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DISINFECTANT HISTORY: A FACTOID

Literature suggest the earliest manufactured disinfectant was **chlorine** (Cl)—first described in 1774 by Karl Wilhelm Scheele (1742-1786), a Swedish chemist & pharmacist who first isolated oxygen (circa 1772) & chlorine in 1774. Scheele's 1777 book *Experiments on Air & Fire*, argued that our atmosphere was composed of two gases, **Oxygen** supported combustion & **nitrogen** inhibited combustion—Scheele predated Joseph Priestley's supposed discovery of oxygen by 2-years.

Scheele was born in Stralsund, Pomerania (now northern Germany). At 14 he apprenticed to an apothecary in Gothenburg, Sweden. Following his studies as an apothecary, he moved to Malmö & then to Uppsala in 1770. He was offered academic positions in Germany & England, but he elected to run his pharmacy in the small village of Köping on the western edge of Lake Malären just west of Stockholm.

Conceivably Scheele's most important discovery was **chlorine**, named after the Greek word (khloros) due to its greenish-yellow color. Since 1774, chlorine has been recognized as perhaps the most effective & rapid acting disinfectant against a wide spectrum of microorganisms. In addition he also discovered that light modified certain silver salts—50-years before they were regularly used in photographic emulsions.

Claude-Louis Berthollet studied medicine at Chambery & later graduated from Turin to then settle in Paris in 1772 as the private physician of Philip, Duke of Orleans. Berthollet earned a noted reputation & in 1780 he was admitted to the French Academy of Sciences. In 1785, he identified chlorine as oxygenated muriatic (oxymuriatic) acid, which in 1785 led him to propose chlorine as a textile bleach.

In 1794, Claude-Louis Berthollet became a teacher of chemistry at the Polytechnic Academy in the Normal School of Paris where he took an active role to refashion the Academy as the French National Institute. In 1798, he was one of a few scientists who accompanied Napoleon Bonaparte to Egypt, forming themselves into the Institute of Egypt on the plan of the French National Institute.

On the fall of French Directory, Berthollet was appointed senator & grand officer of the Legion of Honor; under the new Empire, he became a Count & after the return of the Bourbon family he took his seat as a peer. He then moved to Arcueil where he developed a well-equipped laboratory, which became a research center for many distinguished scientists of his era, their proceedings were published in 3-volumes from 1807 to 1817 as *Mémoires de la société d'Arcueil*. Berthollet's most remarkable contribution to chemistry was his *Essai de statique chimique* (1803), the first systematic attempt to tackle the issue of chemical physics—he died on Nov. 6^{th} 1822.

Besides his medical profession Berthollet was a well-known textile producer in the village of quay Javelle near Paris where he formulated a textile bleach by dissolving gaseous chlorine through a mixture of water & potash. It became known as "eau de Javelle"—a solution he named after quay Javelle where it was produced. Due to its caustic nature, he modified the agent with sodium carbonate—a soda ash. His eau de Javelle became known to have medical properties by his colleagues who had learned of its disinfectant capacity against microbial contamination, hence they began its as a disinfectant for routine use in local hospitals.

Since Berthollet's Paris of 1785—most World Public Health agencies have enjoyed it to now, serving as a medical agent for lavage & disinfection. Eau de Javelle rapidly captured the medical sector as an agent to clean septic canals & community toilets. As a social commentary; it is sad that chlorine is more popular to clean the Bidet & toilet than to disinfect wounds. Today, eau de Javelle remains an important historical agent, however, it still possess a great medical lavage future.

Antoine-Germain Labarraque was born in France (1777-1850)—a noted chemist & pharmacist of his age. He complemented Berthollet's science & was acclaimed to have discovered the salt of hypochlorus acid—a compound of NaOCl—while serving in the French army. He used his alkaline hypochlorite solution for disinfection of the diseased populace, which did much to assist the end of the European Cholera epidemic of 1832. As his medical efforts became known, he was formally given credit to have begun the antiseptic era of medicine & cleansing of instruments, surgical sites & washing of hands. However, the high-pH of his disinfectant ranged from irritating to caustic when left on open wounds or tissues for too long. Nevertheless, Labarraque's solution soon became important for the cleansing & disinfection of instruments & equipment of surgical theaters of that day.

By the mid 1800's, Pasteur's germ theory was accepted by many clinicians, which led to a worldwide practice of disease control. In 1843, Boston, Dr. Oliver Wendell Holmes was credited with understanding childbed puerperal fever & its prevention. Holmes concluded the disease was carried on the hands & clothing of the doctors from one patient to another. Holmes noted one colleague who repeatedly washed his hands with a calcium hypochlorite between patients & was unusually free of disease.

In the same era Dr. Semmelweis insisted that all hospital attendants & clinicians who attended the autopsy theater, to wash their hands & clothing with lime chloride (A $CA(OH)_2$ POWDER, CHLORIDE & HYPOCHLORITE) before moving to the obstetric theater. His demands resulted in a stunning decrease in puerperal disease. Obvious conclusions—disinfection of hands & clothing was extremely important to prevent the spread of infection & disease!

In 1827, Thomas Alcock published his "Essay on the use of Chlorites of Oxide of Sodium and Lime", recommending chlorine for disinfection & deodorizing a wide range of environments e.g. hospitals, workshops, stables, toilets, reservoirs, sewers & areas contaminated with blood & body fluids. At that era to defend against cholera, the Marseille Health Commission recommended chlorine for disinfection of hands, clothes & drinking water. In 1881, Robert Koch demonstrated the bactericidal effect of chlorine on pure cultures of bacteria in his research laboratory in Berlin while defining his famous *Koch's Postulates*. In 1894. Dr. Traube then advocated the purifying & disinfecting properties of chlorine in community water treatment against bacteria.

During World War I many soldiers were injured in horrible land battles—Henry Drysdale Dakin, an English chemist was housed on the French Hospital ship the *Aquitaine* to assist the French surgeon Alexis Carrel with the wounded soldiers. Dr. Carrel was born June 28th 1873 in Sainte-foy-les-Lyon & died Nov 5th 1944 in Paris. In 1912 Carrel received the Nobel Prize for developing a procedure to suture blood vessels & the preservation of tissues outside the body. Together Carrel & Dakin developed a method of flushing wounds with their antiseptic solution to treat infected war wounds. Fortunately, Dakin was familiar with Labarraque's solution & used his ingenuity to devise a means to create the disinfectant from seawater—readily available. As the medical dispensary was short on supplies, many soldiers suffered severe infections due to poor cleansing. Following the successful use of his solution throughout the war, Dakin published his observations in 1915, describing electrolysis of seawater to develop chlorine as a more tissue tolerant surgical lavage & disinfection agent.

In the 1940's Milton solution was marketed throughout the UK as a general disinfectant & antiseptic used mainly for cleansing baby's bottles & mother's breasts after her suckling the infant. In 1943, the US Ministry of Health approved NaOCl as an alternative to steam, for the on-site sterilization of dairy milking equipment.

In 1931, Walker introduced a 5% NaOCl to dentistry & was again reinforced by Grossman & Maimen in 1941. During my personal discussions with Dr. Grossman he related that following his US studies in Dentistry, he traveled to Austria to learn of their chairside disinfection for the emerging specialty of endodontics. At the University of Austria he studied the use of chlorine for lavage of mechanically debrided root canals. He brought that knowledge to the US & began the concept of chlorine for disinfection of infected root canals. Professor Grossman advocated chlorine lavage of biomechanically instrumented canals & their closing without culturing. Dr. Grossman felt this was a technical & economical benefit to the patient & clinician.

In the early 1950's Dr. Glickman lectured in Japan on the use of chlorine to lavage & disinfect periodontal sites before & after periodontal surgery. Drs. Hirota & Sudo learned of chemical surgery & thought to use chlorine to disinfect & control hemorrhage in patients who experienced pulp exposure from iatrogenic intervention—in both carious & non-carious lesions. In 1959, they published their studies in Japanese, but even today many colleagues remain unaware of these articles.

In 1960 Chloro·isocyanurates (NaDCC) were approved for commercial sale to be used for controlling the bacterial flora in swimming pools. In 1969, when the Apollo-11 mission men set foot on the moon & returned to earth, hypochlorite was chosen as one of the disinfectants to destroy possible moon germs. In 1971 NaDCC tablets were formally marketed in the United Kingdom for sterilizing babies bottles & teats of lactating mothers. In 1986, Kinder Marketing Co. distributed Chlorine Tablets to the UK's janitorial supply industry & in 1987 NaDCC granules were marketed in the UK for decontaminating body fluids spills, particularly for cleaning-up blood spills.

When you consider that over 100-viruses can cause enteric & other water-borne diseases e.g. typhoid & dysentery, it is a remarkable testimony that a very small quantity of chlorine in our water supplies saves us from these diseases.

In 1993 while my research colleagues & I were carrying out *in vivo* ISO biocompatible usage studies on non-human primates, we placed non-carious mechanical exposures to the vital dental pulp. The animals were under general sedation without local anesthesia & so the pulps often bleed profusely & control of the bleeding was often difficult to achieve. During my many research studies at The Univ of Michigan & The Univ of North Carolina—my colleagues & I had placed hundreds of *in vivo*, non-carious CLASS-V pulp exposures—often trying to control pulp hemorrhage with sterile saline on a cotton pellet & pressure. Once we had managed to slow & stop the pulp bleeding, we would then acid etch & rinse the cavity & exposure site, the bleeding resumed as before—once again creating the same lavage & flow control until bleeding could be stopped & a proper capping agent applied without starting the bleeding process once again.

Until I met Dr. Naotake Akimoto of Tsurumi Dental University, I had never heard of **chemical surgery** of an exposed vital pulp. During a surgical sequence that involved placing class V cavities & mechanical pulp exposure throughout the dentitions of non-humans in preparation for acid etching & direct pulp capping with various adhesive systems, Dr. Akimoto asked if I was aware of the concept of **chemical surgery**? I said no & asked if he would please copy & interpret it for me? From that moment our adhesive capping research success increased to over 97% when NaOCl lavage & rinse was used to develop a bacteriometic seal. Since then, publications from my laboratory research has shown that Dr. Akimoto's concept of **chemical surgery** is an inexpensive means to increase your clinical success of direct pulp capping.

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