Oral hyperalimentation in the nutritional management of burned patients

CAROLINE FABIANI, SUE CANDY

Summary

Total daily protein and energy requirements for burned adult patients were adapted from Sutherland's formulae and implemented in the Burn Unit at Tygerberg Hospital. Patients were given a high-protein ward diet and oral hyperalimentation, and weekly recording of body mass was used for monitoring. It was found that the high protein and energy intake minimized body mass loss during the period after thermal injury.

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A burned patient admitted to Tygerberg Hospital is managed nutritionally by oral hyperalimentation. The hypermetabolic response, characteristic of thermal injury, results in: (*i*) an increased catabolic rate; (*ii*) decreased body mass; and (*iii*) severe protein wasting.

This hypermetabolic response draws on endogenous body stores in order to meet the suddenly increased energy expenditure. As a result there is a drastic decrease in body mass. If a 'normal' energy intake is maintained during the early period after thermal injury, mass loss is still severe. Therefore 'aggressive' nutritional support during this period should ensure an adequate source of both protein and energy to minimize the effect of prolonged catabolism.

Over a period of 6 months 31 patients admitted to the Burn Unit at Tygerberg Hospital were studied.

Nutritional requirements

Energy

Accurate evaluation of the burned patient is necessary in order to estimate the daily energy expenditure; one method is by direct or indirect calorimetry, which is expensive, time-consuming and often unavailable. Another method takes into consideration body mass and the percentage of the total body surface burned.

Body mass alone is inaccurate in calculating energy requirements; the percentage of the total body surface burned is important because the extent of injury determines the magnitude of hypercatabolism. In this regard, formulae using body mass and the percentage of the total body surface burned have been compiled so that the daily energy requirement of a burned patient can be calculated.

Curreri *et al.*[1] expressed the ideal daily kilocalorie (kcal) intake for a burned adult patient as the sum of 25 kcal x body mass (kg) plus 40 kcal x the percentage of the total body surface burned. The ideal daily energy intake for a burned adult patient, according to Sutherland,[2] is expressed as the sum of 20 kcal x body mass (kg) plus 70 kcal x the percentage of the total body surface burned. These energy requirements were expected to minimize a decrease in body mass.

Protein

Body mass and the percentage of the total body surface burned are also important in estimating daily protein requirements. Taking these factors into consideration, the daily protein needs of a burned adult patient are expressed as the sum of 1 g protein x body mass (kg) plus 3 g protein x the percentage of the total body surface burned.[2] However, protein cannot be considered in isolation since its utilization depends on an adequate energy provision, which is expressed as kcal/nitrogen ratio.

To obtain optimal nitrogen efficiency a normal individual needs 7 - 8% of the total daily energy intake in the form of protein, in other words, a kcal/nitrogen ratio of 300 - 350:1. Injured patients need a lower kcal/nitrogen ratio, since protein losses increase more rapidly than the metabolic rate. In such cases 200 - 225:1 is recommended.[3] For burned patients Sutherland[2] recommends 200:1.

The daily requirements of a burned adult patient must therefore take into consideration body mass and the percentage of the total body surface burned for daily energy estimates, as well as a suitable kcal/nitrogen ratio to ensure the efficient utilization of protein. These nutritional needs must be adequate in minimizing the prolonged catabolic effect occurring after thermal injury.

Nutritional management

The average burned patient admitted to Tygerberg Hospital has a low body mass and a low serum albumin level (< 35 g/l), which is attributed to a poor nutritional status before the injury. In calculating the daily nutrient requirements, it would therefore be inaccurate to use the body mass of the burned patient on admission.

Nutritional requirements are calculated using 70 kg as an assumed ideal body mass of a 'reference' man. Sutherland's formulae for protein and energy are used to estimate the nutritional needs of a 70 kg adult with a varying percentage of burns (10 - 90% total body surface burned). The total daily protein (g) and energy (kcal) requirements calculated are shown in Table I. The first column shows Sutherland's recommendations for protein and energy according to the percentage of the total body surface burned and a kcal/nitrogen ratio of 130:1. The second column shows an adjustment of the daily energy recommended by Sutherland in order to obtain a more suitable ratio of 200:1 (Tygerberg I).

Department of Dietetics, Tygerberg Hospital, Parowvallei, CP
CAROLINE FABIANI, B.SC.DIET., DIP.HOSP.DIET. (Present address: Grey's Hospital, Pietermaritzburg)
SUE CANDY, B.SC.DIET., DIP.HOSP.DIET.

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TABLE I. TOTAL PROTEIN AND ENERGY REQUIREMENTS FOR A 70 kg ADULT WITH VARYING PERCENTAGE BURNS

% total body surface burned	Sutherland[2] Protein (g)	Sutherland[2] Energy (kcal)	Tygerberg I Protein (g)	Tygerberg I Energy (kcal)	Tygerberg II Protein (g)	Tygerberg II Energy (kcal)
10	100	2 100	100	3 200	130	3 200
20	130	2 800	130	4 160	166	4 160
30	160	3 500	160	5 120	205	5 120
40	190	4 200	190	6 080	243	6 080
50	220	4 900	220	7 040	282	7 040
60	250	5 600	250	8 000	320	8 000
70	280	6 300	280	8 960	358	8 960
80	310	7 000	310	9 920	397	9 920
90	340	7 700	340	10 880	435	10 880
kcal/nitrogen ratio	130:1		200:1		156:1	

The Tygerberg I regimen was implemented in the Burn Unit. Total protein and energy needs were provided by a high-protein ward diet and supplementary liquid feeds. The patients were monitored by weekly recording of their body mass and there was a minimal decrease during the period after thermal injury. However, the serum albumin levels remained below the normal range (35 - 50 g/l). Therefore it was decided to increase the daily protein intake. The third column of Table I shows the further adjustment. The total energy intake proved satisfactory in minimizing body mass decrease and was kept the same as in the Tygerberg I regimen. However, the total daily protein intake was increased to obtain a new kcal/nitrogen ratio of 156:1 (Tygerberg II).

These recommended daily protein and energy requirements were provided by a high-protein diet and oral liquid feeds. The high-protein diet consisted of three nutritionally balanced meals plus an in-between snack and a glass of high-protein milk. The oral hyperalimentation consisted of supplementary liquid feeds, which were made from a combination of commercial products. Artificial flavouring and colouring were added to improve palatability. Supplementary feeding varied from 5 to 9 glasses per day.

Nutritional implementation

In order to meet the total protein and energy requirements the amount of protein and energy supplied by the high-protein diet must be considered. The remaining protein and energy must be given in the form of liquid supplementary feeds.

The high-protein diet at Tygerberg Hospital provides 120 g protein and 3 100 kcal, plus a high-protein milk drink (1 glass = 250 ml) providing 15 g protein and 250 kcal. This provides a total intake of 135 g protein and 3 350 kcal, which is adequate for a 70 kg adult with 0 - 19% total body surface burns (Table II). Any patient with a larger percentage of burns needs considerably more protein and energy, and in these cases the high-protein milk drink is replaced by frequent concentrated liquid feeds providing 50 g, 80 g, 110 g, 140 g and 170 g protein. The severity of the burns determines the amount of oral hyperalimentation required (Table II).

As an ideal body mass of 70 kg was used to derive the total protein and energy requirements, the patients are categorized according to the percentage of total body surface burned. Table II shows the different percentage of total body surface burned categories, the amount of protein and energy provided by the high-protein ward diet and the oral hyperalimentation, and the total protein and energy intake. An oral limit is

TABLE II. PROTEIN AND ENERGY AS SUPPLIED BY DIET AND HYPERALIMENTATION ACCORDING TO % TOTAL BODY SURFACE BURNED

% total body surface burned	High-protein ward diet Protein (g)	High-protein ward diet Energy (kcal)	Oral hyperalimentation Protein (g)	Oral hyperalimentation Energy (kcal)	Total Protein (g)	Total Energy (kcal)
0-19	120	3 100	15	250	135	3 350
20-29	120	3 100	50	1 250	170	4 300
30-39	120	3 100	80	2 000	200	5 100
40-49	120	3 100	110	2 800	230	5 900
50-59	120	3 100	140	3 500	260	6 600
>60	120	3 100	170	4 300	290	7 400

reached at the 60% of total body surface burned category. This limit is largely determined by the volume and concentration of oral hyperalimentation, which provides 4 300 kcal in 2 100 ml. This means that the patient has to drink 9 glasses of liquid per day at a concentration of 2 kcal/ml. Therefore patients with 60% or more of the total body surface burned fall into the same category which provides a total of 290 g protein and 7 400 kcal. It is important to remember that age, sex and depth of burns may influence the nutritional needs and hence the categorization.

Administration of oral hyperalimentation

Aggressive nutritional support starts immediately after fluid resuscitation, once the ileus which follows injury resolves. This is usually on the 3rd day.

There are five volumes of oral hyperalimentation, 1 200 ml, 1 400 ml, 1 600 ml, 1 900 ml and 2 100 ml, which are administered as 5, 6, 7, 8 or 9 glasses per day respectively at set times. The number of glasses of fluid and the specific feeding time for each individual patient are displayed on a card at the head of the bed. This helps nursing staff to administer the feed at the correct intervals, and ensures adequate total intake over 24 hours.

Evaluation

The nutritional adequacy of the regimen was evaluated by weekly monitoring of the body mass of individual patients during the period after thermal injury. Body mass is a useful measurement and perhaps the best indicator of adequacy of intake, provided it is a frequent estimation of naked body mass. A decrease in mass of 10 - 14% is probably acceptable, whereas a 20% loss is drastic.[1] Burned patients on this regimen (Table II) were grouped according to the percentage of total body surface burned. The change in body mass from admission until discharge was expressed as a percentage. The burn category was evaluated for patients admitted to the Burn Unit over a period of 6 months and the findings are set out in Table III.

Discussion

Patients with 0 - 39% total body surface burns appear to have adequate nutritional support for maintenance of their body mass during the catabolic phase after thermal injury. The range of nutritional support would be a minimum of 135 -

TABLE III. BODY MASS CHANGE (%) DURING HOSPITALIZATION AFTER BURNS

% total body surface burned	Body mass change	No. of patients
20 - 29	6% increase	7
	7% decrease	1
30 - 39	3% increase	3
	20% increase	2
	No change	1
	6% decrease	3
40 - 49	10% decrease	7
	10% increase	1
50 - 59	2% decrease	1
	20% decrease	1
	7% increase	1
60+	6% increase	2
	11% decrease	1

200 g protein per day and 3 350 - 5 100 kcal per day. If other factors influence the magnitude of the catabolic response, the nutritional support could easily be increased up to limits of 290 g protein and 7 400 kcal per day.

Patients suffering more than 40% total body surface burns are at a higher risk of losing body mass. The catabolic expenditure after this severity of thermal injury is tremendous and immediate aggressive nutritional support is necessary. Despite intakes of 230 - 290 g protein per day and 5 900 - 7 400 kcal per day, there is still a decrease in body mass during the first 4 weeks after the thermal injury. From the 4th week until wound closure there is a gain in body mass, although the patients' initial mass (recorded on admission) is not regained.

The recommended protein and energy intakes appear to provide adequate nutritional support in minimizing the effect of hypercatabolism. The majority of the 31 patients in this study suffered full-thickness burns and the nutritional support was considered efficient.

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Hospital admissions for adverse reactions to drugs and deliberate self-poisoning

D. I. COOKE, W. VAN DER MERWE, D. J. PUDIFIN

Summary

In a prospective study of 300 patients, 14 admissions (4,6%) were considered to be related to adverse drug reactions. A further 29 admissions (9,6%) were due to self-poisoning with drugs prescribed for therapeutic purposes. Agents causing adverse reactions were predominantly cardio-active drugs and anticoagulants. Mean duration of hospital stay in this group of patients was 8,3 days (range 2 - 18 days); there were no deaths. Tranquillizers and antidepressants were most commonly used for self-poisoning. Duration of admission in these patients was much shorter than in the previous group — mean 1,8 days (range 1 - 5 days), and there was 1 death. To the best of our knowledge, this is the first reported series of such cases in South Africa. It shows that drugs are an important cause of morbidity in hospital patients in the RSA.

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Department of Medicine, University of Natal and Addington Hospital, Durban
D. I. COOKE, B.SC., M.B. CH.B. HONS, M.R.C.P. (Present address: Department of Radiology, Leeds General Infirmary, Leeds, England)
W. VAN DER MERWE, M.B. CH.B.
D. J. PUDIFIN, M.B. CH.B., F.R.C.P., F.C.P. (S.A.)

The fact that drugs can cause disease has been recognized for some time.[1-7] Toxic effects may result either from therapeutic use or deliberate overdosage. The proportion of hospital admissions related to adverse reactions to drugs varies from 1% to 6%, depending on the origin of the study.[2,3] Although no study of this kind has been performed in the RSA, several authors[5,6] have pointed out the potential dangers of drugs.

Patients and methods

Between August and October 1982, 150 consecutive white male and 150 consecutive white female patients admitted to two general medical wards of Addington Hospital, Durban, were prospectively analysed. Admissions for drug-related conditions were divided into: (*i*) deliberate self-poisonings; and (*ii*) adverse drug reactions. An adverse drug reaction was defined as any undesired or unintended effect of a drug. The definition of the cause and effect relationship between a drug and an adverse reaction was that described by Trunet *et al.*[7]

The age distribution of the patients is shown in Figs 1 and 2.

Results

Table I shows the observed adverse drug reactions. There were 14 patients in this group, 9 women and 5 men; none of these patients was under 50 years of age. No deaths occurred in this group, but 1 patient (case 10) had two cardiac arrests with *torsade de pointes*; resuscitation was successful on each occasion. He had been taking disopyramide, and the ECG on