Weight Loss Following Thermal Injury

THOMAS W. NEWSOME, M.D., MAJOR, MC,* ARTHUR D. MASON, JR., M.D.,
BASIL A. PRUITT, JR., M.D., COL, MC

From the United States Army Institute of Surgical Research, Brooke Army Medical Center, Fort Sam Houston, Texas 78234.

THE SEVERE WEIGHT LOSS frequently associated with thermal injury has been attributed to a combination of hypermetabolism and inadequate caloric intake. Energy expenditures as much as twice normal have been documented during the first 3 weeks after such injury,[2,7] and negative nitrogen balance may persist for 5–6 weeks.[5] At the same time, oral alimentation may be restricted by prolonged ileus, disorientation, facial burns, associated injuries, or the need for respiratory support via an endotracheal or tracheostomy tube. Prior to the recent development of technics for intravenous hyperalimentation, administration of nutrients by the venous route was also limited. Even with the administration of 4,000–8,000 calories per day by a combination of intravenous and oral routes, actual weight gain is seldom achieved in the first few weeks postburn, although weight stabilization may be attained.[6]

Most of the studies of this catabolic phase of burn injury have been confined to intensive but brief monitoring of oxygen consumption, evaporative water loss, and body weight in relatively small numbers of patients during the first 3 weeks postburn. Soroff's[5] study of nitrogen balance is the only long-term analysis of postburn metabolism and it was limited to patients with burn sizes of 20–35%.

In order to define the temporal pattern of postburn weight loss and determine its relation to burn size, we have divided a selected patient population according to burn size and analyzed their weight changes over a 3-month postburn period.

Methods

A retrospective analysis was made of the weight records of 1,028 patients admitted to the United States Army Institute of Surgical Research burn unit between December 1967 and November 1970. This time period was chosen because it immediately preceded the initiation of high caloric parenteral feedings. Eighty-six patients with reliable preburn weights, serial weight assessments postburn, and without major amputations were consolidated into three burn-size ranges of 0–19% (17 patients), 20–39% (25 patients), and 40+% (44 patients). Patient ages ranged from 2–70 years with the greatest number in the 15–40 year range.

Each patient had been weighed on a Toledo 100 Kg. scale with 50 Gm. graduations. Weekly weights from the time of admission to the eighth week postburn were recorded in the 0–19% and 20–39% ranges. At 12 weeks postburn no patients with burns under 20% and only four patients with 20–39% burns remained hospitalized. Hospital discharges occurred later in patients with burns of more than 40% and weight data of this group were recorded at 12 weeks. Those weights obviously biased by dressings were discarded. For comparison, all weights were expressed as per cent of preburn weight.

For each time period, the three data groups were subjected to a preliminary analysis of variance. In those periods where significant ($p < 0.05$) intergroup differences were detected, all possible comparisons of differences between individual groups were tested for significance ($p < 0.05$) by the technic of Scheffe.[4]

Hospital records were also used to determine, for each burn size group, the mean date of wound coverage by reepitheliazation and/or autografting.

Results

Figure 1 shows a distinct pattern of weight loss following thermal injury in which both extent and duration of loss are proportional to burn size.

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* Present address: 6515 Orchid Lane, Dallas, Texas 75230.

Request reprints: Library Branch, US Army Institute of Surgical Research, Brooke Army Medical Center, Fort Sam Houston, Texas 78234.

In the 17 patients with burns covering less than 20% of the total body surface, mean weight loss was 3.5% one week postburn. The maximum loss of 6% occurred 3 weeks after injury. Weight gain began at the fourth week and return to preburn weight was recorded at 8 weeks. Wound coverage in this group was attained at a mean time of 33 days postburn.

In 25 patients with burn sizes from 20–39%, significant weight loss did not appear until the second week postburn (6%) and the maximum decrease of 12% was not reached until the end of the fourth week. Modest weight gains were noted at 6 and 8 weeks. Mean time of wound coverage in this group was the fortieth postburn day.

In the 44 patients with burns of more than 40% there was a 4% weight loss at 1 week, a 10% loss at 2 weeks, and a continuing loss until a maximum of 22% was reached at 8 weeks. In the survivors still hospitalized 12 weeks after injury there was a wide range of weight loss, but the mean weight loss was smaller than at 8 weeks. Wound coverage was completed at a mean time of 57 days postburn in this group.

Statistical analysis of intergroup weight differences demonstrated persistent significant difference between the mean per cent of preburn weight of patients with burns of under 20% and that of patients with burns of over 40% at all times beyond the first week postburn. The difference between patients with less than 20% burns and those with 20–39% burns did not achieve significance until the fourth week, while the difference between the latter group and patients with greater than 40% burns was not significant until the eighth week.

Examination of the weight curves (Fig. 1) reveals that weight stabilization occurred approximately 2 weeks prior to completion of wound coverage in both the 0–19% and 20–39% groups and that 2 weeks prior to wound closure in the 40+% group the rate of weight loss flattened. Weight gain was subsequently associated with wound closure in all groups.

Discussion

These data define a temporal pattern of weight loss following thermal injury in which the magnitude and duration of loss are directly related to the severity of injury.

A metabolic study closely paralleling this review is that of Soroff[5] in which nitrogen balance was carefully monitored over a 3-month period in 11 patients with burn wounds of from 20 to 35% of the total body surface. Although nitrogen requirements did not return to control levels until 60–70 days postburn, a positive cumulative nitrogen balance was reached between 30–39 days with the use of high protein dietary supplements.

TABLE 1. *Intergroup Statistical Comparisons*

Postburn Week	A–C	A–B	B–C
1	NS	NS	NS
2	*	NS	NS
3	*	NS	NS
4	**	*	NS
6	*	NS	NS
8	**	*	*

Group A—0–19% burns
Group B—20–39% burns
Group C—40 + % burns
Significance: NS—not significant
* —$0.01 < p < 0.05$
**—$0.001 < p < 0.01$

This latter figure correlates reasonably well with the 28-day point at which the mean weight stabilized in our study group with burns of from 20 to 39% of the total body surface. The failure of this group to achieve more than modest weight increase over the next 4 weeks may confirm the persistence of significant catabolism suggested by Soroff's data.

The relation of wound closure to postburn metabolic rates has been the focus of several studies which have documented concomitant increases in both oxygen consumption and evaporative water loss in the early weeks postburn.[1–3,7] Because of the calculated magnitude of daily evaporative water loss from the burn wound into a normally humidified environment (2 Gm./Kg./% burn[3]) and the measured heat cost of vaporization of 0.58 calories/Gm. at 30°C., a causal relationship between evaporative loss and postburn hypermetabolism has been hypothesized. This does not, however, appear to be a simple relationship, for Zawacki, *et al.*[7] have shown that diminishing evaporative loss over a 12-hour period does not alter the metabolic rate. Gump

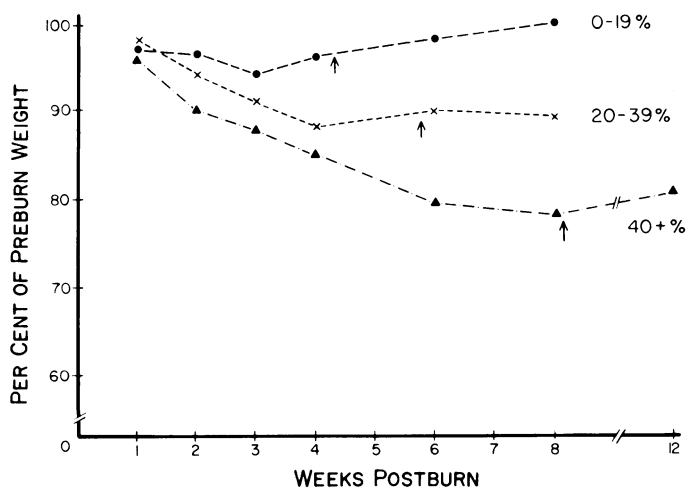

FIG. 1. Mean weight following thermal injury in three burn-size ranges is plotted as a per cent of preburn weight. Arrows mark the mean time of wound closure for each range.

and Kinney[2] have presented additional data suggesting that while evaporative losses decline during the first 2 weeks, the metabolic rate rises. In contrast is a report from Sweden[1] that postburn metabolic rates are decreased by a warm, dry environment which may provide a portion of the heat required for vaporization. Clouding interpretation of this study is the fact that the control temperature of 22°C. used for contrast is sufficiently low to enhance pretreatment hypermetabolism.

Definitive wound closure, defined as the completion of reepitheliazation and/or autografting of the burn wound, followed weight stabilization by almost 2 weeks in each of the burn size ranges considered. At the time when reversal of weight loss occurred, however, coverage of significant portions of the burn wound had already been effected in most patients by a combination of reepitheliazation of second degree burn and allografting of third degree burn. Whether such closure bears a causal relationship to the reversal of weight loss cannot be determined from our data, since the patient groups did not include individuals in whom such coverage was deliberately delayed. Our data do show that final wound closure, like weight stabilization, occurs later as burn size increases.

Metabolic stimuli other than the open wound are active in the burn patient and probably relate to burn size. Among these are hyperdynamic circulation, elevated catecholamines, and sepsis. As the burn wound heals, these ebb, and the patient's metabolic demands diminish.

Since both the magnitude and the duration of the catabolic phase following burn injury seem clearly related to the extent of injury and are difficult to effectively mute, emphasis must be placed on supplying the patient with a caloric intake adequate to achieve net caloric balance. The effectiveness of vigorous oral and intravenous caloric support has been the subject of a recent report from this institute by Wilmore, et al.[6]

Summary

A pattern of weight loss has been found in patients with thermal injuries. The magnitude and duration are directly related to the extent of injury. A maximum mean loss of 22% of preburn weight occurred 8 weeks postburn in patients with burns covering more than 40% of the total body surface. Weight stabilization preceded definitive wound closure and was considered to reflect diminishing metabolic demands.

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