

Resolving the Confusion and Controversy Surrounding Silver in Medicine over the Past 88 Years.

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Overview and Review

For the past 88 years, many scientists and physicians have been confused or misled regarding the risks and benefits of various silver-based drugs in medicine.^{1, 2, 3} Up to the present day, this confusion has led to unwarranted and never ending cycles of controversy.^{4, 5} This controversy may be resolved by both clarifying the terminologies common to differing forms (i.e., *speciations*) of silver and understanding how the various speciations of silver impact the metal's bioavailability and bioactivity.⁶

It can be successfully argued that there is only one legitimate speciation of silver that is bioavailable and bioactive⁷ for therapeutic purposes. The ideal speciation of silver occurs during ionization when the atom or particle of silver becomes both positively charged and easily liberates from attachment to any other molecule or atom. To illustrate, there are radical differences in the ionization potential for silver salts versus suspensions of silver. Silver salts are dissolved in a solution, whereas suspensions of silver are colloidal in nature (are insoluble in solutions). As such the latter have the possibility to far surpass the physical chemistry limitations of dissolved silver-based drugs.

Ionization of silver into this ideal speciation only occurs under great difficulty in nature.⁸ Technologies common to the pharmaceutical industry have suffered a similar fate.^{9, 10} It is possible, at high concentrations of certain dissolved silver *salts* (e.g., silver nitrate), for large amounts of liberated ionized silver to occur in select mediums, but at a caustic cost due to the salt's physical properties that accrue during ionization.^{11, 12, 13} This is not oligodynamic silver, since *oligo* from the Greek, specifically relates to metal ions *few* in number.¹⁴ As far as silver in medicine goes, the idiom that, "less is better than more" must govern its best use practices. "Less is better than more" only applies to oligodynamic states of silver.

In summary, oligodynamic silver is exclusively liberated or easily liberated free ions of silver, few in number, within any given biological milieu.^{15, 16, 17} All respective speciations of silver differ in their ability to ionize into oligodynamic silver.^{18, 19} Suspensions of pure oligodynamic silver particles imbued with vast surface area (i.e., that optimally occur at low nanometer to high picometer size ranges)^{20, 21} is the superior and uncommon species of the metal²² that is *medically necessary* for therapeutic purposes. Oligodynamic silver is effective in low ppm concentrations and, therefore, provides wide margins of safety while simultaneously retaining optimal efficacy.^{23, 24, 25, 26, 27, 28, 29, 30, 31}

Terminology

Elemental Silver

Elemental silver is a term that simply means the actual amount of pure silver present in a product.

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Silver Atoms

When a silver atom, which has no charge, becomes positively charged through electrolysis where an electron is liberated, it becomes a silver ion or more appropriately a silver cation. When a silver cation loses its charge (i.e., accepts an electron), it becomes a silver atom again.

Atoms of silver can also “cluster” together, creating a silver particle comprised of a few or many silver atoms. Such particles of silver are typically created during ordinary electrolysis, where a rod (termed an electrode) made of pure silver is placed into water with another metallic non-silver rod, and a current is passed between the two rods. The silver rod will then emit chunks of silver particles into the water.^{32, 33} As the name implies, this is called the “chunk” effect.

Speciations of Silver

Speciation is a term used to define the chemical and physical properties of metals that controls and determines their fate, transport and toxicity. There are many *speciations* of elemental silver found in nature as well as those created by technology. Each speciation of silver has a unique and differing pattern regarding its fate, transport and effects.³⁴

Speciations of silver may be designated as Ag^0 , Ag(I) , Ag(II) or Ag(III) . The suffixes relate to the charge of the silver atom or particle -- 0 indicates no charge is present, (I) indicates one positive charge is present, (II) indicates two positive charges are present, and (III) indicates three positive charges are present on a single silver atom or particle.^{35, 36}

Furthermore, these four speciations of silver are bundled to their respective sources, which additionally influence the speciation's bioactivity. For example, the four speciations can derive from either: (a) dissolved silver compounds, or (b) insoluble suspensions of silver. In summary, the bioactivity of silver in medicine varies greatly according to the formula of the silver.

In essence, the weaker the bond of the silver to its source, the more readily it forms ionized (free or liberated) charged atoms or particles, and the more bioactive it becomes. In contrast, the stronger the bond of the silver to its source, the more difficult it becomes to ionize and engage in bioactivity. More distinctly, there are hundreds of speciations of both dissolved silver compounds or silver suspensions. The vast majority liberate poor quantities of bioactive silver, and most of the remaining generate *caustic* quantities of bioactive silver.

In contrast, oligodynamic silver is both positively charged and liberated or easily liberated. However, because it can only occur in extremely low ppm concentrations, it becomes extremely difficult for this speciation of silver to induce toxicity in humans. Therefore, the *speciations* that the elemental silver is converted into by a manufacturer determines its quintessential medical properties.³⁷

Bioavailability and Bioactivity of Silver

The rate at which free ionic silver - Ag(I) – approaches equilibrium in a biological milieu, such as the blood, is critical to its bioactive (e.g., antimicrobial) properties. As stated above, when the Ag(I) easily dissociates from its source, the Ag(I) becomes distributed onto various dissolved or suspended (i.e., colloidal) inorganic or organic substances. Generally, dissolved substances binding to Ag(I) will induce a more rapid distribution of the silver, and colloidal substances will combine with Ag(I) in such a fashion that the silver becomes distributed more slowly across biological milieus or foci. In both cases, the bioavailability and bioactivity of the free Ag(I) depend upon the intensity of binding strength to these substances.³⁸

In other words, bioavailability and bioactivity may not be related. For example, a given speciation of Ag(I) may readily bioaccumulate in organisms, but the bioactivity may be absent. Bioactivity relates strictly to the silver's charged state. If the silver's charge is tightly bound to any substance, bioactivity is low. If the silver's charge is loosely bound to any substance, bioactivity is high.³⁹ However, suspended and free Ag(I) particles in the low nanometer size range achieves Particle

Diffusion Coefficients many orders of magnitude greater than larger nanoparticles,⁴⁰ thereby enabling heightened bioavailability into biological tissues.

Therefore, the ideal speciation of silver would be a suspension of bioactive Ag(I) with vast surface area that rapidly saturates the foci.^{41, 42}

Ionic Silver

Ionic silver is a term that most frequently describes silver combined within a salt. In solution, the ionic silver is pushed away (dissociates) from its respective partner molecules to various degrees according to the solvent's dissociation constant specific to the respective salt or solute. This is the common usage of the term *ionic* silver.

Ionic silver is more uncommonly used to describe colloidal silver simply because the silver colloid is not dissolved into any solution. Also, most colloidal silver speciations are very low in liberated ionic silver. However, on occasion the term “ionic silver” is applied to colloidal silver speciations to indicate the proportions of liberated and charged silver particles - Ag(I) – that are present in the suspension.⁴³ Regardless, *ionic* silver is bioactive silver.

Metallic Silver

Metallic silver,^{44, 45} neutral silver, and zero-valent silver⁴⁶ are all synonyms for Ag⁰. All of these possess *no* biological value and *no* function or purpose in supporting healthy immune functions.

These types of silver may also be defined as “non-oligodynamic” silver. They must be converted with great difficulty into liberated (i.e., bioavailable) and charged (i.e., bioactive) silver ions (oligodynamic silver) before they can enhance immunocompetence.⁴⁷

Biologically speaking, when a positively charged atom or particle of silver attracts to a cell, and then binds to that cell (adsorption), the silver atom or particle loses its charge. The silver atom or particle is then considered uncharged. When the silver atom or particle becomes liberated from its attachment to the cell, it becomes re-charged through a process called *ionization*.^{48, 49, 50}

Silver Ions and Silver Cations

Silver atoms or particles that possess a positive charge are properly called silver ions or silver cations. In colloidal chemistry, the term silver ion is commonly used to describe liberated (i.e., bioavailable) positively charged (i.e., bioactive) colloidal (i.e., suspended) silver atoms or particles. The term silver ion is most often represented in the older literature as Ag⁺,⁵¹ and in the more recent modern literature as Ag(I),⁵² or more infrequently stated as a silver cation. A cation is simply any positively charged ion; an anion is simply any negatively charged ion. Generally speaking, metals only form cations.

Metals by themselves are not soluble in water, so when they become liberated as cations they become suspended in the water. As briefly touched upon above, the process of liberation is called ionization. Undoubtedly, the best way to ionize silver atoms into silver cations in water is via high-tech electrolysis. As Goetz stated: “The practical advantage of the electrolytic method of charging water metal lies, of course, in the ability to produce very concentrated solutions (of Ag⁺) without the presence of high concentrations of anion which, particularly in the case of silver, could be deleterious when used for disinfection...”⁵³

Both silver ions and silver cations are ionic silver.

Oligodynamic Silver

Carl Nageli (1893) first identified the oligodynamic effect (from the Greek *oligos* = few, and *dynamis* = power) to best describe how extremely low metal *ions* (e.g., silver and copper) concentrations beyond definitive chemical analysis exert potent biocidal actions. Webster's Dictionary gives further definition to the biocidal properties of extremely low metal ion concentrations as follows:

Ol-i-go-dynamic *adj* [ISV *olig* + *dynamic*, orig. formed as G *oligodynamisch*] 1: active in very small quantities <an ~ germicide> 2 a: produced by very small quantities < ~ action of finely divided silver in disinfecting water> b: of or relating to the action of such quantities.⁵⁴

Therefore, only positively charged (i.e., bioactive) and liberated (i.e., bioavailable) forms of elemental silver in low concentrations (i.e., parts per million – ppm) are properly “oligodynamic” silver.⁵⁵ Oligodynamic silver acts as an oxidizing catalyst. For a metal to act as a catalyst, it must be charged either positively or negatively to induce electron transfer events. If the metal is neutral or uncharged, it cannot accept an electron onto itself from the molecule making contact, nor could it donate an electron onto the molecule making contact. This is the reason that oligodynamic silver is charged silver, and the only type of silver that conducts biologically meaningful events. Such oxidative properties easily destroy lower life forms (i.e., pathogens) due to their lack of sophisticated antioxidant systems, while remaining harmless to higher life forms housing functional/sophisticated antioxidant systems.^{56, 57, 58}

More definitively, when a positively charged particle of silver does not absorb (i.e., dissolve) to a cell’s components, it appears to enter into the colloidal milieu of the cell’s intracellular chambers as a suspension in order to act as a bio-catalyst upregulating manageable amounts of pivotal innate and acquired immune mechanisms.^{59, 60} As a bio-catalyst, the oligodynamic state may remain stable or be recycled to sustain the oxidative catalysis.^{61, 62, 63}

Oligodynamic silver, especially oligodynamic nanosilver,^{64, 65, 66} (or even more so ‘picoscalar’ silver) is clearly the superior speciation of silver essential for medical applications.^{67, 68, 69, 70, 71}

Due to the vast surface charge exposure intrinsic to picoscalar oligodynamic silver particles, these are the most desirable forms of silver ions, silver cations or ionic silver known to humankind.

Discussion

Many medical researchers over the past century have looked for other means to generate oligodynamic silver from non-silver salt formulations, such as from colloidal or suspended states of silver. These researchers understood that pure suspensions of oligodynamic silver could theoretically achieve the vast surface areas required for ideal therapeutic bioactivity by reducing the size of the respective suspended silver particles. Therefore, with such enormous gain to the surface area of the oligodynamic silver, only very low part per million (ppm) concentrations would be required to achieve optimal therapeutic benefits. In all practicality, such low ppm concentrations would in turn virtually eliminate all risks of toxicity.

But up until a recent series of breakthroughs in nanotechnology, suspensions of silver could not be rendered to generate the required levels of oligodynamic silver to achieve therapeutic efficacy⁷² unless enormous amounts of the suspension were administered. Such enormous administration levels were unwise unless one desired to risk inducing argyria.⁷³ For this reason, medical boards have previously and consistently held that suspensions of silver-based drugs cannot be determined by conventional standards of care to be medically necessary. But due to the recent development of uniform low nanometer/picometer oligodynamic silver products, this position is no longer justified.

For example, nanobiotechnology has now made this possibility a fact via enhancing - by many orders of magnitude - the most ideal previous speciation of the metal in suspension (termed *oligodynamic* silver)⁷⁴ suitable for achieving outstanding therapeutic outcomes where nothing else will work.^{75, 76, 77, 78} Specifically this feat is accomplished by rendering suspended silver particles into the ≤ 10 nm to 0.6nm particle size ranges,^{79, 80, 81, 82}

To further clarify, the classical rate-limiting attributes to solute-solvent mediums (i.e., *dissolved* silver sulfadiazine) intrinsic within normal body temperatures for essential redox and biocatalytic events are far inferior to dispersion-colloidal mediums (i.e., *suspensions* of silver ions) for redox or biocatalyst efficiency.^{83, 84, 85}

Dispersion-colloidal mediums (i.e., the *gel* state and/or water polarized in multilayers - PM) is the preferred and obligatory milieu of life forms.⁸⁶ The gel state simply enables greater ability to propagate cell signaling communications associated with genomic and proteomic expressions, *and* most importantly exchange, amass, direct and organize energy within biological temperature constraints.^{87, 88, 89}

Higher life forms produce “high-gain” gel states characterized by highly structured water (PM) which is induced by metal cations and modulated by conformational states of undenatured or non-degraded intracellular proteins.⁹⁰ Such high gain gel states enable punitive environments against lower life form invaders basically by (i) punitive electrical charges, and by (ii) propagating efficient redox events (i.e., the respiratory burst of cytotoxic immune cells and the closely related NO/NOS systems) managed by sophisticated antioxidant systems and balanced cytokine cascades.^{91, 92} Balanced expression of cytokine cascades appears to be chiefly modulated by intracellular reduced glutathione reserves present in adequate amounts.^{93, 94, 95} In the gel state environment, redox and contact catalytic potentials may be profoundly enhanced due to the nanoparticles’ intrinsic zeta potential,⁹⁶ biocatalytic,^{97, 98} and quantum attributes (e.g., powerful long range effects “at-a-distance”).^{99, 100}

In Conclusion

It is technically very difficult and expensive to make only oligodynamic silver, but very easy and cheap to make colloidal silver products and silver salts very low in oligodynamic content. It is even more difficult to make quantities of oligodynamic silver in “uniform” low nanometer and even picometer size ranges (i.e., uniform picoscalar oligodynamic silver hydrosol or UPOSH). Nevertheless, such a nanotechnological achievement^{101, 102} heralds a new era for both true quantum health care¹⁰³ and regenerative medicine.^{104, 105, 106}

In general, for acute infectious processes, the foci need to be saturated with from 1 ppm to 10 ppm of UPOSH over the shortest period of administration, utilizing the most efficacious route of administration. For chronic infectious processes, the foci need to be saturated with from 10 ppm to 30ppm of UPOSH, again over the shortest period of administration possible, but managed according to patient tolerance and antioxidant reserves. In many cases, frequent daily doses are necessary over several weeks, with 3 day breaks between weekly schedules.

In all cases, the specific pathogen and the overall pathogen load dictate what concentrations to use as well as dosage schedule. Titrating upwards slowly or cautiously, but expeditiously is critical for cases with heavy pathogen loads of long duration.

Hypoxic and hyperacidic states common to aging or chronically ill patients¹⁰⁷ limits UPOSH’s efficacy no matter how well administered (especially in unsuspected hypercoagulation syndromes – see www.HEMEX.com), as well as:

- diets lacking in raw food factors (e.g., diet derived poor Na+/K+ host intracellular ratios and PM dehydration states low in reserves of structured water) and/or malabsorption syndromes;
- patients with immunosuppression (especially from toxic heavy metals such as mercury);
- liver decompensation (especially from co-infections with HCV);
- the elderly; and
- patients with downregulated seleno-glutathione systems.

Judicious use of sodium bicarbonate is an excellent “priming” agent to remove excessive acidity while simultaneously correcting hypoxic conditions. This is especially important in successful cancer treatment strategies.

Any and all of the above issues need to be corrected before expecting to achieve optimal results with bioactive silver. For further information, see the IMREF dosage guidelines, pre-loading strategies and contraindications documents.

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