Drs. Mark Duncan & Andrew Willoughby

Nanotechnology in Dentistry

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TEACHING THE BUSINESS OF DENTISTRY
Mark Duncan DDS, FAGD, DICOI, LVIF, FICCMO

Dr. Duncan is a native Texan who relocated to Miami, Florida at a young age. In high school, he and his family moved to Oklahoma where he later attended the University of Oklahoma. His focus was Pre-Med and he received his BS in Psychology in 1990. Upon graduation, however, he was still undecided about whether to pursue a career in medicine, clinical psychology, or dentistry. His instinct guided him to dentistry. He was accepted to the University of Oklahoma College of Dentistry, where he received his DDS in 1995. By his second year in practice, he was putting in more than 200 hours a year in continuing education and in 2002, Mark was invited to be a visiting instructor at LVI. Over the next six years, he had the opportunity to lecture extensively, which led him to a turning point in his career. He ran into a patient in an airport in 2007 and she casually observed that teaching suited him; that he seemed to have a stronger passion for teaching than practicing dentistry. He realized that she was right and in 2008, Dr. Duncan joined the faculty at LVI.

Today, Dr. Duncan is a neuromuscularly trained dentist who has achieved prestigious Fellowship status multiple times; at the world-renowned Las Vegas Institute for Advanced Dental Studies (LVI) and the International Congress of Craniomandibular Orthopedics (ICCMO) in neuromuscular dentistry, the Academy of General Dentistry and the Misch International Implant Institute. He is also a Diplomate in the International Congress of Oral Implantologists. Dr. Duncan is the President of Hartfell Technologies Inc. (HTI), where his particular interest is exploring the intersection between dentistry and medicine and the wide variety of areas those disciplines overlap. It is this focus that led him to partner with Dr. Andrew Willoughby. Through their collaborative efforts at HTI, they have opened doors to a world that offers astounding potential in all aspects of health care.

Mark currently resides in Las Vegas, NV and is the Clinical Director and on the faculty at LVI where he teaches the Core 1-7 programs as well as a variety of other non-core courses. He is an accomplished, highly regarded international lecturer who speaks on a variety of topics including new and emerging technologies in dentistry.

He recently accepted our invitation to serve as a member of The Progressive Dentist Magazine’s content advisory panel for 2013.

When he’s not practicing dentistry, teaching, lecturing or innovating, Mark enjoys an active lifestyle and time spent with friends and family. He enjoys watching his 15-year-old daughter Faryn play volleyball, and his 12-year-old son Eli play basketball and baseball. When it’s his turn to play, he enjoys snow skiing and experiencing the beauty of the desert on his Excelsior Henderson SuperX. He also looks forward to time on a beach or scuba diving and continues to beat himself up while participating in the physically grueling “Tough Mudder” competitions, www.toughmudder.com and enjoys challenging others to experience it for themselves.
For the first time since we began publishing *The Progressive Dentist* magazine, we’ve chosen to feature two dentists, side by side as our CoverDocs™. Although they practice in two different countries, they work closely together in some very interesting ways. Their collaborative work in nanotechnology is the epitome of progressive, and just may change the way many of you practice in the very near future. First, an introduction to our CoverDocs™, and then we’ll share a recent interview with them about the incredible advances in nanotechnology.

Andrew Willoughby  
DMD, LVIF, FICCMO

Dr. Willoughby is our first Canadian CoverDoc™. He has been practicing dentistry for twenty-four years and owns and operates North Hart Dental, Centre for Neuromuscular Aesthetic Dentistry in Prince George, British Columbia. He also operates Cloverdale Crossing Dental in Cloverdale, B.C. Dr. Willoughby has earned and established an excellent reputation within the dental and healthcare communities as a progressive cosmetic and neuromuscular aesthetic dentist. He has earned Fellowship status at the Las Vegas Institute for Advanced Dental Studies (LVI) and the International Congress of Craniomandibular Orthopedics (ICCMO) in neuromuscular dentistry. Andrew is the only neuromuscularly trained, Premier Provider of Invisalign in Western Canada. He is concurrently pursuing his Fellowship with the International Congress of Oral Implantologists (ICOI), the American Academy of General Dentistry (AGD), the American Academy of Craniofacial Pain (AACP), the American Academy of Cosmetic Dentistry (AACD) and The American Academy of Cosmetic Orthodontics (AACO) as well as a Mastership with ICCMO. Dr. Willoughby also has aspirations to pursue his Ph.D in Oral Medicine next year. Andrew is a sworn perfectionist in every sense of the word and as you can see, he is relentless in his pursuit of postgraduate clinical education. “In this business we owe it to our patients to become perpetual students. As dentists, we can never stop learning”.

In addition to the above, Dr. Willoughby still finds time to serve as a dental consultant, business advisor and analyst to at least half a dozen companies in the healthcare industry. He holds five US patents – four of which pertain to the CAD/CAM manufacturing of dental implant abutments and were successfully licensed to ITI Straumann of Switzerland in June of 2002. He is the Chairman and Founder of Hartfell Technologies Inc., which he has worked tirelessly to build with his friend and co-Founder Dr. Mark Duncan. HTI is a leader in the utilization of nanotechnology in dentistry. His latest patent application entitled “Dental Uses of Nanometallic Silver Hydrosol” establishes new paradigms for the use of nanotechnology in dentistry and is a continuance-in-part application of a US patent issued to American BioTech Labs of Alpine Utah in 2003.

When Andrew is not immersed in the business of dentistry, he is either “tinkering” with one of his beautiful sports cars, reading, traveling with his wife Denise or spending time with their three children, five grandchildren or three schnauzers - Chardonnay, Cabernet and Merlot. If you’re wondering, yes, Andrew is also an avid collector of fine wines!
In order to establish the business case for what you’re doing, it’s important for our readers to understand the clinical potential and applications. How did you first become interested in nanotechnology?

Dr. Willoughby

I was first introduced to the manufacturers of this nanotechnology (ABL in Alpine, Utah) by my brother in 2004. I was so impressed with their scientific documentation and their product that I arranged a trip to Utah to talk with their senior management team and tour their facilities. That trip exposed me to a way of radically improving treatment outcomes for my patients and changed the way I practice dentistry! I went back to my practice and started using ABL’s powerful antibacterial disinfectant gel in combination with almost every clinical technique I performed and the results were immediate and profound – my surgical patients were showing less post-op complications, less post-op pain, surgical sites were healing quicker and showing less signs of inflammation and in combination with the oral antibiotics I was prescribing, patients were showing rapid wound healing – including increased rates of epithelialization and wound closure. In June of 2009, after performing literally hundreds of restorative, endo, perio and surgical procedures with Metallic Nano-Silver Particle (MNSP) products, ABL asked if I would help them file a number of product and protocol specific dental patents.

In early 2011 I assigned this intellectual property to ABL and in return, ABL licensed our company, HTI with the exclusive global rights to their product for the dental industry.

My continued clinical research into the use of this unique nanotechnology quickly led to the realization that what is desperately needed in our profession is a powerful wound healing disinfectant – one that helps heal pulp tissues rather than irritate them and one that can target specific pathogens rather than just a random assortment of bacteria. This led to the development of a new series of clinical protocols which we refer to as the “VeraSIL protocols” and these include: a new connective tissue reattachment procedure using an Erbium Laser, new restorative protocols, endodontic protocols, bone grafting protocols, dental implant as well as non-surgical periodontal protocols.

Dentistry is rapidly changing and is being led by discoveries and technology improvements that create paradigm shifts in health care. We believe that the next generation of dental products will incorporate bioactive nanoparticles directly into the sub-molecular structure of the material. By incorporating our MNSPs into a dental resin polymer like P.E.G.D.M.A., Tegma, we have taken a significant step toward this goal!

Silver in health care is nothing new. Silvadine has been commonly used in medicine, and even Band-aid now has silver products commercially available. Why isn’t it more commonly used in dental procedures?

Dr. Willoughby

Almost all silver products today are based on an ionic or silver ion construct and the problem with ionic silver is that “in vivo”, it has very limited efficacy and bioavailability. Most ionic forms of silver are very easy to make – usually a chemical form of silver (i.e. Silver Nitrate) is diluted down to a certain ppm level and then a protein is added to the
silver for stability. Ionic silver by definition is missing a single electron and works very hard to reach a state of equilibrium by stealing back an electron from a cell or pathogen. In test tube studies, ionic silver tends to kill bacteria slightly faster than metallic silver but, in human studies - once inside the body - the silver ions are much less effective because their limited ionic charge is quickly neutralized by other cells and thus, rendered ineffective as they are excreted in their first pass through the liver. Ionic or chemical forms of silver are highly unstable and because they require such high concentrations to be effective, they tend to react poorly when formulated into or with other compounds.

We on the other hand, have developed a technology that is based on a unique molecular construct of a MNSP, which provides superior disinfection and anti-inflammatory properties when compared to other forms of colloidal silver. SilverSOL is manufactured for HTI, by American BioTech Labs in Alpine, Utah and is FDA and EPA approved for various indications. These MNSPs range in size from 5-7 nanometers and are surrounded by a multivalent silver oxide coating comprised of thousands of Ag4O4 molecules. In dry form, each MNSP will cluster, but not touch each other due to the electric charge of its silver tetric oxide coating. In a solution of pure water, SilverSOL molecules will uniformly disperse via attachment to the water molecules. The silver tetric oxide coating of SilverSOL is unreactive in the gastric acid environment of the human stomach due to the molecular bond between the silver tetric oxide coating and the surrounding water complex. It is this strong molecular bond which prevents the stomach acids from denaturing and metabolizing the nano-metallic silver particle contained within the Ag4O4 coating.

Unlike ionic and mild silver proteins, this strong molecular bond to water also prevents the SilverSOL from being neutralized in their first pass through the liver and continuing to function until they are ultimately washed through the system, which is estimated to take two days.

What truly differentiates ABL’s silver products from all the others and makes it so much more effective is that each pure SilverSOL molecule has this very thin, unusual silver oxide coating, which emits a unique electrical charge barrier.

**ProDentist**

How critical is particle size to the efficacy and performance of SilverSOL?

**Dr. Duncan**

A nanoparticle is a microscopically small particle between 1 and 100 nanometers in size. A recent *Nature* magazine article on the “Quantum Plasmonic Resonance of Nanoparticles” confirmed what we have known for the past decade decade. Nanoparticles less than 10 nanometers in diameter have an inherent vibrational frequency or “flux” which can be quantified - in the case of SilverSOL, this resonance flux or vibration occurs at between 890-910 terahertz (200-300 nanometers) which is the same resonance frequency at which germicidal ultraviolet light causes bacteria, viruses and yeast to be destroyed. We refer to this mode of action as “nano-catalytic”. This vibrational frequency is unique to SilverSOL and is passed from the metallic silver particle to the outer Ag4O4 coating and then to the surrounding water molecules because of the strong molecular bond...
between the silver tetric oxide coating and the water molecules. This is why there is such a profoundly bacteriostatic effect with such ultra-diluted amounts of MNSP. In one of our manufacturer’s earlier nanotechnology patents it states that:

“The smaller the average particle size, the greater the surface area and the greater the contribution of the particular surface chemistry. However, if the particles are excessively small there can be a loss of stability and or other interactions that can negatively affect the product”.

This indicates that there is an optimal particle size for effectiveness of nanoparticles depending on the type of micro-organisms you are trying to kill. The knowledge of optimal particle sizes has helped our manufacturer file and receive patents on what we have found to be the most bioactive particle sizes. Our company has helped ABL file all of its dental related patents and ABL’s US patents now cover MNSPs coated with silver oxide between 1 and 99 nanometers in size and which have multiple modes of action and bio-disruptive capabilities against pathogens.

As far as the performance of SilverSOL product is concerned, it kills all pathogenic bacteria, viruses, yeast, protozoa and microscopic parasites against which it has been tested. Certified laboratory test reports indicate that it quickly kills pathogens such as Candida Albicans, MRSA, VRE, Hepatitis A, B & C, HTLV3, H5N1 Avian Bird Flu and many other tough to kill microorganisms such as E. Coli and Acinetobacter baumannii. In hospital based human studies, oral ingestion of our SilverSOL has been demonstrated to put malaria patients into full remission in an average of five days. SilverSOL is currently being tested against the two of the most aggressive periodontal anaerobic pathogens that exist – Tannarella forcythia and Treponema denticola. Our nanosilver wound dressing gel (“SilverSTAT”) is FDA approved as both a powerful antibacterial and disinfectant agent with broad based claims including use of the gel in cuts, burns, abrasions, lacerations, surgical incise wounds, medical device insertion sites, and donor/recipient graft sites. The clinical results with this nanosilver gel have been phenomenal, as Dr. Willoughby will later describe. The liquid SilverSOL solution also has current EPA clearance as both surface disinfectants and dental unit waterline cleaners. I will let David Hall tell you what we have planned.

**ProDentist**

So, if I understand this correctly, your nanotechnology is both bio-disruptive and nano-catalytic and has multiple modes of action against a wide range of pathogens?

**David Hall**

Yes, that is correct and it is a large part of what makes SilverSOL so unique.

This MNSP technology does not kill bacteria via chemical cell lysis as do most other disinfectant technologies. SilverSOL attacks microbes via a series of pathways including protein inactivation, DNA denaturing and disassociation, binding affinity and an oligodynamic effect. These various modes of action are referred to as “bio-disruptive” and “catalytic”. Also, the inherent plasmonic resonance of the solid metallic nanoparticle can also be described as “catalytic”. In the sense that the resonance confers a vibrational effect to surrounding cells which affect only pathogens and not normal cells or cell function. And lastly, rapid destruction of pathogens in wounds and around diseased and inflamed tissue leads to the down regulation of Matrix Metalloproteinase (MMPs). These multiple modes of action all confer upon the MNSP profound anti-pathogenic properties as well as pro-healing activities. As mentioned earlier, the unique molecular structure of the MNSP confers a constant bioavailability thus allowing for highly effective activities at ultra dilute concentrations relative to any other silver molecular structure.

Even after the silver oxide coating has been stripped away, the nano-catalytic action inherent to the pure metallic silver particle continues to kill bacteria - this is why the bioavailability and bacteriostatic nature of our MNSP technology is unparalleled.

**ProDentist**

This technology has hundreds of clinical applications and multiple modes of action. This is big news.

**Dr. Duncan**

Yes - incredible isn’t it? The broad based application of this technology in dentistry is virtually unlimited since almost everything we do as dentists has to do with killing bugs, while healing tissue, and if you can do both contemporaneously without harming the normal oral flora, then you can see why we are so excited about the possibilities. There are patients seeing amazing results, and Andrew has incredible documentation based on his years of clinical experience using this material in his practices.
Dr. Willoughby

We have developed a number of unique and proprietary clinical protocols which rely heavily upon the capabilities of SilverSOL. With the advent of this MNSP technology, we have been able to modify and improve on a whole host of clinical protocols for everything from non-surgical treatment of refractory periodontitis, to implant placement and guided tissue regeneration using bone allografts, membranes and general restorative procedures, to products and clinical protocols.

David Hall

As you might imagine, we are quite excited about this technology as it represents a paradigm shift that spans dentistry and has equally exciting medical applications. One of the most challenging environments in which to work is the mouth and when we routinely see increased comfort and decreased healing time and decreased post-operative infection, well, that is a pretty exciting thing! We are in the process of finalizing the wording on instructions for delivery in periodontal tissue management, endodontic therapy, implant dentistry, advanced surgical applications, and soon restorative avenues.

ProDentist

I’m sure that by now, many of our readers are wondering about the EPA and FDA approvals to date. What can you tell us about this?

David Hall

Currently MNSPs are cleared in different formulations by both the FDA and the EPA. Moving forward, our focus is on gaining FDA clearance for a wound wash irrigant which can be used clinically to flush and debride the surgical wound in the same way an isotonic solution of saline is used. Unlike saline though, this irrigant solution can also be used to promote healing, decrease inflammation and disinfect the surgical site and tissues. There is NO such product currently available on the market but there is a significant need for anything that can promote wound healing while disinfecting.

We are also currently conducting further testing of both the wound wash irrigant and the wound dressing gel against all periodontal pathogens with a focus on preventing gingivitis and periodontal disease.

ProDentist

This is exciting stuff! Are patients currently aware that this technology exists? It would seem that a dentist who utilizes these treatment protocols would have a tremendous appeal to new patients.

David Hall

Without a doubt. What we have seen is that routinely the inclusion of this technology in dental procedures spurs healing in a way that previously was not thought possible. Bioactive and biostimulating products with no known side effects were thought to be impossible. Until I learned more about the application and efficacy of this unique nanosilver, I would have told you it was science fiction. As I see success after success, I know that this particular bit of science is anything but fiction!

ProDentist

Our last question is for you, Jill. As the director of LVI’s dental hygiene programs and HTI’s periodontal therapies consultant, what do you see as the biggest opportunity for these advances in nanotechnology?

Jill Taylor

For several years now we have been teaching programs at LVI which focus on the removal of dental bio-films due to the oral systemic link that is known to exist between periodontal disease and systemic disease. The clinical techniques that we employ are focused on removing infection and healing tissue by boosting the patients’ natural immune response. We have had a great deal of success employing these protocols at LVI but admittedly, if we could find a better disinfectant – one that is pathogen specific, wound healing, anti-inflammatory and reduces pain - it could be a paradigm shifting technology for dentistry.

We now believe that you can utilize the SilverSOL technology in a modified non-surgical periodontal protocol to a) prevent the dental bio-film and bacterial populations from “maturing” and transforming into more damaging anaerobic populations or b) eliminate these aggressive pathogens in the mouth once they have taken hold and utilize an Oral DNA test as part of a confirmatory diagnosis. With broader based studies we will have analytical, quantifiable data to demonstrate a selective disinfectant technology that not only promotes healing but reduces pain and inflammation as well. This is definitely exciting technology!

ProDentist: We’ve just scratched the surface of this highly progressive technology and the advances and opportunity it represents. Many of you will want to learn more about the clinical studies behind it. We also want to share more with you on the benefits of this technology for your bottom line. We’ve added a series of additional documents, photos and in depth information on our website at www.TheProDentist.com. As a subscriber, you can also follow the conversation in our Facebook group at www.Facebook.com/ProDentist.