

A SERIES OF DENTAL BIOCOMPATIBILITY FACTOIDS

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PART-I: DENTAL BIOCOMPATIBILITY - A HISTORICAL PERSPECTIVE

Have you ever wondered about the biological safety of the dental products that are used by dental professionals or contained in over-the-counter (OTC) products that are used every day? When were US biological testing agencies organized? When did biological testing of dental products & their components become established as part of the scientific record? Are there chemicals used in the formulation of today's dental products that are biologically unacceptable? And if so, why are these irritation & toxic chemicals allowed to remain in the formulation of commercial dental products? Which test standards came first---*in-vitro* (bench-top) or *in vivo* (animal)? Now that we have your attention, we'll attempt to answer these questions in the next several FACTOIDS.

The origin the NIH & NIDR is traced to the Marine Hospital Service (MHS) of 1779, which provided medical care for merchant seamen. By 1880, European scientists had established that bacteria caused cholera & yellow fever; so expanded duties were given to the MHS to examine arriving immigrants for infectious diseases. Dr. Joseph J. Kinyoun—a MHS trained physician at Staten Island, NY—called his laboratory the MHS Hygiene Laboratory—charged to identify bacteria in sick immigrants for diagnosis & to quarantine them so as to prevent the spread of any major social disease like cholera.

For Dentistry, the first real agent to cause a great deal of public & professional scrutiny was the use of “quicksilver” mercury in dental amalgams. Circa 1834, the European brothers—Edward & Moses Crawcour introduced their “silver paste” to colonial dentists. From then to today, America has experienced a number of major professional “amalgam wars”, which focused on the supposed toxic effect of mercury in amalgam restorations. Reviewing the many articles & publications that have been devoted to mercury toxicity, it should be noted that during the early era, there were no defined standards for caries removal, cavity preparation or temporary & definitive material restoration. For silver, many clinicians would file small flakes from the edges of silver coins & triturate them with mercury in an agate pestle for a few moments, place the mix in a fiber pad to squeeze out any excess mercury & then hand manipulate in

their palm to determine its plasticity before placing it into the tooth to set as a rigid mass. In those many decades—before G.V. Black—there were no established standards for amalgam formulation, composition, mixing, insertion or final carving—it was no wonder that mercury was an easy blame for the clinical failure of amalgam restorations.

In the early era of cavity preparation & restoration, the dental literature of the mid to late 1880's reported that charlatans & unqualified clinicians simply attempted a crude effort to remove some of the cavity debris & then simply fill the defect with some type of silver paste, without paying any attention to detail of tooth contact, periodontal health & anatomical contour. Consequently, it was not the biological nature of the amalgam paste that was damaging, but it was the improper clinical placement of the amalgam agent for long-term function. It would be another 50-years—at the turn of the 20th century—before G.V. Black would give his independent research on amalgam composition & principles of cavity preparation to the US dental profession. He made NO Patent attempt & the financial support was entirely his own, since there were no governmental funded research in those days of dentistry.

Between 1910-1925, fluoride research of McCoy & G.V. Black verified that mottled enamel was due to excess fluorine intake, more importantly they demonstrated the ability of fluorides to reduce tooth decay. On June 24th 1948, President Harry S. Truman signed into law, formation of the National Institute of Dental Research (NIDR) as the 3rd arm of the NIH, due to the lobbying efforts of the armed forces to determine why many young WW II servicemen were rejected due to missing teeth. Emphasis of the newly organized NIDR was to examine studies, which would identify the cause of rampant caries & pyorrhea & to identify preventive agents & treatments that would benefit society at large. In 1958 President Eisenhower signed appropriations to construct the 1st NIDR headquarters & laboratory in Bethesda MD. That thrust of NIDR research established that properly controlled water fluoridation (Grand Rapids MI 1948) led to a dramatic reduction & prevention of tooth decay when preventive dental procedures were properly followed.

THE BIOCOMPATIBILITY TESTING PROCESS

The NIDR building became reality in the 1960's, & internal research directions were ready for development. In their supposed infinite wisdom, the NIH & NIDR created a “**grandfather clause**”, which openly accepted the continued use of the old dental

agents that had been in clinical use since the emergence of American dentistry in the late-1700's. The assumption was that if the agents had been in clinical use for so long, then they must be biologically acceptable. On the other hand, any agent developed after 1948 was now subject to new biocompatibility testing standards. But, how was the NIDR of 1950's to begin to develop standards for the biocompatibility of any new dental agent destined for commercial acceptance? One likely thought—there were so many historical dental agents, it would be an almost impossible research effort to rapidly test the biocompatibility of hundreds of agents that had been around for 150-years—let alone the new ones. But even more important in 1950's, there were no biocompatibility “gold standard” guidelines. If the mechanical properties were equal-to or better than equivalent products on the commercial market, they were submitted to a supposed independent research laboratory for biocompatibility testing.

Fortunately, today's new commercial agents & devices have successfully passed the 1st gate of *in-vitro* cell culture bench-top biocompatibility tests. Next, the product is submitted for a 2nd *in vivo* testing gate to be histologically evaluated by placing the agent or device in the soft tissues of a small animal (rat, mouse, rabbit). If successful, the agent or device is next placed as a 3rd *usage* test into the facial surface of teeth for several time periods to evaluate biological response in non-exposed & exposed Class-V cavities. Following biocompatibility passage, the agent is then submitted as a 4th *clinical usage* test gate in humans under very defined conditions.

Outcome studies have known that the clinical profession continues to place sensitizing metals (e.g. nickel containing) & toxic chemicals (aldehydes & ketones) that are **TOXIC** to human dentine & vital pulp tissues—however that is NOT an indictment of your clinical skills. But, perhaps you may now ask—how can some governmental agencies (e.g. FDA, ISO, NIH) continue to allow sales of toxic agents for placement on human tissues? This may be explained as follows: Many worldwide dental groups maintain a **grandfather clause** to allow use of agents (e.g. aldehydes, glutaraldehyde, formocresol, or phenol-carbolic acid) that are toxic & may burn tissues if improperly applied—even though they are certified as germicidal. High concentrations of alcohols, aldehydes & acetone rapidly dehydrate & denature vital cells if improperly placed. Certain currently used dental agents contain lead, formaldehyde & glutaraldehyde, which are known carcinogens—yet, many of these agents are still permitted since they remain **GRANDFATHERED**—remember, they were used for clinical treatment, long

before governments had even established MHS / NIH / NIDR / FDA agencies or had even developed scientific biological testing programs.

Gold crowns & bridges with high nickel or beryllium content will sensitize body tissues, causing redness & swelling that leads to chronic itching & a rash in the mouth face, arms, legs & torso of many humans. When this is recognized, the only recourse is to remove the offending restoration. Unfortunately, many of the 1948-pre NIDR **grandfathered** agents & procedures are not held liable by today's modern biocompatibility standards. Biocompatibility data show that cell sensitivity, irritation & toxicity, which may lead to necrosis, is really a function of **STRENGTH & DURATION** of placement of these irritating agents.

Fortunately for today's patients, most countries in the World abide by harmonized International biocompatibility standards for new product & clinical use. For patient safeguard, new products must first pass material function & suitability tests—followed by *in vitro* & *in vivo* tests, & if they concur with all International tests—they are allowed to the dental marketplace. However, since some “new products” contain older grandfathered agents, these “new products” are not held to the same long-term functional & biocompatible standards—simply because some of their older components were **grandfathered** long before biocompatibility testing was considered or required.

The saying **CAVEAT EMPTOR** means **LET THE BUYER BEWARE**. When a new restorative agent is brought to your clinical attention—before you decide to purchase the agent—your should request the dental salesperson to first provide all of their complete ISO & MSDS data, which supports the new agents long-term clinical safety for placement in your patients in addition to being handled by your office personnel & yourself. Otherwise you may inadvertently place a “new restorative agent” with minimal clinical benefit that may cause irritation & even lead to infection & possible failure.