Silver Iontophoresis
Replacing Antibiotics and Antivirals

Silver has a long history of use as an antimicrobial. Now, an internal infection can be targeted via a silver-nylon conductive cloth placed on the skin and charged positive via a stimulator device, resulting in the flow of an ultra-low direct current of silver ions into the infection.

by Richard Malter

Email:
admin@sismachine.com

Websites:
http://www.siselectromed.com
http://www.electromedicine.org.au

The Global Antibiotics Crisis

There is ever-increasing buzz, scare and probably not small financially motivated scaremongering about the end of the antibiotics era and the growing resistance of superbugs to even the last-line antibiotic armamentarium. At the same time, the Internet is replete with information about the effective and long-known antimicrobial properties of silver metal and silver ions against many different types of pathological (disease-causing) infections, including those caused by superbugs. Available sources are both the numerous alternative medicine pages and the now very many mainstream peer-reviewed medical articles on the same subject.

Drawing on long and hard clinical and electromedical experience and the cases of many confirmed, successfully treated, difficult infections either in place of antibiotics or after antibiotics had failed, this article outlines and explains the complete silver ion electromedicine delivery system recently developed in Australia and now readily and generally available. This independently developed medical equipment can immediately and realistically solve the world's antibiotics crisis, in a high percentage across all cases, probably for the next 50 to 100 years at least.

A Brief, Selected History of Silver in Medicine

It has been known for centuries that silver has significant antimicrobial properties. Silver wire was commonly put into wounds to stop infection. Modern pharmaceutical antibiotics are described as either broad or narrow spectrum, meaning that they are effective against many different types or against only a limited range of potentially disease-causing bacteria. The silver ion (an atom of silver with an electron knocked off electrochemically, thereby retaining a positive electrical charge) is known in modern terms to be an extremely broad spectrum antimicrobial agent. It has been shown to deactivate virtually every type of bacteria, even the superbugs. Additionally, the silver ion is effective against viruses, for which there are very few and often no effective drugs at all.

In the 1970s, a pioneering American orthopaedic surgeon, Robert O. Becker, MD—chief author of the seminal book *The Body Electric* (1985)—used an electrically positive electrode consisting of pure silver wire, implanted into an infected bone, to drive silver ions about a centimetre's distance into the infected bone tissue. It worked and the leg was saved. This is essentially what colloidal silver generators do: release silver ions via the same electrochemical oxidation process from a silver wire electrode immersed in a container of pure water, thus making an ionic "colloidal" silver solution.

Becker wanted to be able to treat larger infected areas of the body beyond the physical scope of a silver wire. His research team hit on the use of a silver-nylon conductive cloth, newly manufactured for NASA for nonmedical usage. When an appropriately scaled voltage was applied to the silver-nylon cloth, polarising it electrically positive, the cloth acted as a flat-surface, pure silver electrode that released silver ions from its surface, just as happened with the pure silver wire electrode. Becker used this electrified silver-nylon cloth electrode system to treat many infected surface wounds, achieving very remarkable, successful results even in cases that had failed to respond to multiple antibiotic drugs.

Becker's core work had not been developed further since his discoveries and innovations in the 1970s. The Internet is scattered with references to it and there are still some active discussion forums, but his work was basically left for dead. Instead, any derivative focus has been on making fabric wound dressings impregnated with silver, now widely available but limited in scope.

The Problem of Medicine Delivery

As an orthopaedist, Becker was working with infected bones via implanted silver wire electrodes, and later with surface injuries. Is it possible to extrapolate from what he did and treat internal tissue infections in organs, glands and other localised anatomical structures deep within the body?

For infectious diseases medicine, *iontophoresis* means being able to target directly and reach an internal body infection with a therapeutic substance...

Across the medical condition spectrum, the H*elicobacter pylori* bacterium can cause stomach inflammation, ulcers and eventually gastric cancer; intractable infections around surgically implanted prosthetics are in most cases an "unconquerable" medical challenge; and the human papilloma virus (HPV) has at least 30 "high risk" sub-types and is strongly associated with cervical cancer. These disease-causing infections would be major targets for noninvasive, effective, silver ion medicine.

Colloidal silver (ionic silver solution), though certainly very useful for surface infections, has major limitations for internal infections, especially critical ones. The human body is often imagined as something like an homogeneous bathtub: if you drop a substance into it, it will undoubtedly spread and go everywhere. Not so.

The body is extremely compartmentalised and barriered at every order of scale. For this reason, some indeterminate percentage of successful infection treatments by standard antibiotics have other explanations. In reality, the drug has not reached the infection in therapeutic dose if at all, or is just not effective against the disease-causing microbe. These instances are probably the result of strong antibiotic-meme placebo effects or are simply coincidental with the immune system's innate capability of dealing effectively with the symptomatic infection on its own considerable merits.

Additionally, for orally ingested silver ions there are a million million molecular binding sites available for them, starting high up in the gastrointestinal (GI) tract itself. The chances of getting any kind of therapeutic dose of silver ions to an acute and severe kidney infection, for example—after routing via the entire GI tract, then up through the portal venous system to the liver, then into the bloodstream, then around the body, eventually to and into the inner compartments of the infected kidney and somehow bypassing along the way the countless possible molecular binding sites—are very slim indeed.

There is also the real-world and underconsidered issue of localised elevated thromboxanes—fatty substances that are part of inflammatory processes and that cause blood clotting and blood vessel restriction. Thromboxanes are often elevated in infected areas of the body due to the activities of the infecting microorganism(s) and other coincidental tissue micro-environment problems. In almost all such instances, these occurrences cannot be felt or distinguished subjectively by the person with the infection. The presence of these thromboxanes means that a reduced amount of medicine or no medicine at all (either natural or pharmaceutical) can reach the infected area of the body via the bloodstream.

The clinical experiences and knowledge of these medicine delivery problems, from which this article is informed, prompted the extensive research and development of the equipment that could provide the comprehensive solution to these obstacles, as outlined in the remainder of this article.

Iontophoresis: Direct Targeting Internally

Under the influence of an electric field—just as is generated between the ends of a battery—ions having a positive electrical charge can be moved through the skin into the body. For infectious diseases medicine, *iontophoresis* means being able to target directly and reach an internal body infection with a therapeutic substance (medicine) noninvasively and without any reliance on the GI tract or vascular system to transport the medicine to the affected area.

Iontophoresis is neither new nor rare. It is sometimes called *electromotive drug administration* or *transdermal drug delivery*. For example, it is often used to deliver a steroid drug in an attempt to dampen inflammation in an injured bone joint. However, these applications are for short-duration medication applications of around half an hour or less, and use milliampere electric currents applied to surface electrodes comprising a compartment containing a liquid solution of the drug to be delivered. However, to treat an infection deep in the body, sustained and continuous silver ion delivery over hours and days can be necessary, and milliampere strength currents applied for longer periods would cause skin burns and tissue damage. A very low voltage, very low electric current iontophoresis system is therefore a medical necessity. The obstacle to the possibility of such deep tissue infection treatments with very low current silver iontophoresis is the skin.

The Skin Barrier's Electric-Voltage-Sensitive Tunnels

Skin is made up of three major layers. The outermost surface of the top layer, the epidermis, is the stratum corneum (SC). The SC comprises mostly keratinocytes—cells that provide the impermeable protective barrier of the organism to its external environment. It also presents the main corpus of electrical resistance to any flow of electric current. The SC is made of up to 100 sandwiched sub-layers and can have a standard, easily measurable electrical resistance value (denoted by "R") along it of up to 20–30 megaohms (MΩ).

To put this relatively high R value into perspective, using the Ohm's law equation for a simple conductor, V = IR, where "V" denotes the voltage and "I" is the current flowing in the circuit, to deliver a very small 10-microampere current through the skin with an R value of 20 MΩ would take 200 volts, close to the voltage of our domestic power supply—far too high for the recipient to tolerate!

Generally, the increased permeability of cellular structures to an applied electric voltage is known as *electroporation*—literally, electrically created holes. Fortunately, Nature has provided electrically permeable crossings of the SC via several skin appendages. Of primary importance to this discussion are the sweat gland appendages of the skin. The sweat glands, crossing the SC and deeper skin layers, have very interesting and medically important electroporation properties.

Sweat glands are like long cylindrical tubes or tunnels, with relatively defined physical diameters and lengths. They are covered on the inside by a double-layered epithelial cell liner. Epithelial cells, with very few exceptions, line the entire body's internal cavities, such as the throat, blood vessels and glands, at all scales. They have been called the safety shields of the body's structures.

Epithelial cells, like all cells, have membranes that when lined up in rows have combined properties of electrical conductivity that can result in the movement of an electric current in the direction parallel to their physical positions. The sweat glands, with their conductive epithelial liners, are overall physically and electrically aligned in such a way that an externally applied electric voltage can potentially create an electric current that flows down and through them.

The sweat glands, with their conductive epithelial liners, are overall physically and electrically aligned in such a way that an externally applied electric voltage can potentially create an electric current that flows down and through them.

While an electric field can be induced along the sweat gland's epithelial cell liner, there is also a leakage (i.e., a loss) of the conductivity of that liner, equally due to its aggregate and basic electrical properties of capacitance and resistance. The special and medically very important characteristic of this overall electroporation phenomenon is that the conductivity leakage profile of the sweat glands varies widely depending on the strength of the externally applied electric voltage.

These physical and electrical properties of the sweat gland tunnels, in total, allow for their carrying of an electric current at both relatively high and very low externally applied voltages. Critically, for extended silver iontophoresis, at low voltages, their relatively fixed physical and dynamic electrical properties suddenly create new pathways for electric currents to cross the skin.

In the lowest voltage domain of up to and around 1.0 volt (V), if the skin had no sweat glands then the conductivity across the outer layers of the skin would be far too small for an electric current to flow. However, with skin being full of sweat glands, with an externally applied 1.0 V a sufficient voltage drop is created along the length of the sweat gland tunnel's voltage-dependent conductive liner to move a small electric current across the skin layers and deeper into the body. Due presumably to coincidental evolutionary influences, this fact just happens to be of great medical importance.

The significance of these phenomena for medical iontophoresis at very low applied voltages of no more than 1.0–2.0 V (which would surprise an electronics engineer not familiar with bioelectrics) is this: a measured resistance of anywhere up to 30 MΩ value across a few centimetres of normal dry skin, when directly contacted and covered with a pure silver-nylon cloth electrode dampened with a little tap water (not conductive medical gel) to help conductivity, will decrease instantly to as low as 5.0 kiloohms (kΩ)—a difference in the order of 10,000 times smaller electrical resistance to the pathway of induced electric current. This fact means that low voltage, very low direct current iontophoresis can be achieved.

Ultra-Low Constant Microcurrent

In electronics you can basically have either a *constant voltage* source or a *constant current* output device. Silver iontophoresis is best achieved with a constant current machine. This device automatically manipulates the actual output current by varying the applied voltage in real time in response to the natural dynamics of the electrophysiology of the skin and its sweat gland tunnels. A constant current device can also self-adapt to the real-world electrical and mechanical interface (contact area) of the silver-nylon cloth electrode and the skin surface to which it is applied, as the person moves, breathes, hydrates and dehydrates.

As the flux of silver ions that can reliably and continuously cross the skin barrier via its sweat gland tunnels has a critical dynamic variance as described above, the precision of the constant current device for performing silver iontophoresis must be extremely fine. The output current range—found by much clinical trial and error over a five-year period to be necessary and optimal for silver-nylon cloth electrode silver iontophoresis—is below 10 microamperes, and with an output current accuracy within a hundred billionths of an ampere of current (100 nanoamperes). This is an electronic specification beyond the capabilities of microampere electrostimulators generally available or outside of a laboratory benchtop equipment setting.

In addition, as the output current is also very small in absolute terms of only a few microamperes, the stimulator device must control for changes in both ambient and local biological tissue temperature, which inevitably affects just about every element—biological and electronic—of the entire electroporation system, as described, via all the usual thermodynamic events generally known across the sciences.

Silver Iontophoresis for Infection Treatments

We can now tie together what has been discussed so far: (1) the innovations of Robert O. Becker and his use of electrified silver-nylon cloth that acts simultaneously as both the large physical area positive polarity electrode and the releasing material of silver ions; and (2) the ultra-low direct microcurrent of silver ions flowing through the otherwise formidable skin barrier via its sweat gland tunnels.

Combining these technologies, it is possible to deliver broad-spectrum and powerful antimicrobial silver ions directly to infected internal tissues (organs, glands, other anatomical structures) deep within the body. Such a silver iontophoresis procedure, which generates tiny subsensory microampere electric currents of silver ions, can be comfortably performed over extended periods, thereby effectively dealing with chronic and difficult bacterial and viral infections, even in hospital and emergency medical situations.

Therapeutic Index of Medications

For a drug such as an antibiotic, the Therapeutic Index is the standard way to assess its beneficial effects versus its potentially harmful ones. This is simply a relationship between the different concentrations of the drugs that have therapeutic effects and those that harm healthy cells.

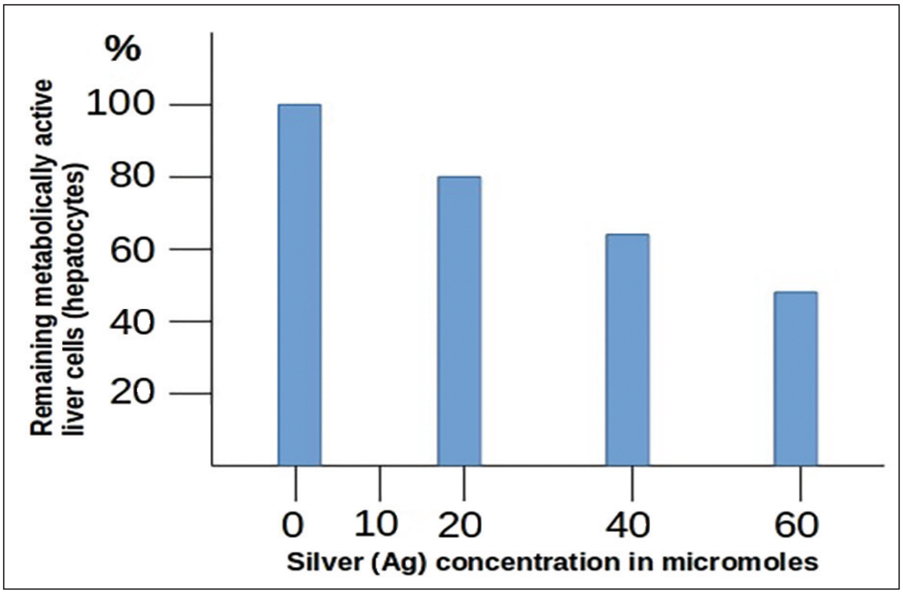

Figure 1: Therapeutic Index of silver nitrate: benefit versus harm (after J. R. Morones-Ramirez *et al.*, "Silver Enhances Antibiotic Activity Against Gram-negative Bacteria", *Science Translational Medicine* 2013 Jun 19; 5[190], http://tinyurl.com/gqhldxm)

A major study was reported in 2013 that tested the Therapeutic Index relationship for silver nitrate, which is not the same as and is less effective than electrically generated free silver ions but still gives us some illustrative data. An extract of the findings of this study is shown in figure 1.

With these data, the study demonstrated that silver is "well within" the Therapeutic Index range applied to government-approved antibiotics and without the other side effects of antibiotics that range from mild to very severe and long term.

Coincidentally to this discussion, the whole emphasis of the published study was biased towards showing how silver can enhance the effects of existing antibiotics. Reading between the lines, it was really a very nice overview of how *silver can be used in place of antibiotics* by the very methods of action studied by its authors.

From the clinical and laboratory experiences that have gone into the R&D of the electromedical equipment described in this article, we estimate that a strong beneficial effect occurs using this equipment at less than or equal to 2.0 parts per million, which is approximately 20 micromoles. However, this calculation is imperfect because it is based on the very imprecise model that assumes a completely watery inner environment of the body, and also because it completely ignores the distance of the targeted infected tissue from the positive electrode releasing the silver ions.

In reality, the very different hydrations and densities of the various internal tissues of the body (bones, muscles, fat, etc.) along the pathway of the silver ion current, plus the distance factors, mean that the calculation is most likely a very large overestimate of what eventually occurs in the targeted infected tissue. In other words, the actual concentration of silver ions (and also not of silver nitrate) is probably far below even 5.0 micromoles. Overall, this means that we achieve very high therapeutic benefit with no harm done to normal healthy cells—as shown by the first bar in figure 1.

To support these calculations further, multiple studies done by Becker *et al*. in the laboratory, where these relationships of effects are much more easily researched, always confirmed this Therapeutic Index for the electrically generated silver ion in question.

The SIS Machine box is a highly sophisticated electronic instrument: a dual, high-precision, self-adaptive stimulator...

The SIS Machine: Universal Application

The other important design specification of the Silver Iontophoresis Stimulator (SIS) equipment in being able to replace antibiotic and antiviral drugs for localised infection treatments is that it can be applied by just about anyone and without requiring any professional medical or electromedical expertise or experience.

Basically, two silver-nylon conductive electrodes are moistened and applied to the body in a positioning configuration that cross-sections the targeted infected area (organ or other anatomical structure). They are held on with standard adhesive surgical or wound-dressing tape available from any pharmacy. The electrodes are then connected to the controller device: a portable, palm-sized, smart electrical box, just small enough to fit into the user's pocket. The SIS Machine box is a highly sophisticated electronic instrument: a dual, high-precision, self-adaptive stimulator and sophisticated real-time algorithm-driven electrode–skin contact monitoring device.

Figure 2 shows typical placements of the silver-nylon cloth electrodes for two common infections: a bacterial or viral infection of the lung, and a bacterial stomach infection.

The equipment has already been used, highly successfully—in many cases where results have been confirmed by standard pathology tests—on young children and by nonagenarians. In numerous cases, it has already prevented the need for hospitalisations and (major) surgical operations.

The SIS Machine is intended and can be described as a

Absolute Minimum Dose Delivery

We can now combine into a more overall understanding the science of the passage of the very smallest direct currents possible through the skin's sweat gland tunnels, outlined above, with the direct experimental and clinical experiential knowledge of the Therapeutic Index of the electrically generated silver ion.

Since actual electrophysiological parameters and limits are involved, the result of what this silver iontophoresis system achieves can be described accurately as the *absolute minimum medication dose delivery*. In other words, it is a minimum medical intervention that can be applied with high therapeutic effect.

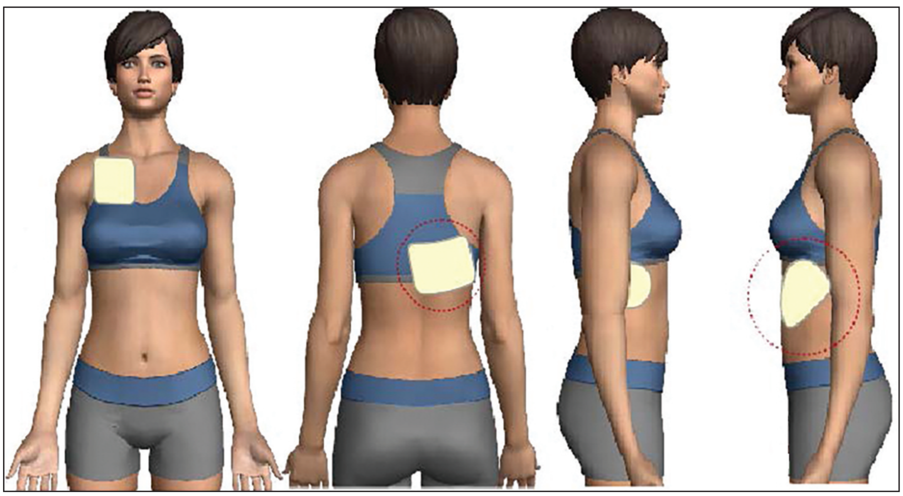

Figure 2: Examples of silver-nylon cloth electrode positioning for treatment of a lung infection (two left diagrams) and a stomach infection (two right diagrams). The red circles indicate the positive polarity electrodes in each case. (Base images created using ZygoteBody™ from http://zygotebody.com.)

kind of high-tech, electromedical addition to a home first-aid kit. The SIS equipment is equally highly appropriate for clinical, hospital, humanitarian aid and natural disaster area applications, to sterilise and protect exposed and damaged tissues quickly.

The SIS Machine project was also specifically conceived to serve as relatively very low cost and reusable medical equipment for less-developed and poorer populations and for use by remote (poor) communities.

Nonpharmaceutical complementary and alternative medicine (CAM), such as herbalism, naturopathy, homeopathy, etc., in the hands of a skilled and experienced practitioner can effectively deal with many health and medical issues. However, in clinical reality, the field of acute and chronic, localised, strong (disease-causing) internal infections by bacteria and viruses—often creating severe medical situations, hospitalisations and not infrequently still leading to deaths—remains generally outside of the scope of CAM treatments.

The SIS equipment can universally and globally fill the medical need for targeted and effective internal body infection treatments in a high percentage across all such cases.

The patent has only been applied for in Australia, meaning that duplication of the equipment anywhere in the world is legally immediately open.

A Patent for Global Benefit

The Silver Iontophoresis Stimulator technology is patent pending.

A patent is usually applied for to secure the future financial earnings of the inventor in reimbursement for their investment of time and money that went into the development of the invention. A granted patent, as a trade-off, must in return contain all the information necessary for someone else in the world "skilled in the art" to be able to reproduce the invention at the end of the term of the patent.

In reality, a top team of electronics and software engineers could most probably reverse engineer the actual electromedical (SIS) machines, described here, in a week; and complex and very expensive legal proceedings would be needed to defend the patent, if financial gain were the main aim for filing it.

The patent has only been applied for in Australia, meaning that duplication of the equipment anywhere in the world is legally immediately open.

The patent was applied for mainly for two related and nonregular reasons.

First, in patent law, a patent filed anywhere in the world constitutes *prior art*. Once patented, the whole invention or any part of it cannot be developed and patented by anyone else in the world. If the Australian patent had not been filed and another party anywhere in the world had filed international patents for the technology, then that patent-holder could legally prevent *anyone else* from introducing the same technology—and then, by simply delaying marketing it themselves, effectively shelve it for the standard international patent duration of 20 years.

Second, once granted, patents are publicly available documents, hosted on government computers for at least 20 years; and after that, since the rise of the Internet, they are still quickly and publicly available from online government archives of expired patents. This means that the invention of this SIS medical technology is guaranteed to exist as freely available information indefinitely.

This permanent, government-backed availability of the invention's details prevents the involved technology from being buried away somewhere, its potential benefits inaccessible to humanity. ∞

About the Author:

Richard Malter lives with his family in Victoria, Australia. The inventor of the SIS Machine, Malter is the Clinical and Research Director of the Electromedicine Clinic & Research Lab, the only such dedicated clinic and laboratory in Australasia. He is the only clinician in the region who has training from and has presented his work at the international symposiums of the International College of Acupuncture & Electro-Therapeutics, New York, USA. In 2013 he was named a Senior Research Scientist of the Research Institute of Global Physiology, Behavior & Treatment, USA. He is also a member of The Bioelectromagnetics Society and the Australian Traditional Medicine Society. He has been invited to present his clinical and research work at international medical and scientific conferences in the USA, Japan, Europe and South America.

In addition and parallel to his personal research interest in endogenous bioelectrics and bioelectromagnetism, Malter has strong political-medical agendas, including making major, direct contributions to the prevention of the documented millions of unnecessary deaths and ruined quality of life that are the result of some conventional medical interventions. The SIS machine project is a prominent example of such a contribution.

Further information about the SIS Machine equipment and Richard Malter's clinical electromedical work can be found at the websites http://www.siselectromed.com and http://www.electromedicine.org.au.

References

Supporting research and references for this article are available at http://sismachine.com/international-research/.