein : 2.5 g./Kg. = 2.5 x 51.4 = 128.5 g.
Calories : 55/Kg. = 55 x 51.4 = 2827

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	88	1.7	1554	30	110 : 1	- 53.0
2	129	2.5	2603	51	126 : 1	- 51.0
3	140	2.7	2811	55	125 : 1	49.6 49.4
4	118	2.3	2510	49	168 : 1	47.8 47.4
5	154	3.0	2779	54	113 : 1	47.3 48.7
6	166	3.2	3514	68	132 : 1	49.0 50.2
7	170	3.3	3276	64	120 : 1	51.1 51.1
8	147	2.8	2775	54	118 : 1	51.9 52.0
9	81	1.6	2356	46	181 : 1	- 52.1

TABLE 27

Case 19.- Admission Weight - 62.0 Kg.

Estimated Requirement

Protein : 2.5 g./Kg. = 2.5 x 62 = 155 g.
Calories : 55/Kg. = 55 x 62 = 3410

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	80	1.3	1941	31	152 : 1	62.9 60.0
2	117	2.0	2943	47	157 : 1	58.1 57.1
3	116	2.0	2652	43	143 : 1	56.2 56.1
4	141	2.3	3509	56	155 : 1	- 57.4
5	159	2.6	3692	60	145 : 1	58.1 59.0

TABLE 28

Case 20.- Admission Weight - 68.5 Kg.

Estimated Requirement

Protein : 2.5 g./Kg. = 2.5 x 68.5 = 171 g.
Calories : 55/Kg. = 55 x 68.5 = 3768

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1		U N K N O W N				69.6 x
2	105	1.5	3210	47	191 : 1	69.8 / 69.2
3	166	2.4	3921	57	147 : 1	68.9 / 66.0
4	169	2.5	4198	61	155 : 1	64.8 / 63.2
5	161	2.3	3992	58	183 : 1	62.4 / 61.9
6	157	2.3	4158	61	166 : 1	61.6 / 61.3
7	150	2.2	3841	56	160 : 1	- / 62.5
8	152	2.2	3286	48	135 : 1	63.7 / 64.2
9	145	2.1	3388	49	146 : 1	- / 65.9
10	172	2.5	3499	51	127 : 1	- / 68.9

x On transfer

TABLE 29

Case 21.- Admission Weight - 80.1 Kg.

Estimated Requirement

Protein : 3 g./Kg. = 3 x 80.1 = 240 g.
Calories : 60/Kg. = 60 x 80.1 = 4806

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	72	0.9	2125	27	185 : 1	83.1 79.0
2	130	1.7	3528	46	170 : 1	75.6 74.2
3	123	1.6	4024	52	204 : 1	73.7 75.0
4	120	1.6	3810	49	198 : 1	74.8 74.2
5	140	1.8	4065	53	181 : 1	73.8 73.0
6	127	1.6	3776	49	186 : 1	71.6 73.0
7	133	1.7	3539	46	166 : 1	72.9 73.4
8	139	1.8	3503	45	113 : 1	73.8 75.0
9	166	2.2	4540	59	171 : 1	76.1 77.2
10	173	2.2	4014	52	145 : 1	77.6 79.2
11	171	2.2	3736	49	136 : 1	79.2 80.6

TABLE 30

Case 22.- Admission Weight - 67.6 Kg.

Estimated Requirement

Protein : 3 g./Kg. = 3 x 67.6 = 203 g.
Calories : 60/Kg. = 60 x 67.6 = 4056

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	101	1.5	2403	36	148 : 1	69.4 / 68.0
2	91	1.4	2500	37	171 : 1	67.6 / 63.8
3	122	1.8	2526	38	129 : 1	61.2 / 58.8
4	121	1.8	2849	43	147 : 1	59.0 / 58.4
5	106	1.6	2726	41	160 : 1	59.4 / 60.2
6	95	1.4	2048	31	135 : 1	63.0 / 62.6
7	68	1.0	2298	34	211 : 1	- / 63.6
8	81	1.2	2230	33	171 : 1	- / 64.4
9	81	1.2	2298	34	177 : 1	65.6

TABLE 31

Case 23.- Admission Weight - 56.1 Kg.

Estimated Requirement

Protein : 3 g./Kg. = 3 x 56.1 = 168 g.
Calories : 60/Kg. = 60 x 56.1 = 3366

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	71	1.3	1607	30	141 : 1	- 57.9
2	124	2.1	2123	38	107 : 1	53.9 53.4
3	120	2.0	2254	40	117 : 1	- 52.0
4	141	2.4	2690	48	119 : 1	51.9 51.3
5	145	2.5	2885	51	124 : 1	51.1 51.3
6	147	2.5	3099	54	132 : 1	51.4 52.3
7	141	2.4	2967	53	131 : 1	52.6 53.2
8	140	2.4	3342	60	149 : 1	- 53.0
9	124	2.1	2538	44	128 : 1	53.0 53.0
10	92	1.6	2082	37	142 : 1	52.9 53.0
11	86	1.5	1832	33	133 : 1	- 53.0
12	84	1.4	2086	44	160 : 1	53.1 54.1

TABLE 32

Case 24.- Admission Weight - 59.0 Kg.

Estimated Requirement

Protein : 3 g./Kg = 3 x 59 = 177 g.
Calories : 60/Kg. = 60 x 59 = 3540

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	131	2.2	2248	38	107 : 1	- 63.6
2	216	3.7	5050	86	146 : 1	58.2 55.6
3	237	4.0	5671	96	150 : 1	55.6 55.6
4	224	3.8	4734	80	132 : 1	56.1 56.4
5	183	3.1	4599	78	157 : 1	56.0 [illegible]
6	175	3.0	4442	75	159 : 1	- 55.1
7	162	2.7	3947	67	152 : 1	55.3 56.0
8	185	3.1	3989	68	135 : 1	- 58.0
9	161	2.7	2894	49	133 : 1	56.7 57.4
10	127	2.2	2611	44	129 : 1	- 59.8
11	144	2.4	2603	44	113 : 1	- 62.4

TABLE 33

Case 25.- Admission Weight 13.2 Kg.: Expected Weight 14.2 Kg.

Estimated Requirement

Protein : 56 g. = 4.1 g./Kg.
Calories : 1450 = 105 /Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	68	5.2	1301	99	119 : 1	- / 13.1
2	81	6.1	1407	107	108 : 1	13.0 / 12.5
3	82	6.2	1578	120	120 : 1	12.6 / 12.8
4	82	6.2	1626	123	124 : 1	13.3 / 13.4
5	84	6.4	1456	110	109 : 1	13.6 / 13.7
6	81	6.1	1345	102	103 : 1	13.3 / 13.9
7	85	6.4	1445	109	106 : 1	13.6 / 13.9
8	90	6.8	1505	114	105 : 1	14.2 / 14.5
9	86	6.5	1663	126	120 : 1	- / 14.7

TABLE 34

Case 26.- Admission Weight 13.1 Kg.: Expected Weight 11.6 Kg.

Estimated Requirement

Protein : 56 g. = 4.8 g./Kg.
Calories : 1300 = 112/Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	41	3.4	900	74	136 : 1	- 13.1
2	48	4.0	1190	98	155 : 1	13.0 13.1
3	47	3.9	1240	102	165 : 1	12.6 12.6
4	46	3.8	1141	94	154 : 1	12.4 13.2
5	48	4.0	1285	106	167.: 1	12.7 12.7
6	53	4.4	1365	113	161 : 1	- 13.7

TABLE 35

Case 27.- Admission Weight 12.7 Kg.: Expected Weight 11.6 Kg.

Estimated Requirement

Protein : 37 g. = 3.2 g./Kg.
Calories : 1250 = 108 /Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	-	-	-	-		-
						-
2	72	5.7	1503	118	131 : 1	12.7
						13.1
3	73	5.7	1448	113	124 : 1	13.2
						12.9
4	66	5.2	1270	100	120 : 1	12.1
						13.1
5	73	5.7	1430	112	122 : 1	12.7
						12.3
6	82	6.4	1654	130	126 : 1	13.0
						12.8

TABLE 36

Case 28.- Admission Weight 20.8 Kg.: Expected Weight 17.9 Kg.

Estimated Requirement

Protein : 56 g. = 3.2 g./Kg.
Calories : 1600 = 91/Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrgoen Ratio	Weight Kg.
1	19	0.9	558	27	186 : 1	21.3 20.8
2	20	0.9	769	37	240 : 1	- 19.9
3	45	2.2	1277	61	177 : 1	19.0 17.0
4	68	3.3	1792	86	164 : 1	19.1 19.9
5	64	3.1	1690	81	155 : 1	20.9 21.2
6	73	3.5	1975	95	169 : 1	- 20.7

TABLE 37

Case 29.- Admission Weight 20.6 Kg.: Expected Weight 22.0 Kg.

Estimated Requirement

Protein : 74 g. = 3.3 g/Kg.
Calories : 1800 = 80 /Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	80	3.9	1559	76	122 : 1	- / 21.1
2	100	4.8	2257	109	141 : 1	20.9 / 20.8
3	77	3.7	1699	82	114 : 1	20.8 / 19.6
4	96	4.7	2061	100	134 : 1	19.5 / 19.5
5	96	4.5	1974	96	132 : 1	20.9 / 20.1
6	96	4.7	1986	96	129 : 1	- / 20.3
7	63	3.1	1538	75	152 : 1	20.5 / 21.1

TABLE 38

Case 30.- Admission Weight 17.4 Kg.: Expected Weight 18.3 Kg.

Estimated Requirement

Protein : 56 g. = 3.1 g./Kg.
Calories : 1600 = 87 /Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	21	1.3	981	56	289 : 1	- 16.2
2	66	3.8	1546	89	146 : 1	- 15.9
3	21	1.3	821	47	212 : 1	14.6 14.4
4	53	3.0	1241	71	146 : 1	15.5 16.1
5	69	4.0	1607	92	146 : 1	16.1 16.2
6	63	3.6	1515	87	150 : 1	16.0 15.5
7	68	3.9	1506	86	138 : 1	15.0 16.7
8	62	3.5	1529	88	154 : 1	16.9 16.8
9	47	2.7	1331	76	177 : 1	- 16.6
10	43	2.5	1370	79	198 : 1	- 16.4

TABLE 39

Case 31.- Admission Weight 17.9 Kg.: Expected Weight 20.8 Kg.

Estimated Requirement

Protein : 56 g. = 2.7 g./Kg.
Calories : 1750 = 84/Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	49	2.7	1114	62	143 : 1	- 18.0
2	106	5.9	2103	117	124 : 1	18.1 17.9
3	120	6.7	2120	118	110 : 1	17.9 18.4
4	141	7.9	1986	111	88 : 1	17.6 17.7
5	129	7.1	2022	113	98 : 1	17.9 18.1
6	86	4.8	1538	86	111 : 1	18.2 18.1
7	68	3.8	1324	74	121 : 1	17.9 17.8
8	65	3.6	1461	82	140 : 1	17.5 17.5
9	73	4.1	1634	91	140 : 1	17.9 18.1

TABLE 40

Case 32.- Admission Weight 20.6 Kg.: Expected Weight 19.3 Kg.

Estimated Requirement

Protein : 56 g. = 3.5 g./Kg.
Calories : 1700 = 82 /Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	105	5.1	1545	75	92 : 1	21.4 20.8
2	126	6.1	1871	91	93 : 1	19.5 18.7
3	113	5.5	2202	107	133 : 1	17.4 17.6
4	84	4.1	2096	102	157 : 1	17.7 17.7
5	83	4.0	2106	102	158 : 1	18.2 18.0
6	89	4.3	2300	112	162 : 1	18.5 18.9
7	83	4.0	2210	107	151 : 1	19.6 19.5
8	80	3.9	2010	97	157 : 1	19.5 19.2
9	79	3.4	2033	99	161 : 1	- 20.0

TABLE 41

Case 33.- Admission Weight 22.7 Kg.: Expected Weight 18.9 Kg.

Estimated Requirement

Protein : 56 g. = 3.0 g./Kg.
Calories : 1650 = 87/Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	103	4.5	2015	89	122 : 1	- 22.8
2	119	5.2	2264	100	119 : 1	- 22.4
3	122	5.4	2420	106	124 : 1	21.9 21.4
4	107	4.7	2254	99	132 : 1	21.0 21.0
5	135	5.9	2508	110	116 : 1	21.0 21.6
6	123	5.4	2466	108	125 : 1	21.6 21.9
7	113	5.0	2351	103	130 : 1	22.0 21.9
8	100	4.4	2101	92	131 : 1	22.2 22.4
9	97	4.3	2158	95	139 : 1	22.7 23.1
10	66	2.9	1523	67	144 : 1	23.0 23.1
11	53	2.3	1135	51	134 : 1	22.3 23.0
12	50	2.2	1107	49	138 : 1	22.8 22.3

TABLE 42

Case 34.- Admission Weight 20.5 Kg.: Expected Weight 19.3 Kg.

Estimated Requirement

Protein : 56 g. = 2.7 g/Kg.
Calories : 1700 = 82/Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	64	3.2	1229	62	120 : 1	- 20.9
2	93	4.5	1755	86	118 : 1	20.5 18.9
3	64	3.2	1716	83	162 : 1	18.9 18.1
4	46	2.4	1735	85	234 : 1	17.5 17.3
5	63	3.1	1944	95	192 : 1	- 18.6
6	78	3.8	2104	103	168 : 1	19.4 19.7
7	62	3.0	1570	77	158 : 1	19.5 18.9
8	77	3.7	1977	96	161 : 1	19.2 19.4
9	77	3.7	2087	102	170 : 1	19.1 19.3
10	73	3.6	1927	94	165 : 1	19.5 19.8
11	62	3.0	1618	79	163 : 1	19.4 19.1

TABLE 43

Case 35.- Admission Weight 21.4 Kg.: Expected Weight 20.8 Kg.

Estimated Requirement

Protein : 56 g. = 2.7 g./Kg.
Calories : 1750 = 84/Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	70	3.3	1104	52	99 : 1	- 20.6
2	85	4.0	1471	69	108 : 1	- 19.9
3	118	5.5	2090	98	140 : 1	19.9 19.8
4	127	5.9	2188	102	108 : 1	20.6 19.8
5	113	5.3	2024	94	123 : 1	20.0 20.0
6	79	3.7	1417	66	112 : 1	19.5 19.2
7	122	5.7	2094	98	107 : 1	19.0 19.4
8	105	4.9	1808	89	108 : 1	20.6 19.4
9	125	5.8	2134	100	107 : 1	20.6 20.0
10	117	5.5	2091	98	112 : 1	20.7 20.4
11	120	5.6	2042	95	106 : 1	20.1 20.6
12	124	5.8	2185	102	110 : 1	21.0 21.6
13	107	5.0	1926	90	113 : 1	21.6 21.5
14	94	4.4	1632	76	109 : 1	21.8 21.7
15	79	3.7	1455	68	115 : 1	21.6 21.6
16	82	3.8	1497	70	114 : 1	21.5 21.8
17	71	3.3	1256	59	110 : 1	21.2 21.1
18	70	3.3	1971	92	176 : 1	20.9 21.4
19	68	3.2	1926	90	177 : 1	21.4 21.9
20	65	3.0	1894	88	182.: 1	22.3 22.6
21	65	3.0	1904	89	183 : 1	22.4 22.5

TABLE 44

Case 36.- Admission Weight 18.9 Kg.: Expected Weight 20.8 Kg.

Estimated Requirement

Protein : 56 g. = 2.7 g./Kg.
Calories : 1750 = 84/Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	65	3.4	1100	58	106 : 1	20.0 19.0
2	95	5.0	1567	83	103 : 1	18.6 17.0
3	90	4.8	1828	97	127 :1	16.4 16.8
4	87	4.6	1902	100	137 : 1	16.0 16.4
5	94	5.0	2140	113	143 : 1	16.9 17.2
6	86	4.5	2201	116	159 : 1	17.0 17.3
7	53	2.8	1351	71	159 : 1	16.6 16.4
8	97	5.1	2306	122	149 : 1	16.0 17.3
9	102	5.4	2430	129	149 : 1	17.7 17.8
10	91	4.8	2148	114	147 : 1	17.8 18.1
11	94	5.0	2150	114	143 : 1	17.9 18.4
12	84	4.4	1958	103	146 : 1	18.5 18.9
13	87	4.6	1966	104	141 : 1	19.0 18.7
14	89	4.7	2037	108	143 : 1	19.0 19.2
15	80	4.2	1819	96	142 : 1	19.4 19.5
16	75	4.0	1731	91	144 : 1	20.0 19.6

TABLE 45

Case 37.- Admission Weight 18.1 Kg.: Expected Weight 18.9 Kg.

Estimated Requirement

Protein : 56 g. = 3.0 g./Kg.
Calories : 1650 = 87/Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio.	Weight Kg.
1	55	3.0	905	50	103 : 1	- 18.1
2	80	4.4	2038	113	159 : 1	18.1 17.7
3	80	4.4	2070	114	159 : 1	17.4 18.1
4	73	4.0	1911	106	163 : 1	- 17.8
5	75	4.1	1930	107	161 : 1	17.7. 18.3
6	76	4.2	1970	109	161 : 1	18.0 18.2
7	76	4.2	1970	109	161 : 1	18.3 18.3
8	63	3.5	1385	76	137 : 1	18.3 18.6
9	55	3.0	1307	72	149 : 1	18.6 18.1
10	42	2.3	1044	58	156 : 1	17.8 17.9
11	53	2.9	1369	75	161 : 1	18.3 18.8

TABLE 46

Case 38.- Admission Weight 17.3 Kg.: Expected Weight 17.9 Kg.

Estimated Requirement

Protein : 56 g. = 3.1 g./Kg.
Calories : 1600 = 89/Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	47	2.7	1141	66	152 : 1	- -
2	82	4.7	1836	106	140 : 1	17.2 15.9
3	95	5.5	2003	116	132 : 1	15.7 15.7
4	95	5.5	1958	113	129 : 1	15.8 16.0
5	81	4.7	1690	98	130 : 1	16.4 16.4
6	76	4.4	1902	110	156 : 1	16.1 16.2
7	80	4.6	2035	118	159 : 1	16.5 16.5
8	104	6.0	2444	141	147 : 1	16.8 16.4
9	88	5.1	2030	117	144 : 1	- 16.8
10	98	5.7	2188	126	139 : 1	17.2 17.3
11	102	5.9	2345	135	144 : 1	- 17.7
12	100	5.8	2187	126	137 : 1	18.1 18.4
13	68	3.9	1460	84	134 : 1	18.6 18.6

TABLE 47

Case 39.- Admission Weight 22.6 Kg.: Expected Weight 17.9 Kg.

Estimated Requirement

Protein : 56 g. = 3.1 g./Kg.
Calories : 1600 = 89/Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	48	2.1	948	42	123 : 1	- 21.9
2	122	5.4	1906	84	98 : 1	- 21.7
3	116	5.2	2261	100	124 : 1	20.9 20.6
4	127	5.7	2191	97	108 : 1	20.1 21.0
5	95	4.2	1928	85	127 : 1	21.0 20.8
6	111	4.9	1731	77	107 : 1	20.7 20.6
7	88	3.9	1975	87	140 : 1	20.3 19.4
8	63	2.8	1311	58	130 : 1	18.1 18.6
9	66	2.9	1577	70	149 : 1	19.7 20.4
10	64	2.4	1660	73	162 : 1	- 21.3

TABLE 48

Case 40.- Admission Weight 27.3 Kg.: Expected Weight 25.2 Kg.

Estimated Requirement

Protein : 74 g. = 2.9 g./Kg.
Calories : 2000 = 79/Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio.	Weight Kg.
1	72	2.6	1460	53	127 : 1	- 25.7
2	103	3.8	2100	77	127 : 1	25.3 26.3
3	118	4.3	2392	88	127 : 1	26.0 25.9
4	110	4.0	2290	84	130 : 1	25.4 25.4
5	106	3.9	2372	87	139 : 1	25.7 25.6
6	103	3.8	2288	84	138 : 1	25.5 26.0
7	106	3.9	2276	83	134 : 1	25.9 26.0
8	106	3.9	2183	80	128 : 1	- 26.4
9	102	3.7	2184	80	134 : 1	26.0 26.2
10	118	4.3	2423	89	128 : 1	27.0 27.0
11	101	3.7	2368	87	146 : 1	- 27.0
12	98	3.6	2649	97	168 : 1	27.1 27.6

TABLE 49

Case 41.- Admission Weight 33.6 Kg.: Expected Weight 31.7 Kg.

Estimated Requirement

Protein : 102 g. = 3.4 g./Kg.
Calories : 2450 = 81/Kg.

Week	Average Protein Intake g.	Average Protein Intake g./Kg.	Average Calorie Intake	Average Calorie Intake per Kg.	Calorie Nitrogen Ratio	Weight Kg.
1	70	2.1	1361	41	121 : 1	35.4 34.2
2	153	4.5	3372	100	138 : 1	32.3 31.1
3	134	4.0	2677	80	125 : 1	29.4 29.3
4	147	4.4	3118	93	132 : 1	29.3 28.4
5	144	4.3	2897	86	126 : 1	28.2 28.6
6	140	4.2	2835	84	127 : 1	28.7 28.7
7	136	4.0	2978	89	137 : 1	29.2 29.4
8	147	4.4	3266	97	139 : 1	29.4 29.5
9	155	4.6	3481	104	140 : 1	29.7 30.0
10	144	4.3	3270	97	142 : 1	30.8 30.8
11	121	3.6	3121	93	162 : 1	30.9 31.4
12	132	3.9	3385	101	160 : 1	31.6 32.3
13	110	3.3	2839	84	161 : 1	32.4 32.3
14	119	3.5	2994	89	158 : 1	33.2 33.0
15	116	3.4	3059	91	164 : 1	33.6 34.1
16	117	3.5	3194	95	171 : 1	34.3 35.0
17	57	1.7	1560	46	171 : 1	- 35.6