on cardiorespiratory function or lactate production." And male track athletes supplemented with DMG exhibited no significant changes in short-term maximal treadmill performance.

On the other hand, an early finding that DMG can enhance both humoral and cell-mediated immune responses has been fortified by some subsequent research. This animal research needs to be extended to humans.

Early fears that DMG might be mutagenic now appear to be unfounded.

CONTRAINDICATIONS, PRECAUTIONS, ADVERSE REACTIONS

CONTRAINDICATIONS

Those with hypersensitivity to any component of the preparation should not use DMG.

PRECAUTIONS

DMG is not advised for pregnant women or nursing mothers and should only be used in children under medical supervision.

ADVERSE REACTIONS

Those with the rare disorder of dimethylglycine dehydrogenase deficiency may complain of a fish odor when taking DMG supplements. No other significant adverse reactions have been reported with DMG.

INTERACTIONS

There are no known drug, nutritional supplement, food or herb interactions. There is no known interaction with alcohol.

OVERDOSAGE

There are no known reports of overdose with DMG.

DOSAGE AND ADMINISTRATION

Use of DMG should be restricted to items specifically labeled DMG or dimethylglycine. Items labeled pangamic acid, calcium pangamate and vitamin B15 should be avoided. DMG comes in tablets, capsules and sublingual preparations, typically at a dose of 125 milligrams. The usual dose is 125 milligrams daily with meals.

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Dimethyl Sulfoxide (DMSO)

TRADE NAMES

Rimso-50 (Edwards Lifesciences)

DESCRIPTION

Dimethyl sulfoxide or DMSO is a very hygroscopic, sulfur-containing organic compound. It is a colorless liquid with a faint scent of sulfur and mixes readily with a wide range of water-insoluble and water-soluble substances, including water itself. DMSO is rapidly absorbed into the body if ingested or even if touched by the hands, very quickly producing a garlic-like taste. It occurs naturally in small amounts in vegetables, grains, fruits and animal products. DMSO is formed as a byproduct of wood pulp processing and is used as an industrial solvent.

Up until the 1970s DMSO was sold in vitamin stores and used both externally and internally, primarily for various aches and pains. DMSO is approved by the FDA for the palliative treatment of interstitial cystitis and for limited veterinary use. It is not allowed for use as a dietary supplement. A second-generation DMSO, methylsulfonylmethane or MSM (see Methylsulfonylmethane), which is a metabolite of DMSO, is marketed as a dietary supplement.

DMSO is also known as sulfinylbismethane and methyl sulfoxide. The inclusion of DMSO, which is not a nutritional supplement in this PDR, is for historical and informational purposes, and because one of its metabolites, methylsulfonylmethane or MSM, is marketed as a nutritional supplement. The claims for MSM are related to claims made for DMSO.

ACTIONS AND PHARMACOLOGY

ACTIONS

DMSO may have anti-inflammatory, antioxidant and analgesic activities. DMSO also readily penetrates cellular membranes.

MECHANISM OF ACTION

The mechanism of DMSO's actions is not well understood. DMSO has demonstrated antioxidant activity in certain biological settings. For example, the cardiovascular protective effect of DMSO in copper-deficient rats is thought to occur by an antioxidant mechanism. It is also thought that DMSO's possible anti-inflammatory activity is due to antioxidant action. The membrane-penetrating ability of DMSO may enhance diffusion of other substances through the skin. For this reason, mixtures of idoxuridine and DMSO have been used for topical treatment of herpes zoster in the United Kingdom.

PHARMACOKINETICS

DMSO is readily and rapidly absorbed following administration by all routes and distributed throughout the body. It is metabolized in part by oxidation to methylsulfonylmethane and by reduction to dimethyl sulfide. These metabolites are excreted in the urine and feces. Most of administered DMSO is excreted in the urine as such. Dimethyl sulfide is excreted through the lungs and skin, producing a characteristic sulfuric odor.

Following ingestion by Rhesus monkeys, DMSO was rapidly absorbed, reached a steady state blood level after one day and was cleared from the blood within 72 hours after ending treatment. Urinary excretion of unmetabolized DMSO and methylsulfonylmethane accounted for about 60% and 16%, respectively, of the ingested dose.

INDICATIONS

The medical use of DMSO is currently restricted by the FDA to the palliative treatment of interstitial cystitis and to certain experimental applications. It may have shown some usefulness in some forms of arthritis and connective tissue injuries, in amyloidosis, in scleroderma, in the prevention of skin ulceration induced by some antineoplastic agents, in reversing cerebral edema and intracranial hypertension and in the topical treatment of herpes zoster. It may have some anti-cancer, neuroprotective and cardioprotective effects. It has not been established that it can halt progression of degenerative joint disease.

RESEARCH SUMMARY

DMSO has been used for years to treat the symptoms of interstitial cystitis. Dermal applications often bring quick relief from pain caused by arthritis and connective tissue injury. It has not been established, however, that DMSO has any effect on the degenerative processes of arthritis. There is some preliminary evidence that DMSO diminishes destructive changes in the joints in a spontaneous arthritis animal model. This warrants followup. In another animal model, DMSO did not suppress the clinical manifestations of arthritis.

DMSO has exerted favorable effects in the treatment of amyloidosis, possibly, it has been hypothesized, by helping to move amyloid deposits out of tissue and into urine. In one case study, a girl with secondary amyloidosis, which was a complication of juvenile rheumatoid arthritis, was treated with topical DMSO. Gastrointestinal symptoms and massive proteinuria improved. There was marked improvement of decreased left ventricular function and creatinine clearance.

Topical preparations containing high concentrations of DMSO have helped resolve cutaneous manifestations of scleroderma in some.

In a multi-center, placebo-controlled study, 157 patients with acute tenopathies were randomized to treatment with 10% DMSO gel applied three times daily or gel excipient for 14 days. Treatment in all cases started within 72 hours after onset of acute symptoms. Pain and mobility were significantly improved in the DMSO group, beginning as early as three days after onset of treatment. After 14 days, 44% of DMSO subjects were pain free, compared with 9% of placebo subjects.

Skin ulcers have been prevented by a topical application of DMSO and alpha-tocopherol in patients under treatment with anti-neoplastic agents that typically induce these ulcers. In other studies, topical DMSO has alleviated some of the symptoms of herpes zoster. It has demonstrated neuroprotective effects in experimental cerebral ischemia, significantly reducing infarction volume compared with controls. It has also demonstrated some efficacy in reversing cerebral edema and intracranial hypertension. Chronic treatment with DMSO has experimentally protected against cardiovascular—but not renal—effects of copper deficiency.

Some animal studies have further suggested that DMSO might have some anti-cancer effects. A 3% concentration of DMSO added to the drinking water of a strain of mice that spontaneously develop a series of diseases, including some cancers, had significant beneficial effects. Commencing at 10 weeks of age, mice were given the DMSO, and 90% of them were still alive at 40 weeks compared with 50% of controls. Incidence of tumors was far lower in 40-week-old treated mice than in 20-week-old untreated mice. Significant tumor regression has been seen in other DMSO-treated mice. Followup research is needed.

CONTRAINDICATIONS, PRECAUTIONS, ADVERSE REACTIONS

CONTRAINDICATIONS

None known.

PRECAUTIONS

DMSO is neither a nutritional supplement nor an over-the-counter product; its use for the treatment of interstitial cystitis—performed by interstitial instillation—requires a physician with expertise in this procedure. Bladder instillation may be harmful in patients with urinary-tract malignancy. Those who receive long-term treatment with intravesical DMSO should have liver and renal function tests as well as ophthalmologic evaluation performed every six months during treatment. DMSO has been associated with lens changes in animals.

Pregnant women and nursing mothers should avoid using DMSO.

DMSO used as an industrial solvent is not medical grade.

ADVERSE REACTIONS

Adverse reactions reported in those using DMSO for treatment of interstitial cystitis include garlic-like taste, transient chemical cystitis, bladder spasm, discomfort, allergic reactions and anaphylactoid reactions. Adverse reactions for topical use include garlic-like taste, local dermatitis, nausea, vomiting, headache, burning eyes and sedation. Concomitant use of DMSO and sulindac may cause peripheral neuropathy.

INTERACTIONS

Sulindac may decrease the pharmacologic effects of DMSO. DMSO may impair sulindac's conversion to its sulfide metabolite by competitive inhibition of sulfide reductase. Peripheral neuropathy has been reported with the simultaneous use of DMSO and sulindac.

DOSAGE AND ADMINISTRATION

No recommended dose. DMSO is not a nutritional supplement. It is used as a treatment for interstitial cystitis, and treatment must be performed by a qualified physician. DMSO is metabolized to methylsulfonylmethane, which is available as a nutritional supplement. See Methylsulfonylmethane.

DMSO sold as an industrial solvent is not medical grade.

HOW SUPPLIED

Cream — 70%

Gel — 70%, 90%

Injection — 50%, 100%

Liquid — 99%, 90%, 70%

Solution — 50%

LITERATURE

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DL-Phenylalanine

TRADE NAMES

DL-Phen-500 (Key Company), DL-PA-500 (Bio-Tech Pharmacal), Endorphenyl (Tyson Neutraceuticals).

DESCRIPTION

DL-phenylalanine refers to a racemic mixture consisting of 50% D-phenylalanine and 50% L-phenylalanine. L-phenylalanine is an essential protein amino acid. (See L-Phenylalanine.) D-phenylalanine is the enantiomer of L-phenylalanine. D-phenylalanine is a nonprotein amino acid, meaning that it does not participate in protein biosynthesis. D-phenylalanine