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NUTRITIONAL SUPPORT FOR THE THREE PHASES OF CARE

BY LISA PERRY, DC

ABSTRACT: *Nutritional support for the Three Phases of Care approach to injury recovery optimizes the biochemical pathways associated with the body's healing process. Each phase of the healing process (acute, sub-acute, and chronic) can best be supported by therapeutic strategies that address the critical aspects of the phase. For example, during the acute phase a patient would most benefit from inflammation modulation, whereas during the sub-acute and chronic phases the emphasis shifts to tissue repair and support for improved range of motion.*

Research demonstrates that natural healing systems, such as chiropractic and clinical nutrition, promote healing and wellness with very little associated health risks. Conventional treatment and management approaches for injury and chronic conditions—non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroids and muscle relaxants—have potential for serious adverse side effects. Combining clinical nutrition with chiropractic care offers a safe and effective approach to injury recovery and long-term wellness care.

Phase 1: Acute (Activation of defense response)

Characterized by pain, swelling, lack of motion, and/or muscle spasm.

Therapeutic Goal: Manage the inflammation and pain through the modulation of eicosanoid production.

Phase 2: Sub-Acute (Reparative processes begin)

The beginning of new tissue synthesis, such as collagen, and replacement of extracellular matrix (connective tissue).

Therapeutic Goal: Provide building blocks for tissue regeneration to support new connective tissue and restore range of motion.

Phase 3: Chronic (Ongoing care)

Reparative processes of acute injuries carry on months after as connective tissue continues to develop strength and support. Additionally, Phase 3 addresses issues from chronic tissue injury with resulting limited range of motion.

Therapeutic Goal: Slow the degenerative process, support healthy tissue regeneration, and help manage chronic or out-of-balance inflammatory response.

Targeted Nutrition Complements the Three Phases of Care

Targeted nutrition plays an important role in achieving maximum health after injury. Nutrients provide the materials necessary for repairing and building tissue, as well as safely managing pain and inflammation through specific biochemical processes relative to each Phase of Care. For example, a supplement containing reduced iso-alpha-acids (RIAA)—an active factor derived from hops—has been shown to reduce mediators of inflammation while showing a low potential for gastrointestinal damage.[1] Supplementing with glucosamine and chondroitin sulfates—both integral components of connective tissue—has also been shown to safely assist with the repair and maintenance of cartilage.[1]

Other nutrients that play a beneficial role at specific phases of recovery are antioxidants, such as Vitamin C and E, known to depress the damaging effects of free radical damage on tissue and expedite the progression of recovery by improving tissue health and integrity. Additionally, vitamin C is required by enzymes that are important in the tissue repair process, such as the formation and maintenance of collagen and extratracellular matrix.[1]

Aligning targeted therapeutic nutrition with the characteristics of each Phase of Care is central for swift and proper recovery.

Phase 1: Acute Managing Pain & Inflammation

Duration: 12-72 Hours

Phase 1 is characterized by inflammation. Inflammation is a protective and restorative response as the body attempts to repair itself following an injury.

Phase 1 typically lasts 12-72 hours after the initial injury. The classic signs of inflammation are local redness, swelling, heat, pain, and loss of function. It is important to note that a degree of inflammation exists in any structure exhibiting atypical tenderness or pain, with or without the classic signs. However, it is when inflammation becomes excessive or uncontrolled that delayed healing, pain, and chronic inflammation become concerns.

Treatment Strategy

The therapeutic goals during Phase 1:

- Minimize pain
- Reduce excessive swelling
- Relax tight muscles
- Restore motion

Key Factor: Eicosanoids

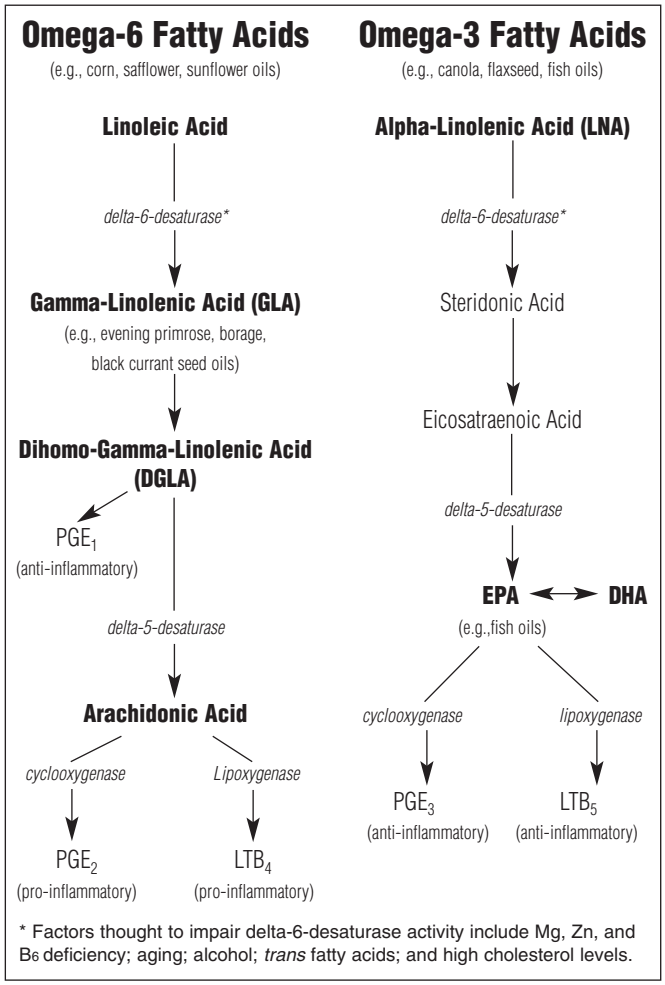
Eicosanoids are short-lived, hormone-like substances present in tissues throughout the body that function as mediators of a variety of physiological responses, including inflammation. Some eicosanoids have pro-inflammatory effects, while others have anti-inflammatory effects.[2]

Eicosanoids are produced from omega-6 and omega-3 polyunsaturated fatty acids present in cell membrane phospholipids. Eicosanoids are released by the action of phospholipids that are activated during injury or trauma.

Omega-6 fatty acids produce arachidonic acid (AA)—the direct precursor of pro-inflammatory mediators [i.e., the 2-series prostaglandins (PGE_2) and 4-series leukotrienes (LTB_4)]. Omega-3 fatty acids include eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)—the direct precursor of the 3-series prostaglandins and leukotrienes of the anti-inflammatory 3-series and 5-series leukotienes (Figure 1).

The conversion of fatty acids to their respective eicosanoids is accomplished by the cyclooxygenase and lipoxygenase enzymes (Figure 1). Much of the current analgesic and anti-inflammatory drug therapies available are based on the pharmacological manipulation of one or both of these enzyme classes.[2-4]

Figure 1: Metabolic Pathways of Essential Fatty Acids



* Factors thought to impair delta-6-desaturase activity include Mg, Zn, and B_6 deficiency; aging; alcohol; *trans* fatty acids; and high cholesterol levels.

A common omega-3 fatty acid is alpha-linoleic acid. As shown in Figure 1, its derivatives include EPA and DHA, which occur naturally in fish. Because a large portion of fats in Western diets are high in omega-6 fatty acids, omega-3 fatty acids are generally deficient in relation to omega-6. Data indicates that problems may arise when one type of fatty acid predominates over the other, leading to an imbalance in eicosanoid production toward those that are pro-inflammatory.[2-4] Therefore, supplementing omega-3 fatty acids may help modulate the inflammatory response.

Nutritional Support for Balanced Inflammation, Swelling & Muscle Relaxation

Herbs for Pain Management

A number of chemical compounds (phytochemicals) found in common herbs demonstrate pain and inflammation-reducing properties by influencing the cyclooxygenase and lipoxygenase pathways, and possibly by other mechanisms as well.[5-7] In addition, bioflavonoids—a broad class of phytochemicals found largely in citrus fruits, tea, and wine—may modify pain and reduce inflammation, also by inhibiting cyclooxygenase, lipoxygenase, and phospholipase.[8]

- Hops Strobile *(Humulus lupulus)*—Reduced Iso-Alpha-Acids (RIAA)

  Recent data suggest that components from hops—reduced iso-alpha-acids (RIAA)—may inhibit the formation of prostaglandins (e.g., PGE_2) via upstream modulation of gene expression.[1,9]

- Rosemary Leaf Extract *(Rosmarinus officinalis)*

  Research suggests that rosemary down-regulates the activation of transcription factors (e.g., NFk-B) that perpetuate the inflammatory cascade.[10,11]

- Ginger *(Zingiber officinale)* and Turmeric *(Cucurma longa)*

  Numerous studies suggest that both herbs may block cyclooxygenase and lipoxygenase activity, thereby inhibiting inflammatory prostaglandin and leukotriene release.[12-16] Furthermore, curcumin has been shown to reduce significant amounts of free AA and limit the formation of pro-inflammatory mediators.[15]

- Boswellia *(Boswellia serrata)*

  An extract of Boswellia, *Boswellia serrata* has been found to specifically inhibit 5-lipoxygenase, the key enzyme of leukotriene biosynthesis.[17,18] Research suggests that inhibiting lipoxygenase may be a beneficial way to treat patients with a variety of inflammatory diseases, including autoimmune conditions.[18-20]

- Bioflavonoids—Quercetin

  Bioflavonoids are an extensive group of plant polyphenols ubiquitous in the plant kingdom.[21] The therapeutic applications of bioflavonoids include controlling pain and inflammation, providing antioxidant activity, and inhibiting enzymes involved in AA metabolism.[3,8,22]

  Quercetin is a powerful bioflavonoid and an effective inhibitor of lipoxygenase and prevents the overproduction of tumor necrosis factor-alpha (TNF-α) and nitric oxide, which can perpetuate the inflammatory process.[3]

Proteolytic Enzymes for Swelling & Trauma

Oral proteases inhibit the synthesis of pro-inflammatory prostaglandins.[3,23-26] Studies have shown that patients who received proteolytic enzymes demonstrated significant reductions in pain and inflammation and faster recovery rates compared to the placebo groups.[27-31] Common proteases include:

- Trypsin, chymotrypsin, and pancreatin—derived from porcine (pig) or bovine (cow) origin. (Porcine sources generally yield higher specific activity than do bovine sources.)
- Bromelain—derived from pineapple
- Papain and chymopapain—derived from papaya

Nutrients for Muscle Relaxation

- Calcium and Magnesium

  Neural regulation of skeletal muscle contraction is mediated by calcium ions through their interactions with muscle proteins (e.g., troponin, tropomysin). Magnesium acts in opposition to calcium ions, promoting muscle relaxation.[32,33] Muscle cramps may result from altered neuromuscular function due to an imbalance in calcium and/or magnesium. Studies suggest supplementation with magnesium and calcium may be effective in reducing muscle cramps.[34,35]

- Lemon Balm Leaf *(Melissa officinalis)*

  Lemon balm is a traditional herbal medicine known for its use as a mild sedative to induce calmness and relaxation. It has a long history of safe use and no adverse side effects have been reported.[36,37]

- Passion Flower *(Passiflora incarnata)*

  Alkaloids, flavone glycosides, and sterols found in this plant appear to provide a broad range of activities that promote a tranquilizing effect on the central nervous system; the mechanism(s) of this action have not been determined.[38-41]

- Valerian Root *(Valeriana officinalis)*

  Valerian is one of the most relaxing herbs available, and is recognized for its ability to calm the entire body.[38,39] Consequently, patients experiencing injury may find valerian root beneficial for its soothing effects.

Phase 2: Sub-Acute Repairing Tissue

Duration: 4-6 Weeks

Phase 2 is the primary repair phase. Tissue repair begins immediately after an injury, and accelerates after pain and swelling are controlled, lasting for a minimum of 4-6 weeks. During this time, the body continues to regenerate cells and collagen, as well as develop scar tissue.

Treatment Strategy

The therapeutic goals during Phase 2:

- Support formation of new connective tissue
- Reduce excessive scar tissue formation
- Minimize pain
- Support restoration of motion to improve joint function
- Prevent degeneration and chronic stiffness

Key Factor: Connective Tissue Structure

Collagen is the major component of connective tissue—70% to 90% by weight. It is also the most abundant protein in the human body, comprising approximately 30% of total proteins.[3] The basic structural unit of collagen fibers consist of long protein chains assembled from amino acids. When collagen fibers are cross-linked to form larger collagen fibers, this provides connective tissue its tensile strength.[42,43] Similar to collagens, elastins are highly cross-linked proteins, found in connective tissues such as tendons, ligaments, skin, and large blood vessels. Elastins give various connective tissues rubber band-like elasticity and resiliency.[42-44]

Proteoglycans (PGs), which are aggregates of proteins and glycosaminoglycans (GAGs), compose about 1% of the dry weight of bones, tendons, and ligaments. PGs form the ground substance of connective tissues and function to improve their load-bearing and compression capabilities by sequestering water.[3,42,43] Proper nutrition to provide the necessary amino acids and GAG building blocks, as well as the nutrients to support collagen fiber generation, is essential for optimal connective tissue and cartilage formation.[45-48]

Nutritional Support for Soft Tissue Repair

Amino Acids for Tissue Repair

As stated earlier, collagen fibers are made up of long chains of amino acids, of which one-third is glycine. Proline and lysine are also prevalent. Hydroxylation of these amino acids is necessary for collagen synthesis and requires the reducing agent ascorbic acid (vitamin C) and alpha-ketoglutarate as cofactors.[43,44] Research has shown that providing the amino acids, as well as the substrates necessary for their hydroxylation, supports healthy collagen fiber formation.[43]

Glucosamine and Chondroitin Sulfates for Tissue Repair

PGs are important for the viscoelastic properties of connective tissues, and they are composed primarily of GAGs—long chain polymers of repeating disaccharide units.[43,47] Glucosamine and chondroitin sulfate are major components of both PGs and GAGs, making them vital for the synthesis of new connective tissue during the healing process. Furthermore, glucosamine and chondroitin sulfate have been shown to reduce pain and inflammation.[48-51]

Manganese, Copper & Zinc for Tissue Protection

Adequate dietary supply of the minerals manganese, copper, and zinc is required for proper function of antioxidant enzymes, such as the superoxide dismutases (SODs); which are found in the mitochondria and cytoplasm of cells. Two types of SODs exist: the copper-zinc SOD (Cu-Zn SOD) and the manganese SOD (Mn-SOD). These enzymes protect tissues by converting

damaging superoxide free radicals into hydrogen peroxide, which is further catabolized by catalase into water and oxygen. Research suggests that providing adequate intake of these minerals is needed for SOD induction and may improve SOD activity, as well as provide protection from the negative effects of free radicals.[52,53]

Phase 3: Chronic
Ongoing Care for Acute and Chronic Injuries

Duration: Long Term

As the repair process continues, Phase 3 provides the proper nutrition and treatment strategy necessary to bring patients back to a state of full recovery by supporting increased tissue strength, health, and integrity. It is important to recognize that the tissue around an injury is not fully regenerated for several months after an injury. The inflammation and immediate damage may be gone, but the tensile strength of a tissue is still in repair.

Repair occurs by an initial arrangement of a connective tissue matrix. But for several months after that initial arrangement (which occurs in Phase 2), the extracellular matrix proceeds to strengthen and continues to regain the pre-injury tensile strength of the connective tissue. This is the time when tissue reinjury can occur, since many people feel the area is "fine and strong"; however, the underlying connective tissue is not entirely repaired. The building blocks for tissue regeneration are necessary for the strength and the development of the tissue and, finally, the elimination of scar tissue.

In addition to inadequate support for the long-term tissue strengthening during Phase 3 of healing, many patients suffer from a chronic injury—preventing the injury from fully healing due to continual underlying degenerative changes or continued inflammation that may occur from a subclinical imbalance in pro-inflammatory mediators. Chronic inflammation characterized by slow onset and gradual loss of function may also be present.[3] Because of these characteristics, there may be difficulty stabilizing the integrity of tissues. For chronic injuries, Phase 3 can help reduce chronic pain, control tissue degeneration, and increase range of motion, which are key to improving overall symptoms.

Treatment Strategy

The therapeutic goals during Phase 3:

- Reduce chronic pain
- Control tissue degeneration
- Nutritionally support tissue health and integrity

Nutritional Support for Chronic Injury

Essential Fatty Acids

Supplementing with omega-3 fatty acids—specifically EPA and DHA—may help promote the balance of eicosanoid synthesis toward anti-inflammatory mediators and away from pro-inflammatory mediators.[2-4,24,54,55] Additionally, research also indicates that enhancement of omega-3 status attenuates pain.[3,56]

It is important to note that supplementation with these polyunsaturated fatty acids may require additional vitamin E intake to prevent increased peroxidation of membrane lipids.[57]

Glucosamine & Chondroitin Sulfates

(See page 3, *Phase 2: Sub-Acute* for more information.)

Antioxidants for Tissue Protection

An imbalance in the ratio of oxidants to antioxidants can lead to the degradation of cartilage and other connective tissues. Damaging oxidative species arise as by-products of metabolism and can increase dramatically in the presence of pro-inflammatory cytokines, such as interleukin-1 and TNF-α. The antioxidant defense system, which includes the micronutrients vitamins C and E keeps these levels of damaging oxidants in check. Deficiencies in any component of the antioxidant defense system can expose tissues to oxidative damage. Therefore, supplementing with a full spectrum of antioxidant nutrients is essential for ensuring long-term tissue health.[3]

Niacin and NAC for Improved Range of Motion

Niacin and N-acetylcysteine (NAC) are known to interrupt the upregulation of poly (ADP-ribose) synthetase, also known as PARS. PARS activation has a well-documented effect on joint tissue integrity; consequently, inhibiting PARS helps to promote the health of joint tissues and reduce minor pain.[58-63]

Support for Chronic Joint Pain

A recent pilot trial indicates that a combination of RIAA, rosemary extract, and oleanoic acid successfully improves joint pain by 50% ($p<0.0001$).[64] Due to their gastroprotective nature, this combination of ingredients is also friendly to the lining of the GI tract.[65]

Effective Wellness Care

Improving Body Composition through Diet & Exercise

Effective Wellness Care is a customized combination of:

- Healthy diet
- Moderate exercise
- Proper rest and stress reduction
- Structural care
- Nutritional supplementation

A healthy diet condusive to weight management is one of the important components to Wellness Care. It has been shown that increased body weight also increases the risk for developing inflammatory joint conditions in weight-bearing joints.[66] Therefore, controlling excess body fat can play a key role in preventing the onset of chronic conditions, as well as minimize the risk of reinjury to tissue.

Moderate exercise can reduce stress and tension, as well as elevate mood and mental performance. It also aids in physiological recovery to improve musculoskeletal strength, flexibility, and body composition. Consequently, moderate exercise is important to promote healing and prevent reinjury. Furthermore, nutrients play a major role in recovery and often work hand-in-hand with proper exercise to maintain optimal health and decrease susceptibility to reinjury.

Nutritional Support for Optimal Wellness Care

Because dietary habits change and most adults do not consume enough of the right nutrients, a long-term strategy that includes a nutritional foundation is key to maintaining optimal health. This approach includes a high quality multivitamin that provides bioactive folate, balanced antioxidants (e.g., comprehensive mixed carotenoids), amino acid chelates, and essential bone minerals. In addition to a premium multivitamin, supplementing with pure omega-3 fish oils (e.g., EPA and DHA) can help establish and maintain a healthy balance between dietary omega-6 and omega-3 fatty acids.

Table 1: Summary of Nutrients for Each Phase of Care

Phase 1: Acute	Phase 2: Sub-Acute	Phase 3: Chronic
Pain Management reduced iso-alpha-acids (RIAA) rosemary boswellia turmeric ginger **Swelling** trypsin chymotrypsin homeopathy **Muscle Relaxation** magnesium & calcium lemon balm passion flower valerian root	**Cartilage Support** glucosamine & chondroitin sulfates **Soft Tissue Support** proline & lysine alpha-ketoglutarate vitamin C **Quench Free Radicals** manganese, copper & zinc	**Inflammation Management** eicosapentaenoic acid (EPA) docohexaenoic acid (DHA) **Range of Motion** niacin N-acetylcysteine (NAC) **Joint Pain** reduced iso-alpha-acids (RIAA) rosemary glucosamine & chondroitin sulfates **Tissue Protection** vitamins C & E mixed carotinoids selenium

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