# Harnessing the Power of DMSO

If you spend much time around horses, sooner or later you'll encounter dimethyl sulfoxide (DMSO). After all, this pungent, syrupy liquid is used to treat a variety of equine health problems ranging from orthopedic inflammation to neurological injury.

Yet DMSO's route to acceptance in equine veterinary care has been far more circuitous than that of most therapeutic substances. For starters, it was developed not in a pharmaceutical laboratory but from the industrial wastes of paper manufacturing. Initially, it was considered a potential miracle drug: "My first experiences with DMSO were in the 1960s," says Barney Fleming, DVM, of Custer, South Dakota. "At that time it was considered something magic and everyone wanted to stick their finger in it." But within a few years, the use of DMSO ceased entirely, in the wake of safety concerns. In the decades since, especially after it was approved for use in horses in 1970, DMSO has gradually gained renewed acceptance.

"DMSO is not just another medicine; we're looking at a whole new therapeutic principle," says Stanley W. Jacob, MD, of the Oregon Health and Science University medical school, who was the first in the United States to investigate the medical potential of DMSO. "A medicine treats a particular disease. A therapeutic principle is a new method for treating diseases in general."

In other words, DMSO doesn't just have specific effects on the body; its actions can also help other treatments work better. "DMSO is an economical therapy, and many people who have used it over the years swear by it and feel that it is a great help for many medical conditions," says Fleming.

However, DMSO is a powerful agent that must be used with care. "DMSO is a relatively safe product when properly applied, but it can be harmful if misused," says David McCarroll, DVM, DACVIM, of Interstate Equine Services in Goldsby, Oklahoma. "The best thing to do is use it under the direction of your veterinarian."

### Solvent to solutions

DMSO's remarkable versatility as a therapeutic agent comes from its molecular structure, which allows it to interact with water in unusual ways. "DMSO is literally water's alter ego," said Jacob in a lecture to the American College for Advancement in Medicine in 1980. Because DMSO and water molecules are similar in shape, size and polarity, they share three important properties:

- DMSO and water blend together extremely well, at all concentrations. "The DMSO-water bond is 1.3 times stronger than the water-water bond," said Jacob, in his 1980 lecture.
- Water has two and DMSO has six hydrogen atoms that act like magnets to dissolve and "hold onto" large quantities of complex organic molecules without binding with them or changing their structures.
- In the body, DMSO can pass through cell membranes as readily as water does without damaging the tissues, and it can replace water molecules within many bodily fluids. And, because DMSO so readily dissolves other molecules, it can also carry them through the cell membranes with it. "DMSO alters cell membrane permeability," says Jacob. "It moves through membranes and substitutes for water so that it pulls substances through cells that ordinarily would not move through them. This is its basic mechanism of action."

An indication of this action lies in that distinct taste DMSO causes in your mouth after it touches your skin: "When applied topically or by IV, DMSO goes into the blood quickly and is excreted through the lungs, giving the breath a garlic or burnt-almond smell," says McCarroll. "People need to be aware of this when they use it, so they won't be surprised." These properties, along with a few others, account for the ways DMSO is currently used in veterinary medicine.

## Anti-inflammatory action

In horses, DMSO is applied as a topical gel or administered in liquid form intravenously or through a nasogastric tube. It is classified as a nonsteroidal anti-inflammatory drug (NSAID) because it has antioxidant properties that can interrupt the inflammatory process. DMSO binds readily with hydroxide (OH) and other "free radicals," which are oxygen compounds that can damage or destroy healthy cells. Free radicals are often a byproduct of inflammation, and as they build up, they can stimulate more swelling and inflammation, which produces even more free radicals. Studies have shown that DMSO is a powerful free radical scavenger, and can slow or halt the destructive cascade of inflammatory damage to healthy tissue.

DMSO gel is sometimes applied topically to reduce swelling and inflammation associated with strained muscles and soft tissue injuries. Because the chemical is hygroscopic—meaning it attracts and binds to water molecules—it draws excess fluids out of tissues. "It makes a great sweat for swollen legs because it reduces edema," says Fleming, who frequently uses DMSO in his work with endurance horses. Liquid DMSO injections may also be used to treat bowed tendons and other injuries of dense tissues that are difficult to reach with other drugs.

In addition, DMSO is also often administered orally or intravenously in the early stages of laminitis to arrest inflammation in the soft tissues of the hooves. "The toxic effects that are taking place in the feet of the horse can be relieved considerably by administering a 10 percent solution of DMSO, adding it to the IV fluids," says Fleming. "It enhances the elimination of the toxins and reduces the damaging changes taking place in the foot."

Finally, DMSO is sometimes prescribed to treat brain or spinal inflammation associated with trauma, oxygen deprivation or diseases such as West Nile encephalitis or equine protozoal myeloencephalitis (EPM). "DMSO does two things; it reduces inflammation, and since it is hydrophilic it also draws moisture from the tissues, reducing edema and swelling in the meninges or spinal cord, or any other tissues," says Marlin C. Baker, DVM, of Alpha Equine Breeding Center in Granbury, Texas.

## What more can DMSO do

DMSO also has wide-ranging applications that go beyond the control of inflammation:

Enhancement of drug action. When DMSO penetrates the skin and other membranes, it can readily carry many types of complex molecules with it—and that capability is often harnessed to help carry other drugs deeper into the targeted tissues. "For treating sore muscles, we just add DMSO to dexamethasone or prednisolone or any other drug we want to get inside the tissues as an anti-inflammatory," says Fleming. "When you rub those drugs over the skin they only work topically, but if you add DMSO to them, they go into the tissues and work better."

DMSO can also carry other drugs into tissues that are otherwise difficult to penetrate. For example, some skin infections, such as ringworm, rainrot or scratches can be hard to treat because the infective organisms can be deep under the skin or crusty scurf. DMSO can help other antifungal or antibacterial drugs reach their targets more effectively.

Not all drugs work well with DMSO, depending on their molecular weight, shape and electrochemistry. And DMSO will not carry bacteria or viruses across cell membranes because they are too large.

#### Pain relief

Research shows that DMSO slows or blocks conduction of impulses along nerve cells, which in effect reduces pain from musculoskeletal injuries, postoperative incisions and other sources. Relief is only temporary—lasting up to a few hours—because as the DMSO dissipates, normal function returns. However, DMSO is also often used in conjunction with other analgesic drugs to produce more long-lasting pain relief. "We also use it as an adjunctive therapy in intestinal surgeries and for analgesia postoperatively," says McCarroll. "Many surgeons use DMSO in postoperative colic cases to improve microcirculation around the bowel. This promotes better healing and also gives some pain relief."

#### **Diuretic action**

Because DMSO draws fluids from tissues, it may be administered intravenously in cases where it is necessary to increase the horse's urinary elimination, such as to flush toxins from the system faster. "We use it for cantharidin poisoning [blister beetle toxicity]," says Baker. "In this situation it is given intravenously, to lessen the effect of that toxin on the kidneys and GI tract."

Some veterinarians also routinely administer low levels of intravenous DMSO to horses who are tying up, experiencing massive cramping of the large muscles after exercise. "By giving it intravenously, with fluids, it also helps the horse urinate more," Baker says, which in turn both helps the horse flush out and excrete the waste products from the breakdown of muscle cells and increases blood circulation into the area.

DMSO may be used to draw fluids out of the lungs in cases of acute pulmonary edema. "It is beneficial in respiratory disease because it reduces inflammation and draws some of the fluid/edema out of the lungs," says Baker. "Along with DMSO, we use Banamine or some kind of corticosteroid (to also reduce swelling and inflammation) and sometimes it's hard to tell which one is doing the most good, but they seem to work well together to gain a better response."

#### Inhibition of microbial growth

DMSO is a bacteriostatic agent, which means it inhibits the reproduction of bacteria but doesn't necessarily kill them outright. Some veterinarians add it in low concentrations to flushes used to rinse out draining abscesses or other infected wounds. Baker uses DMSO when he flushes out guttural pouches: "It's not irritating when it's diluted enough, and it does help liquefy a lot of the heavy, purulent material that is often found in the guttural pouch."

### **Prudent precautions**

Because DMSO carries molecules through the skin and into the body, it's important to make sure the skin is clean and free of any other chemicals that could be inadvertently carried into the bloodstream. Fly sprays, for example, are safe when used as directed on the skin, but they contain chemicals that could become toxic if they are absorbed into the body.

"[DMSO] should not be used in conjunction with any organophosphate or cholinesterase-inhibitor insecticides," says McCarroll. "If a person applies one of these types of fly repellents and uses DMSO, this can have an additive effect and cause toxicity. The insecticide or parasiticide would have been fine used alone, but when combined with DMSO it will potentiate or increase the effects of that drug and make it toxic to the animal."

Many liniments also contain ingredients that are toxic if taken internally. "You don't want to use [DMSO] with certain types of products, such as those that contain mercury salt," says McCarroll. "This would take the mercury into the horse and can cause a fatal mercury toxicity. Iodine is not as toxic to the horse, but could also cause a problem. Certain other drugs like alcohol, insulin, corticosteroids and atropine may be made more powerful if used concurrently with DMSO."

This ability of DMSO to ease absorption of other topical products is also an issue if a horse is to be drug-tested for competition. "There is a relatively new nonsteroidal anti-inflammatory drug called Surpass that is designed to be used topically," says McCarroll. "When used according to directions it will not cause a positive drug test. But if you combine it with DMSO the drug level will be too high within the body and will cause a positive test."

Because DMSO is a powerful diuretic as well as a vasodilator, it can be harmful when given to dehydrated horses and those in shock. "It can increase loss of fluid via the kidneys and further dehydrate the animal," says McCarroll. "It also dilates the peripheral blood vessels and can thus lower the animal's blood pressure. If the animal is in shock, this would make the condition worse."Repeated or overzealous topical use of DMSO can dry out the skin, leading to scurf and scaling, redness or rash. DMSO produces heat when applied with other solutions, such as water or saline, alcohol or acetone, which can have therapeutic benefits—but too high a concentration can actually burn the skin. "In these instances it will produce a significant amount of heat and can actually cause thermal injury if a person is not careful with it," says McCarroll.