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Precious Metal

By: Sue Sturgis

People have touted the therapeutic benefits of silver for millennia. Hippocrates, the Greek father of medicine, observed that the metal protected against disease. Romans stored wine in silver jugs to keep it from spoiling and applied silver to wounds to help them heal. In 5th century Persia, King Cyrus the Great had his drinking water carried in silver vessels to guard against contamination.

As it turns out, the ancients were onto something. Modern science has confirmed the antimicrobial effects of silver, which binds with proteins in bacterial cell membranes to inhibit respiration and smother germs. That's why drops containing silver are now used to prevent eye problems in newborns, and silver sulfadiazine helps stave off infections in burn patients. A bonus of employing silver as a germicide is that it sidesteps the resistance that pathogens can develop in response to antibiotics.

Nowadays, silver is sparking fresh interest for its ability to guard against foot problems among patients with diabetes, problems that contribute to the more than 80,000 lower limb amputations performed in the U.S. each year.

Acor, the Cleveland-based manufacturer of therapeutic footwear, last year began incorporating silver into its entire line of diabetic shoes. The company uses X-Static, a patented technology marketed by Noble Fiber Technologies of Clarks Summit, PA, that binds silver to fabric. Other medical supply companies are offering diabetic socks, compression garments, and prosthetic interfaces that also incorporate X-Static technology, which lasts through at least 250 washes, according to Noble.

"Essentially what we do is take fibers and universally coat them with silver," said Bill McNally, Noble's president. "They can be knit or woven or dyed. They can go through any traditional textile process."

The antibacterial and antifungal properties of X-Static have been verified by more than a decade of testing at research institutions including Pennsylvania State University and Cornell University and by the U.S. Army. Studies have shown that silver-impregnated fibers kill pathogens such as Escherichia coli, Pseudomonas, Klebsiella, Trichophyton mentagrophytes, and Streptococcus species. A test conducted in 2002 for Noble by North American Science Associates (NAMSA), an

independent laboratory company that provides testing for the healthcare industry, found that X-Static eliminated more than 99% of Staphylococcus aureus, which can lead to gangrene. And a study by Penn State researchers that appeared in the January 1987 issue of Antimicrobial Agents and Chemotherapy found that X-Static not only killed a wide range of pathogens but also was more bactericidal than silver nitrate.

"Silver does have benefit in treating diabetic feet," said Marc Brenner, DPM, a past president and fellow of the American Society of Podiatric Dermatology who's on staff at North Shore Hospital and Long Island Jewish Hospital on Long Island in New York. "It certainly should be added to the armamentarium."

An obsession with silver

A former salesman for Abbott Laboratories, McNally was working in marketing at a hospital when the facility experienced an outbreak of methicillin-resistant S. aureus (MRSA), a severe infection that usually develops in hospitalized patients who are elderly, very sick, intubated, or who have open wounds, including patients with diabetic ulcers.

"Everybody was very concerned," McNally said. "People were dying."

He asked the facility's infection control nurse what hospital staff planned to do about the outbreak. She told him there was nothing they could do-short of painting the walls with silver.

"I never forgot that," McNally said. "She sent me on an exploration of silver. It became almost an obsession."

He discovered that silver's medical use historically involved silver compounds rather than pure silver. The problem with such compounds is that they dissipate quickly. But then McNally came across the X-Static technology, which utilizes elemental silver.

Manufactured by Sauquoit Industries of Scranton, PA, X-Static was used by the U.S. Department of Defense to shield electronics against electromagnetic pulses from nuclear bombs and to create rooms safe from electronic eavesdropping, both high-tech applications that took advantage of the metal's unparalleled electrical conductivity.

McNally initially purchased rights to use the X-Static technology in the ophthalmic arena. In the mid-1990s, he launched a firm that manufactured silver electrodes to diagnose eye disease. The technology employed a filament of silver about 1/10 the diameter of a human hair that is laid across the cornea to measure the retina's electrical activity.

"We pretty much revolutionized eye electrodes," McNally said. "Because of silver's softness, you could just put it right on somebody's eye and they didn't even know it was there."

The silver electrodes were wildly successful, giving McNally the resources needed to explore other applications for X-Static.

From astronauts to diabetes

McNally's next product was a diabetic sock that incorporated silver for its antimicrobial properties.

"In my infinite wisdom, I launched the diabetic sock in Japan, which happens to have one of the lowest diabetes rates in the world," McNally said, laughing.

Nevertheless, the product took off, though McNally at first couldn't figure out why.

"Every diabetic patient in Japan would have to have been buying, like, a thousand pairs of socks," he said.

What he discovered was that people bought the socks because of how they smelled-or, rather, how they didn't. Though Noble has not done any studies to confirm this, the theory is that silver binds with the ammonia and denatured proteins that produce body odor and alters the composition, resulting in instant odor reduction.

Silver offers other benefits, too. Because it's thermally conductive, it prevents localized buildup of heat and staves off hot spots that can lead to blisters. X-Static's blister-reducing ability was confirmed by a 2002 field test conducted by the U.S. Army at Fort Benning, GA, according to Noble. And since it's extremely reflective, it traps infrared radiation generated by the body, keeping the wearer warm in cold weather. All of these qualities created interest in X-Static socks and other garments among nondiabetic patients, inspiring McNally to create a consumer division.

Consequently, Noble's business has exploded in the past five years. The company has expanded the number of licensees selling X-Static products from five to 260. Fortune magazine in May named Noble one of the "cool companies" of the year.

Among those offering X-Static garments today are leading manufacturers of athletic clothing such as Adidas, Champion, and Spyder. During the 2004 Olympics, 61 teams wore clothing made with X-Static. NASA astronauts wear X-Static shirts, and X-Static socks are standard issue for the U.S. Marine Corps and Army.

"People with diabetes can get the same technology that NASA uses," McNally said. "What we're doing is providing a prophylactic function, mitigating the opportunity for blisters to occur because of the reduction in thermal hot spots. But should they nick their foot because of diabetic neuropathy, then we become an active dressing. And that really is the beauty and the mystery of silver: it responds based on the stimulus it receives from the host environment."

Research continues on silver benefits

While Noble's foray into the consumer market has been successful, McNally has not forgotten his roots in the medical industry. He continues to look for new ways X-Static can benefit people with health problems, particularly diabetes.

In fact, Noble's very first licensee was Venosan USA, a manufacturer of medical stockings based in Asheboro, NC. McNally met Venosan president Robert Spalding about 10 years ago, when they spoke at a conference on medical textiles at Clemson University.

"We just took a shine to each other," Spalding said. "And quite clearly, there was an application for silver in my products."

Soon after their meeting, Venosan began offering its Silverline compression stocking for men. A diabetic sock soon followed and has gone on to become a bestseller for the company.

"It's a neat product," Spalding said. "Plus it gives me a nice little niche in the market."

That niche is becoming more crowded, however, as a growing number of companies now sell diabetic products with X-Static. Dr. Socks, Elite Medical, and Medical Resources Limited offer X-Static diabetic socks. Riecken's Foot Comfort World sells an X-Static shoe insole. Knit-Rite provides diabetic and prosthetic socks as well as torso interfaces and knee sleeves utilizing the X-Static technology. Juzo offers stump shrinkers with X-Static.

Interestingly, X-Static stump wear has shown promise for reducing phantom limb pain, and some who wear X-Static footwear report that their feet hurt less, according to consumer reports collected by Noble. At this point the evidence for silver's analgesic benefits remains anecdotal, though it does make a certain amount of intuitive sense, McNally pointed out.

"If you accept the basic tenet that pain is electrically based, there's some foundation for these experiences people are having," he said.

Eddie Scott, Juzo's director of product development, said his company is currently exploring X-Static's pain-reduction capabilities.

And pain is not the only area in which research on X-Static is taking place. Venosan is now studying whether X-Static can help boost blood microcirculation, which is often compromised in patients with diabetes. The work is being conducted at a Swiss research institution.

"There's a magnetic field to silver," Spalding said. "We believe it can increase the blood flow at the micro level."

No silver bullet

Despite the explosion in diabetic footcare products containing X-Static, Acor is currently the only company offering the technology in conjunction with diabetic shoes. Keith Brewer, vice president of Branier Orthopedic in Sunrise, FL, said that although his company is aware of silver technology, it is waiting for more data on benefits before jumping in.

Acor approached Noble with the idea of adding silver to its shoes about two years ago.

"They were very excited at the prospect of introducing a product that has the potential to help the diabetic epidemic by creating a healthier environment for the diabetic foot to live in on a daily basis," said Jeff Binczyk, Acor's marketing director (Editor's note: At press time, Binczyk was no longer with the company).

In January 2004, Acor launched a foot orthotic system called Sole Defense. With sizes based on arch type, the product has an X-Static topcover. Then in August, the company announced that henceforth every pair of footwear ordered from Acor would have an X-Static liner. The company also offers custom footwear and orthotics sheet goods made with X-Static.

"It's a paradigm shift in the market," Binczyk said. "For practitioners who want to help their patients by minimizing bacteria and blisters and eliminating odor, we think that we have the product."

Of course, one of the drawbacks to silver is its price. Even though silver accounts for a relatively small proportion of the product-X-Static generally makes up 5% or less of a garment, or about 0.08 ounces for a 2.7-ounce pair of socks-it does boost the overall production cost. And as demand for silver rises with the growth of its applications, the price can be expected to climb.

Nevertheless, Acor opted to launch its X-Static shoe line without raising prices.

"It is more expensive to manufacture, so it's a premium enhancement to the line," Binczyk said. "But we decided we wanted to hold the line on pricing to offer this enhancement."

Still, not all practitioners are convinced of silver footwear's benefit for patients with diabetes. Vincent Giacalone, DPM, who is in private practice at the Diabetic Foot Care Center in Emerson, NJ, and at the Diabetes Foot and Ankle Center at the Hospital for Joint Diseases in New York, said he embraces the use of wound care products containing silver but remains skeptical of silver footwear.

"Most of the time we use silver products in dressings when we're concerned that a wound is critically contaminated and we want to lower the bacteria count," he said. "When you put silver into a sock or a shoe, I'm not sure how much benefit you're getting. You can argue that the silver in the sock is killing bacteria around the foot, thereby reducing the risk of infection, but I don't know of any studies that show people who wear silver socks have less risk of infection than those who don't."

Giacalone also questioned the argument that silver's ability to reduce hot spots is helpful for patients with diabetes.

"If someone's got diabetes and they're getting a hot spot, the key is not to draw the heat away, it's to stop whatever's causing the hot spot, and that's usually pressure," he said.

Indeed, even practitioners like Brenner who recommend Acor's products for their patients with diabetes emphasize they're no panacea. Silver footwear, said Brenner, is just one aspect of diabetic foot care, which also entails patient history and wound assessment, debridement, offloading, proper nutrition, and systemic and topical treatments.

"Silver is part of the puzzle but not the entire puzzle," he said. "There is no silver bullet for diabetic feet."

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