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Burns and Nutrition: The Interrelationship of Nutrition and Physical Therapy for Enhancing Burn Healing-An Updated Review

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Abstract:

Background: Burns result in significant physical harm and trigger metabolic disturbances, such as hypermetabolism and hypercatabolism, which exacerbate the healing process and increase vulnerability to infections. These conditions make burn patients particularly reliant on effective nutritional support to foster recovery and reduce complications. However, providing adequate nutrition in both peacetime and austere settings remains challenging due to limited resources and logistical constraints.

Aim: This review aims to examine the metabolic effects of burn injuries and discuss the essential components of nutritional support, including macronutrient and micronutrient requirements, to enhance healing. It also addresses strategies for nutritional assessment and intervention in both resource-rich and austere environments. In the same time, the main role of physical therapy as an aid in burn therapy using low power laser intensity.

Methods: The review synthesizes existing literature on burn-induced metabolic changes and nutritional support strategies. It includes a discussion on assessment methods, the role of macronutrients and micronutrients, and the impact of various nutrition regimens on burn healing outcomes. The recommendations are based on evidence from randomized controlled trials (RCTs), observational studies, and clinical guidelines.

Results: Nutritional support plays a pivotal role in promoting wound healing, preventing infections, and maintaining lean body mass in burn patients. Key dietary recommendations include protein intake of 1.5–2 g/kg/day, a high-carbohydrate diet (60–65% of total energy), and the strategic use of micronutrients like vitamin C, vitamin E, zinc, and selenium. The Milner equation for calculating energy requirements in patients with burns covering ≥20% total body surface area (TBSA) proved effective in guiding nutritional interventions.

Conclusion: Effective nutritional intervention is essential for optimizing burn recovery. Tailored nutrient strategies, including adequate caloric intake, protein, and specific micronutrients, significantly enhance

healing outcomes. Both in resource-rich and austere environments, the integration of precise nutritional assessment and targeted interventions is crucial for improving burn care management.

Keywords: burns, nutrition, hypermetabolism, wound healing, macronutrients, micronutrients, Physical Therapy, Milner equation, protein, vitamin supplementation.

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Introduction:

In both times of peace and conflict, thermal injuries pose serious health risks. Extreme burns cause severe physical harm in addition to a series of metabolic changes, most notably hypermetabolism and hypercatabolism. Lean mass and body weight are significantly reduced in the hypermetabolic condition, which frequently causes a basal metabolic rate that is twice the normal amount. The patient is more vulnerable to infections and wound healing lags in this state. Compared to other traumas or illnesses, such metabolic disturbances are more severe and persistent in patients who have sustained substantial burns [1]. For burn victims, proper nutritional assistance is essential for promoting wound healing and reducing complications. However, ensuring optimum nutrition can be significantly hampered by the harsh conditions of battle. In order to provide proper nutritional support in such difficult circumstances, creative solutions are required due to limited access to traditional medical supplies. The metabolic reactions to burn injuries are thoroughly reviewed in this publication, along with nutritional evaluation techniques, macronutrient and micronutrient requirements, and nutritional support options in austere and peacetime settings.

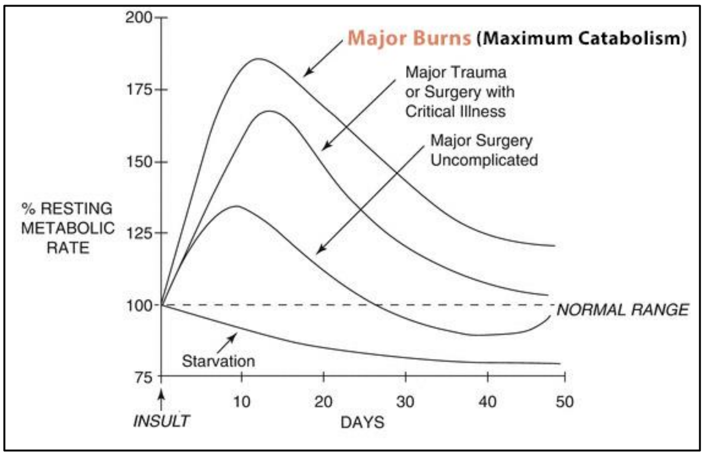

Figure 1: Burns and Catabolism.

Nutritional Assessment in Burn Patients

Gathering pre-injury weight, height, medical history, biochemical information, medication use, and physical examination results is essential to an effective nutritional assessment of burn patients. A visual assessment can assist in detecting malnutrition symptoms, such as temporal wasting, prior to fluid resuscitation. When possible, the patient or family members should be consulted in order to document recent weight loss and inadequate oral intake prior to the injury [2]. Accurate nutritional calculations depend on knowing the patient's normal dry weight because patients may have severe hypervolemia, with edema potentially contributing an additional 25 kg to body weight. Medical records, identification cards, self-reported information, and recent weight data adjusted for IV fluids given before admission are some of the sources used to estimate dry weight.

Because of increased catecholamines and acute-phase reactants, the systemic inflammatory response to burns raises resting energy expenditure. To maximize wound healing, avoid infections, and maintain lean body mass, it is crucial to precisely consume macronutrients to meet these increased energy demands. In order to prevent underfeeding or overfeeding, which can both negatively affect recovery, it is essential to estimate energy requirements accurately. Interestingly, there were no discernible changes in the results of a randomized controlled study (RCT) that looked into calorie objectives for burn patients between supplying 20% and 40% more energy than resting levels. However, the results were biased in favor of the lower-calorie group due to baseline age disparities across groups [3]. For individuals with burns that cover at least 20% of their total body surface area (TBSA), the Milner equation has been found to be a valid technique for assessing resting energy expenditure.

This caloric goal, augmented with an activity factor of 1.4, aims to maintain weight and, in combination with anabolic agents and physical therapy, supports the retention of lean body mass and strength [5,6,7,8]. Further assessments using indirect calorimetry and dual X-ray absorptiometry (DEXA) provide additional insights into the adequacy of nutritional support and body composition changes over time [9]. While visceral protein markers such as prealbumin, transferrin, and retinol-binding protein are not reliable indicators of nutritional status in burn patients, monitoring caloric intake from enteral and parenteral nutrition, intravenous fluids, and oral consumption is essential. Overfeeding, defined as exceeding 120% of the caloric goal, is avoided to prevent complications such as ventilator dependence from increased carbon dioxide production. Target enteral nutrition rates should be achieved within 48 hours of admission, with daily caloric intake maintained within 80–120% of the goal starting on the third hospital day, alongside achieving a positive nitrogen balance [2].

Kcal/day = [BMR × (0.274 + 0.0079 × TBSA - 0.004 × PBD) + BMR] × 24 × BSA × AF
TBSA = total body surface area burned (%) × 100, ex.: 20% burn, enter “20”
Note: TBSA does not change with healing; always use the initial burn size
BSA (m2) (usual answers: 1.5–2.5) = body surface area
Square root of (HT × WT)/3600
HT = height (cm)
WT = weight (kg) (for obese pts, use actual dry weight)
AF = activity factor (typically 1.4 for weight maintenance [5,6,7] and 1 when paralyzed)
PBD = post-burn day
BMR = basal metabolic rate
Male BMR = 54.337821 − (1.19961 × Age) + (0.02548 × Age2) − (0.00018 × Age3)
Female BMR = 54.7494 − (1.54884 × Age) + (0.03580 × Age2) − (0.00026 × Age3)
(usual answers for BMR: 20–40 kcal/m2/h [8])
(usual answers for the Milner equation: 2000–6000 kcal/d)

For patients with burns covering ≥20% TBSA, nutritional recommendations include the following:

- **Energy:** Calculated using the Milner equation.
- **Protein:** Initially 25% of the energy goal, adjusted to achieve positive nitrogen balance.
- **Carbohydrates:** 60–65% of the energy goal.
- **Fat:** 10–15% of the energy goal.
- **Micronutrients:**
    - Vitamin C: 500 mg thrice daily.
    - Vitamin E: 400 IU daily.
    - Zinc: 50 mg elemental or 220 mg zinc sulfate daily.

- Selenium: 400 mcg daily.
- Thiamine: 100 mg daily.
- Folate: 1 mg daily.
- Vitamin D3: 20,000 IU every three days.
- Phosphorus: 30 mmol of intravenous sodium phosphate every six hours.
- Multivitamins with minerals: One tablet daily.

For burns involving <20% TBSA, nutritional guidelines are adjusted to 35 kcal/kg energy and proportionally modified macronutrient and micronutrient requirements. Wound healing remains the overarching goal of aggressive nutritional interventions.

Carbohydrates serve as the primary energy source and play a pivotal role in burn patient recovery. A dietary approach favoring higher carbohydrate intake and reduced fat consumption has been shown to yield significant clinical benefits. Specifically, randomized controlled trials (RCTs) have demonstrated that a diet with at least 60% carbohydrates and no more than 15% fat intake correlates with a reduced incidence of pneumonia and wound infections, shorter hospital length of stay (LOS) relative to the percentage of total body surface area (TBSA) burned, decreased likelihood of PaO2/FiO2 ratios below 200, and expedited wound healing proportional to TBSA burned [14,15]. Furthermore, a meta-analysis combining data from these RCTs revealed a reduction in pneumonia rates, reinforcing the advantages of this macronutrient distribution in burn patients [16]. Fat intake, although required to prevent essential fatty acid deficiencies, is needed only in minimal amounts. Studies indicate that as little as 1–4% of total energy intake from fat is sufficient for this purpose [17,18]. Five small RCTs have investigated the inclusion of fish oil in burn patients' diets and identified several benefits, including improved body weight at discharge, reduced wound infections, decreased hospital stays adjusted for burn size, and less severe sepsis and septic shock. However, these benefits come with the caveat of an increased overall infection rate associated with fish oil supplementation [14,15,19,20,21,22]. Protein metabolism is profoundly affected in burn patients, with significant protein losses occurring through urinary excretion and wound exudate, coupled with elevated protein uptake in wound beds to support healing. A protein intake of at least 1.5–2 g/kg per day is recommended for burn patients. Alternatively, a target of 25% of total caloric intake from protein can be adopted as an initial guideline. Nitrogen balance studies can further assist in evaluating protein losses. Despite the increased need for protein, it is advised to avoid exceeding 5 g/kg of ideal body weight daily, even in cases of negative nitrogen balance, to prevent adverse effects associated with excessive protein consumption.

The Waxman equation [23] is used to estimate nitrogen losses from open wounds:
nitrogen loss/day over the 1st week (gm) = 0.3 × BSA × %TBSA Open Wound
nitrogen loss/day after the 1st week (gm) = 0.1 × BSA × %TBSA Open Wound
%TBSA Open Wound = total body surface area unhealed burn wound plus total body surface area unhealed donor sites (%) × 100, Ex: 20% TBSA unhealed burn + 20% TBSA unhealed donor, enter “40”
Note: %TBSA Open Wound does change with healing
BSA (m2) (usual answers: 1.5–2.5) = body surface area
square root of (HT × WT)/3600
HT = height (cm)
WT = weight (kg) (for obese pts, use actual dry weight)
Nitrogen balance = (gm protein intake/6.25) − [UUN × 1.2 + 2 + Waxman + (ΔBUN)]

ΔBUN = change in blood urea nitrogen during UUN collection
UUN = urine urea nitrogen
Note: UUN inaccurate with renal failure/elevated BUN
The Waxman equation [23] is used to estimate nitrogen losses from open wounds:

Micronutrients

Burn patients use more vitamin C because they have more oxidative stress and significant tissue damage. In this population, vitamin C supplementation has been shown to improve immunological function, speed wound healing, and encourage collagen formation [24,25]. For those with severe burns, our regimen calls for 500 mg of vitamin C to be given three times a day. According to one study, burn patients who do not survive have much lower vitamin E levels than survivors [26]. Low amounts of vitamin C may be the cause of this insufficiency. Vitamin E supplementation enhances wound healing results, according to experimental investigations conducted in animal models [27–31]. We therefore give 400 IU of enteral vitamin E every day. Among burn patients, zinc deficiency is common and has been linked to immunological impairment and delayed wound healing. Benefits of zinc supplementation have been shown to include enhanced immune function, decreased infection rates, and quicker wound healing. On the other hand, copper insufficiency may be brought on by taking 40 mg of elemental zinc daily [25]. We administer 50 mg of elemental zinc (which is equal to 220 mg of zinc sulfate) orally per day for severe burns. Barbosa et al. evaluated vitamin E, vitamin C, and zinc supplementation in a randomized controlled trial (RCT). In the intervention group, patients were given twice the recommended daily intake for zinc and 1.5 times the upper limit for vitamin E and vitamin C. The time to wound healing was considerably reduced with this supplementation regimen (5 ± 1 days vs. 8 ± 1 days, $p < 0.01$) [32].

Vitamin A is essential for immunological response, wound healing, and the development of epithelial cells. Vitamin A supplements help burn patients re-epithelialize and lower their risk of infection. Due to large liver storage, vitamin A shortage is uncommon, although it might hinder collagen formation and wound healing [25]. According to research on animals, vitamin A may mitigate the negative effects of corticosteroids on wound healing [25, 33]. But in burn patients who aren't getting any more supplements than multivitamins, vitamin A toxicity has been documented, particularly in cases of acute renal injury [34]. Our protocol does not include routine supplementation. Because of its antioxidant qualities, selenium is frequently diminished after burn injuries. Supplementing with it has been linked to reduced infection rates and better wound healing [25,35,36]. As part of our treatment, we administer 400 mg of enteral selenium every day. It has been demonstrated that thiamine administration lowers lactate levels in burn patients [37]. Therefore, we give 100 mg of thiamine every day. Patients with severe burns frequently have vitamin D deficiency, especially in the early post-burn period. Hemodilution during resuscitation and inflammation-induced decreases in carrier proteins, including albumin and vitamin D binding protein, are the causes of this deficit. Reduced bone mineral density, a higher risk of lengthy bone fractures [39], decreased scar flexibility, and compromised skin barrier function [40] have all been associated with low vitamin D levels. We aggressively supplement 1250 mg of vitamin D3 every three days to address this, and we regularly check the levels of 25-OH vitamin D to make any required modifications. Anemia, neutropenia, and poor wound healing are all linked to copper deficiency, which is commonly seen following severe burns [25,41]. In situations of severe deficiency, intravenous copper supplementation at a rate of 4 mg daily is administered for 1-2 weeks, and copper levels are checked every two weeks. Enteral zinc supplementation is stopped for moderate copper deficits.

A higher mean corpuscular volume (MCV) in macrocytic anemia leads to the measurement of vitamin B12, folic acid, methylmalonic acid, and homocysteine levels. Serum vitamin B12 levels are not as good as elevated methylmalonic acid and homocysteine as markers of vitamin B12 insufficiency. Vitamin B12 is used as a supplement when a deficiency is proven. 1 mg of folate is taken daily to replace folate levels, which tend to drop after severe burns [42, 43]. Low MCV, a sign of microcytic anemia, requires an iron panel to screen for possible iron deficiency. Although its function in burn patients has not been thoroughly investigated, iron is a cofactor in collagen formation and aids in wound healing [44]. Following severe burns, low iron levels and increased ferritin levels are typical [24,44]. However, because frequent blood transfusions in burn patients might result in iron overload, we usually steer clear of iron supplements. Even in well-nourished hypermetabolic individuals, severe electrolyte imbalances, especially phosphorus deficiency, are common in malnourished patients or those starting enteral feeding. During the start of enteral nutrition, phosphorus is forcefully replenished with intravenous sodium phosphate at a rate of 30 mmol every six hours while being continuously monitored. This strategy has been linked to fewer infections and cardiac incidents [45]. Until electrolyte levels stabilize, enteral nourishment is temporarily stopped or modified if phosphorus, potassium, or magnesium levels drop below 2 mg/dL, 3 mmol/L, or 1 mg/dL, respectively. Strategies for micronutrient supplementation should be customized to meet the needs of each patient, taking into account particular test findings and clinical evaluations.

Enteral Nutrition

With its ability to maintain gastrointestinal integrity, strengthen the immune system, and reduce the risk of infection, enteral nutrition (EN) is thought to be the best way to provide nutritional support. As soon as it is clinically possible, usually during the first 24 hours of admission, the main goal for burn patients is to start EN [9,46,47,48,49,50,51,52,53,54,55,56]. When EN was initiated early (within 0 to 24 hours after admission), there was a significant difference in body mass index changes, according to a randomized controlled trial (RCT) that looked at the time of EN beginning in burn patients [55]. Furthermore, a multicenter observational research showed that starting EN within 24 hours of admission was associated with shorter intensive care unit (ICU) stays and lower rates of wound infections [57]. We make use of an enteral formulation that is rich in carbs and protein. Because they are usually high-fat, formulas for diabetic, renal, pulmonary, acute respiratory distress syndrome, and concentrated EN are not commonly used. Low-fat, high-carbohydrate recipes have been demonstrated to be more successful in accelerating the healing process and enhancing burn patients' results [14,15,16,58,59,60]. Because the high quantities of arginine in immune-boosting formulae have been linked to higher fatality rates in sepsis patients, they are avoided. According to the ISR 1-120 BICU Insulin Clinical Practice Guidelines, an insulin infusion is initiated in diabetes patients as needed. When required, continuous renal replacement treatment is used for patients with renal failure.

The phrase "hemodynamic stability" is not well defined, even though the recommendations [9] advise postponing the start of EN until hemodynamic stability is attained. Thus, the normalization of lactate levels (<3 mmol/L) and the decrease in epinephrine or norepinephrine infusions to less than 0.15 mcg/kg/min are the clinical definitions of hemodynamic stability. Only after these conditions are satisfied is enteral nourishment started. It is crucial to remember that flatus, stool production, and bowel sounds are not accurate measures of bowel function and should not be utilized as prerequisites for initiating EN [9]. Until the desired rate is attained, EN is begun at a rate of 20 mL/h and increased by 20 mL/h every 4 hours as tolerated. When EN starts, protein boluses (5–6 g) are also planned every three hours. Until the target is reached, the boluses are gradually increased by 5–6 g daily. Urinary urea nitrogen levels, which usually increase around hospital day 14, suggest that dosage may need to be further modified to maintain a positive nitrogen balance. A maltodextrin mixture (about 2 kcal/mL) is added to the flush bag once the initial EN target has been met and the phosphorus levels have remained above 3 mg/dL. EN is then adjusted to provide 60–65% of total calories from carbohydrates and at least 25% from protein (or based on nitrogen balance results if higher). Intravenous fluids are reduced as tolerated after EN has achieved its objective, and a minimum water flush of 30 mL every four hours is necessary to maintain feeding tube patency. In order to accommodate the surgical operation, the hourly rate for EN can be raised by roughly 20 to 40 mL/h the day before and then lowered to the baseline rate the day following. In patients with protected airways, post-pyloric EN is typically held throughout transit to surgery; in other patients, EN formulae may be withheld six hours before operation. Up to two hours prior to surgery, clear liquids, like maltodextrin mixes or supplement drinks, can be taken orally or post-pylorically. Up to six hours before to surgery, solid foods such as toast or cereal (but not milk) may be consumed. In order to help prevent aspiration, the stomach is suctioned in the operating room and intensive care unit prior to surgery for patients with nasogastric or orogastric tubes. After the patient is hemodynamically stable after surgery, EN can be started again at the pre-operative rate [61]. While EN is suspended for epinephrine or norepinephrine infusions exceeding 0.15 mcg/kg/min, it is not withheld for the use of vasopressin or dobutamine. To make up for any lost EN time, a catch-up rate is recommended: for every hour of lost EN, the current EN goal rate is raised by one-third for three hours [61].

Enteral Nutrition in the Austere Environment

The US kept control of the airspace throughout earlier military operations, like Operation Iraqi Freedom and Operation Enduring Freedom, which allowed wounded to be evacuated to a level 5 facility in the US within two to three days of their injuries [62,63]. As a result, the average duration of stay at a Combat Support Hospital (CSH), including required surgery and evacuation preparation, was almost 17.4 hours. Dietitians' ability to provide thorough nutritional assessments was severely constrained by this short time frame [63]. The administration of nutrition supplementation in austere circumstances or combat zones is therefore poorly documented. Commercially prepared enteral nutrition formulae are problematic to produce, transport, and store in impoverished countries in austere conditions due to logistical and financial challenges [64]. In addition to product storage restrictions, these settings must deal with the risky nature of enteral formula transportation, which frequently conflicts with the transportation of more vital supplies like water and ammunition [64]. A forward surgical team (FST) was assigned to provide early enteral nutrition to seven patients—including Afghan nationals and service members—who were waiting to be evacuated from the battle zone in Afghanistan, according to a scenario reported by Frizzi et al. [64]. Although the authors did not identify the mechanisms of injury, such as whether any of the patients had burns, these patients experienced severe trauma. For patients who did not require a laparotomy, nasogastric tubes were utilized, and for those who did, surgical gastrostomy or jejunostomy tubes were used. Enteral feeding with 1% low-fat milk at a rate of 30 mL/h started 12 to 24 hours after surgery. Since the FST lacked feeding pumps, bolus feeding was the recommended technique; however, for continuous feeding, a saline intravenous bag was converted into the tube feed container, and the infusion rate was adjusted using a dial-a-flow. After the patients were able to tolerate trickle feeds, the enteral rate was raised to 60 mL/h. Meal-Ready-to-Eat (MRE) dairy shake powder was added to the milk to increase its calorie and nutritional value once tolerance was determined.

Small batches of feeds were made to avoid additive separation, and feeding rates were changed as oral intake rose. Although careful thought is necessary to ensure that appropriate nourishment is delivered within the restrictions of the local environment, homemade enteral formulas offer a workable alternative in austere environments. Local food sourcing might be required, and dietary and cultural constraints in a given area might further reduce the range of food items that are available [64]. At an Iraqi hospital, Stankorb et al. [63] reported using a crude enteral formula made of milk, honey, and eggs in place of commercially available feeding solutions. The time and temperature management needed to store components and preserve the quality of prepared enteral meals must also be considered. Access to equipment like blenders, food processors, or hand-cranked mills, as well as a steady supply of clean water and energy, are necessary for the preparation of these meals [64].

Parenteral Nutrition

On the battlefield, forward surgical teams (FSTs) typically do not have access to commercial parenteral nourishment formulae [64]. Research on the topic is still ongoing, although parenteral nutrition is usually only addressed when enteral feeding is not practicable because of impaired gastrointestinal function or when enteral nutrition is not sufficient to meet the patient's nutritional demands. According to guidelines based on recent research, if the enteral nutrition goal is not met within two days, parenteral nutrition should be considered for high-mortality-risk patients, especially those with a Baux score of ≥60% (i.e., those outside a body mass index of 25–35 kg/m2) [65,66]. While low-mortality-risk patients with good nutritional status before injury are only evaluated for parenteral nutrition after seven days without reaching enteral nutrition goals, patients at moderate risk of death may be evaluated for parenteral nutrition if enteral nutrition goals are not met after five days [9]. Starting at 5, the first dextrose infusion rate should be increased to 7 if well tolerated, especially in those who require little to no insulin. The projected protein goals should be met by administering intravenous amino acids, which should make up 25% of total calories or be altered based on nitrogen balance. The remaining calories should come from dextrose, with the dextrose infusion rate not going over seven. Intravenous lipids in the form of SMOF (soybean, medium-chain triglycerides, olive oil, and fish oil) should account for about 15% of the total calorie intake. Intravenous lipids were only given after seven days without enteral feeding or other sources of fat, such as propofol, prior to the availability of SMOF [10]. To prevent essential fatty acid shortage, 500 calories of intravenous lipids are administered twice a week if necessary. Triglyceride levels are checked once a week while the lipids are administered. During parenteral feeding, it is crucial to regularly evaluate liver function panels and direct bilirubin levels. If the direct bilirubin level rises above 2 mg/dL, copper and manganese administration is stopped. Even when parenteral nutrition is started, efforts should be made to meet enteral nutrition objectives with the aim of stopping parenteral feeding as soon as feasible. To help resolve suspected ileus, trophic enteral nutrition may be administered [10]. As tolerated, increased enteral feeding rates can be accompanied by a tapering of parenteral nutrition.

Oral Nutrition

Patients are usually given a regular, unrestricted food when intubation is not necessary. In the event that intubation takes place, the diet progression is started as soon as the patient is off of artificial ventilation, extubated, and no longer needs a tracheostomy tube, or when the tracheostomy tube size is lowered to #6. Prior to oral ingestion, it is crucial to make sure the patient is in a suitable mental state, which includes being able to control their secretions and speak clearly. To make swallowing simpler, one of the nasogastric or orogastric tubes is removed if the patient also has a Dobb-Hoff tube. During a bedside nursing swallowing evaluation, a pudding-like texture is initially given. The food is then progressed as tolerated toward a conventional diet, supplemented with fluids such as milk. The method of progressing from a clear liquid diet to a full liquid diet, then a soft diet, and finally a conventional diet is not supported by science and may cause nutritional deficiency by needlessly delaying diet advancement. Enteral feeding is stopped for two hours following each meal or supplement to facilitate the shift from enteral to oral nutrition. Specific dietary limitations (such as diabetic, renal, or heart-healthy diets) should not be implemented until the patient can tolerate an adequate amount of oral intake. The patient should be allowed to choose their own meal choices, just like they would at home, as this allows for dietary reeducation in the event that bad food choices are made. To make sure dietary objectives are fulfilled, calorie counts are performed on a regular basis. Because of their low caloric density, beverages like water, Gatorade, Kool-Aid, or those with caffeine are avoided because they may worsen the hypermetabolic state and cause water intoxication or severe hyponatremia in burn patients, who frequently have an overactive thirst mechanism. Only milk and supplements are initially permitted as fluids until the patient reaches their calorie target without experiencing hyponatremia-related problems. Burn patients frequently claim not to be hungry, but they may be extremely thirsty, which makes it easier for them to consume a lot of supplement drinks. The dietician sets a daily supplement goal, which typically falls between 8 and 24 supplements.

Medications for the Hypermetabolic Response

One important factor in helping patients fulfill their projected dietary needs is insulin, a powerful anabolic hormone [68]. However, because of the possibility of negative consequences, including hypoglycemia, close observation is required. When blood glucose levels above 180 mg/dL twice in a row, an insulin drip starts. Only when the insulin drip rate hits 75 units per hour is the intake of carbohydrates modified; at that time, the enteral feeding rate is momentarily decreased. This increased need for insulin is usually temporary, and once the insulin drip rate drops below 75 units per hour, the enteral feeding rate is returned to the desired level. Patients with normal hemoglobin A1c levels at admission should not get long-acting insulin because it can cause hypoglycemia when the inflammatory reaction subsides. A range of 80 to 180 mg/dL is maintained for the goal glucose levels. It has been demonstrated that oxandrolone, a synthetic testosterone analog, improves lean body mass retention and reduces hospital stays for burn patients [69]. Nonetheless, it is necessary to keep an eye out for the possibility of high alanine transaminase levels over 100 U/L. On the fifth post-burn day, oxandrolone is started at a dose of 10 mg twice a day, with liver function tests conducted every week. Oxandrolone is temporarily stopped if alanine transaminase levels are higher than 200 U/L and reintroduced when they drop below 100 U/L. Supporting the retention of lean body mass is the main goal. In juvenile burn patients, propranolol has been shown to be effective in lowering metabolic rates and encouraging the retention of lean body mass. However, during its administration, close monitoring of blood pressure and heart rate parameters is necessary due to potential side effects, such as bradycardia and hypotension [70]. Around day five after the burn, propranolol starts at a dose of 10 mg, given intravenously two to three times daily. In order to achieve a 20% decrease in heart rate, which has been linked to a decrease in the hypermetabolic response, the dosage gradually increased by 5 mg every other day.

Role of Physical Therapy:

Tissue damage, encompassing injuries to the skin, internal organs, and mucous membranes, is classified as a wound, often resulting from various forms of trauma. Proper wound care is essential to prevent infection, starting with accurate identification of the wound type. A universal treatment strategy is rarely effective, as wounds differ significantly in their biology, pathophysiology, and structural characteristics. Wound healing progresses through four distinct phases: hemostasis, inflammation, proliferation, and tissue remodeling, each requiring precise timing and sequence for optimal recovery. Burn injuries, a unique category of wounds, are categorized into first-, second-, and third-degree burns. First-degree burns, confined to the epidermis, typically heal within a week without scarring or specialized care. Second-degree burns, involving the epidermis and superficial dermis, generally heal within two to three weeks in the absence of infection, though scarring may occur. In contrast, third-degree burns penetrate deeper tissues, often necessitating skin grafting and resulting in permanent scars or deformities. Burn wounds are distinct from other wounds due to their physical and chemical origins, requiring specialized management. Unlike acute wounds, which may cause shock from blood loss, severe burns lead to increased capillary permeability and plasma loss. Although initially sterile, burn wounds are highly susceptible to infection and septicemia, often exacerbated by immunodeficiency. Standard dressings and antibacterial treatments used for other wounds are typically insufficient for managing deep burns.

Accurate wound measurement, while prone to overestimation or underestimation, is vital for assessing healing progress. The manual planimetric method is commonly employed, involving tracing wound boundaries on sterile translucent film, transferring the tracing to a grid, and calculating the wound area by counting squares. Low-level laser therapy (LLLT), a non-thermal modality using light with an output power below 0.5 watts, has gained recognition for its ability to modulate biological processes. Often termed "cold lasers," LLLT employs coherent (laser) or non-coherent (LED) light sources to reduce pain and inflammation, enhance tissue repair, and stimulate regeneration. Additionally, non-ablative laser therapies, including photo-rejuvenation, are widely used for scar management, photo-aged skin, fine wrinkles, and inflammatory acne. In clinical settings, validated clinical prediction rules (CPRs) are integral to tailoring treatments for specific patient subgroups, optimizing decision-making, and improving outcomes. This study explores the effectiveness of LLLT in burn healing and examines factors such as patient age, wound size, wound stage, and total burned surface area in influencing therapeutic responses to LLLT.

Conclusion:

Burn injuries significantly disrupt the body's metabolic processes, leading to increased energy expenditure, muscle breakdown, and heightened susceptibility to infections. As a result, managing nutrition is an essential aspect of the recovery process, requiring careful attention to caloric intake, protein levels, and vital micronutrients. The metabolic challenges of burn patients, particularly those with extensive injuries, necessitate precise nutritional strategies to optimize healing and recovery outcomes. The Milner equation provides a reliable method for estimating energy needs in burn patients, especially those with ≥20% TBSA. This equation, alongside a focus on protein intake (1.5–2 g/kg/day), ensures that patients receive the necessary nutrients to maintain lean body mass and promote wound healing. Carbohydrates should constitute a major portion of the caloric intake (60–65%), while fat intake should be minimized but sufficient to prevent deficiencies. Micronutrients play an equally crucial role in the recovery process. Vitamins C and E, zinc, selenium, and other essential nutrients support immune function, collagen formation, and wound healing. Research has demonstrated that supplementation with these nutrients accelerates recovery, reduces infection rates, and improves clinical outcomes. For example, vitamin C boosts collagen synthesis and immune function, while zinc supplementation has been shown to reduce infection rates and promote faster wound healing. However, it is important to balance nutrient intake to avoid overfeeding or underfeeding, both of which can lead to complications. Monitoring caloric intake within 80–120% of the calculated goal is vital to avoid issues such as ventilator dependence or excessive carbon dioxide production. Overall, nutritional support tailored to the individual needs of burn patients is vital for optimal recovery. Clinicians must utilize comprehensive assessment tools, such as indirect calorimetry and dual-energy X-ray absorptiometry (DEXA), alongside traditional measures to guide nutritional interventions. In challenging environments, such as battlefields, innovative nutritional solutions are required to overcome logistical constraints and ensure that burn victims receive the best possible care for healing.

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الحروق والتغذية: العلاقة المتبادلة بين التغذية والعلاج الطبيعي لتعزيز شفاء الحروق - مراجعة محدثة

الملخص :

الخلفية :تسبّب الحروق ضررًا جسديًا كبيرًا وتؤدي إلى اضطرابات في الأيض، مثل فرط الأيض وفرط الهدم، مما يزيد من تعقيد عملية الشفاء ويزيد من القابلية للإصابات. تجعل هذه الحالات المرضى المصابين بالحروق معتمدين بشكل خاص على الدعم التغذوي الفعّال لتعزيز التعافي وتقليل المضاعفات. ومع ذلك، تظل تلبية الاحتياجات الغذائية الكافية في بيئات ما بعد الكوارث أو في ظروف قلة الموارد تحديًا بسبب القيود اللوجستية والموارد المحدودة.

الهدف :تهدف هذه المراجعة إلى دراسة التأثيرات الأيضية لإصابات الحروق ومناقشة المكونات الأساسية للدعم التغذوي، بما في ذلك احتياجات الماكرو والمغذيات الدقيقة، لتعزيز الشفاء. كما تتناول استراتيجيات التقييم والتدخل التغذوي في البيئات الغنية بالموارد والبيئات القاحلة. في نفس الوقت، يتمثل الدور الرئيسي للعلاج الطبيعي كمساعد في علاج الحروق باستخدام أشعة الليزر منخفضة الطاقة.

الطرق :تقوم هذه المراجعة بتلخيص الأدبيات الحالية حول التغيرات الأيضية الناتجة عن الحروق واستراتيجيات الدعم التغذوي. تشمل المناقشة أساليب التقييم، ودور الماكرو والمغذيات الدقيقة، وتأثير الأنظمة الغذائية المختلفة على نتائج شفاء الحروق. استندت التوصيات إلى الأدلة المستخلصة من التجارب العشوائية المحكمة (RCTs)، والدراسات الرصدية، والإرشادات السريرية.

النتائج :يلعب الدعم التغذوي دورًا محوريًا في تعزيز شفاء الجروح، ومنع العدوى، والحفاظ على الكتلة العضلية في مرضى الحروق. تشمل التوصيات الغذائية الرئيسية تناول البروتين بمقدار 1.5–2 غرام/كغم/اليوم، واتباع نظام غذائي عالي الكربوهيدرات (60-65% من إجمالي الطاقة)، والاستخدام الاستراتيجي للمغذيات الدقيقة مثل فيتامينC ، فيتامينE ، الزنك، والسيلينيوم. أثبتت معادلة ميلنر لحساب احتياجات الطاقة في المرضى الذين يعانون من حروق تغطي أكثر من 20% من مساحة سطح الجسم الكلية (TBSA) فعاليتها في توجيه التدخلات التغذوية.

الخلاصة :يعد التدخل التغذوي الفعّال أمرًا أساسيًا لتحسين التعافي من الحروق. تعزز استراتيجيات التغذية المخصصة، بما في ذلك تناول السعرات الحرارية الكافية، والبروتين، والمغذيات الدقيقة المحددة، نتائج الشفاء بشكل كبير. سواء في البيئات الغنية بالموارد أو في البيئات القاحلة، فإن دمج التقييم التغذوي الدقيق والتدخلات المستهدفة أمر بالغ الأهمية لتحسين إدارة الرعاية في حالات الحروق.

الكلمات المفتاحية :الحروق، التغذية، فرط الأيض، شفاء الجروح، الماكرو والمغذيات الدقيقة، العلاج الطبيعي، معادلة ميلنر، البروتين، مكملات الفيتامين.