Electrical Healing and the Violet Ray

an unpublished book *by*
Gary J. Lockhart
(1942–2001)

edited and PDF *of part* placed online
by Ann J. Lockhart and Arthur Lee Jacobson in 2009

INTRODUCTION
(short version)

"It has long been my belief, that the electric influence is the great principle by which the Almighty puts together and separates; and that it might be called, metaphorically speaking, the right arm of God."

Andrew Cross *c.* 1835

"What are electricity, galvanism and magnetism? In these lies the great secret of nature."

Napoleon Bonaparte *c.* 1815

About 5,000 years ago, a peasant farmer brought wild kittens home. When he petted them on dry days, there were small sparks. Maybe he wondered if there was a connection between the tiny sparks and the great lightning bolts that split the skies on stormy days.

Electricity got its name in +1600 from the Greek word for amber. Once it had a name, people began to think of ways of generating it. As soon as we were able to generate and store electricity, doctors began to try using it to cure disease.

The "electric era" began with static generators, then direct current. Batteries began around +1800. Michael Faraday's experiments opened the door to alternating current. AC current was only a curiosity at first, and then it was adopted for the power transmission grid. High frequency alternating currents arrived in 1892 with the suggestion that they would be valuable in medicine.

In +1836, Guy's Hospital of London set up an "electrifying room." Patients generally sat on an insulated stool and received an "electric bath" from a "static machine." Doctors drew sparks from the electrified patients or shocked them with Leyden jars.

In 1872, Dr. Alphonse Rockwell asked to read a paper before the New York Medical Society, but was turned down because "electricity was the domain of crooks." By 1890, five medical schools in New York were teaching courses in electricity. There was a great wave of interest in using electricity for medical treatment, which lasted until about 1910.

Nikola Tesla was the genius who developed the modern system of alternating current. He believed that electricity would revolutionize the world. He wanted to broadcast electrical power and use it to drive cars and airplanes with electric motors. He believed that high frequency electricity would revitalize the body.

In 1892, Tesla traveled through Europe, lecturing. He met with Paul Oudin in Paris where they discussed ways of building electrotherapeutic devices. Paul Oudin built the first "violet ray" and wrote an article on using it to cure skin disorders the next year.

The name "violet ray" occurs for the first time in 1913 in a dental journal. By 1916, inexpensive units were being sold in drugstores under this name. Medical literature uses the terms "high frequency treatment," "D'Arsonvalization" or "effluvation." There is a great deal of confusion on the devices and treatments. The electric medical journals of this time period are rare, but kind librarians at the Bakken Library, University of Michigan, Philadelphia College of Physicians and the National Library of Medicine dug them out of the basement for me.

The great era of electrical healing lasted from 1890 to 1910. By the time inexpensive violet rays were being mass marketed, medical journals were doing longer covering studies on this. At least twelve companies made the devices in France, Germany, England, Canada and the United States. The depression of 1929 put the companies out of business, and the violet ray was gradually forgotten. I have only found two studies on the device in the last 70 years under the name of "d'Arsonvalization."

The violet ray in healing would have been almost totally forgotten, except for one man. Around 1900, Edgar Cayce lost his voice for months and doctors were unable to help him. After he learned how to do self-hypnosis and diagnosed his own medical condition, he quickly regained his voice. Then he went into hypnosis and began to help a few friends with their health problems.

Floods of desperate people flocked through his door seeking help for difficult medical conditions. In his lifetime as a "psychic diagnostician," he gave 14,000 readings in which he mentioned using the violet ray in more than 900 readings. I began this study by calling the

Cayce Association and asking about the violet ray. They knew very little about it, except for knowledge of the numerous readings.

I intended to write a short chapter on the violet ray in a book, but as I began to do research, the story gradually emerged. I wanted to tell the entire store of the evolution of medical electricity. I was surprised to learn that electricity was used to reduce weight, grow hair and remove hemorrhoids. In certain instances, it restored the sight of nearly blind persons, healed desperate cases of rheumatoid arthritis and removed skin cancer.

The best collection of electrical healing devices can be found in the Bakken Museum of Minneapolis. The man who invented the first transistorized pacemaker for hearts founded this library and museum. The Museum of Questionable Medical Devices in Minneapolis has some of the same devices, but its staff take the position that the devices were nothing more than superstition. The Indiana Medical History Museum has a wide variety of electrical gadgetry used to cure disease.

The Electropathological Museum at the University of Vienna contains paintings and objects that show the mystery traces left by lightning or power lines. One exhibit is a tattoo made by a golden chain around the neck of a woman struck by lightning. The founder of the museum, Professor Stefan Jellinek, was one of the first to show that the apparently dead from electrical shock could be restored to life by artificial respiration.

Electricity is a two-edged sword that can restore health and life or injure and kill. The benefits of simple electrical treatments far outweigh the risks involved. Hundreds of thousands of violet rays were sold and used, with few reported problems. There is no endorsement of any treatment in this book, and readers are advised to consult with a medical professional. In using any electrical device, all proper precautions should be employed.

INTRODUCTION (long version)

"It has long been my belief, that the electric influence is the great principle by which the Almighty puts together and separates; and that it might be called, metaphorically speaking, the right arm of God."

Andrew Cross *c.* 1835

Many stories of King Arthur's court in England are about the Holy Grail. The grail was the cup used by Jesus at the Last Supper. The continental European legends speak of the grail as a stone with spirit. The *Parzifal* calls it the "lapis electris." Angels, who were neutral in the strife between God and Satan, guarded the electric stone.

The legend of the Holy Grail is a picture of the future of electricity. The divine power can be either a healer or destroyer. Movies show the Frankenstein monster seething with electric currents. The saints and saviors are pictured with a golden electric halo.

William Gilbert (1544–1603) became the chief physician to Queen Elizabeth. She had such a good opinion of him, that he was later given a pension to continue his scientific studies. He used the money to buy many rare books and experimental equipment. One was a magnetic lodestone ground into a sphere, which used magnetic needles to show how it mirrored the earth's field. He showed that friction on glass, sulfur and other substances would generate an attractive power, which he called "electricity." He named it from the Greek word for amber.

In 1897, physicist Joseph Thomson completed the physical side of Gilbert's work. He made a vacuum tube with two charged plates and a fluorescent screen. Magnetic and electric fields deflected the current, and he found a stream of charged particles. He announced the discovery of the electron.

The history of medical electricity begins with the first practical static generator in 1742 and the Leyden jar for storing electricity in 1745. Doctors electrified patients with static electricity or gave them strong shocks. This produced some promising results, but the technology was incomplete.

The first battery appeared in 1800, opening the door to low voltage direct current. Michael Faraday opened the door to alternating current in 1831 with pulsed "faradic" current. Electricity could now be generated through motion, and batteries could be charged.

In 1836 Guy's Hospital of London set up an "electrifying room." Patients sat on an insulated chair and received an "electric bath" from a static machine. Most patients were women. The treatment consisted of drawing sparks up and down the spine or passing shocks through the pelvis with the Leyden jars. A brass ball grounded to the earth was used to draw the sparks.

Nikola Tesla was the great genius who made alternating current the standard for transmission and use. He observed that high frequency electricity had important effects on health. In 1892 he met with Paul Oudin in Paris where hey discussed ways of building therapeutic high frequency oscillators. Months later Oudin produced the first device that became known as the "violet ray."

Paul Oudin began to experiment with skin disorders and found that acne, eczema and psoriasis were easily treated with the new device. After a few treatments the skin patches would begin to break up and disappear completely in two to three months. When the devices were used to spark warts or skin cancer, the anomalies often were removed within weeks.

The violet ray often took away pain, and many times it was almost considered a miracle. I experienced this after months of enduring a shooting pain in the foot. I used the violet ray around the area for a minute each night, and the pain did not return. A friend had such pain in his shoulder that he was considering quitting work. The violet ray relieved much of the pain. His girlfriend had severe pain in her knees, which resulted from gymnastics when she was younger. The device relieved most of her knee pain.

The device was valuable in dealing with arthritis and was often considered a miracle in rheumatoid arthritis. I lent my violet ray to a friend to help with his arthritis. In a few weeks his enlarged joints shrank to normal size.

The long hours of typing chapters had began to take their toll while I was working on this book. My left hand became painful and

numb from carpal tunnel syndrome, resulting in my making many mistakes. After violet ray treatments for ten days, most of my pain and numbness was gone.

The early electrical healing devices were called by several names, but were generally known as "high frequency oscillators." The *Dental Brief* first used the term "violet ray" in 1913. In 1916, the first inexpensive hand-held devices appeared in drug stores. The public accepted the violet ray and hundreds of thousands of units were sold. Twelve companies made the devices in the United States, Canada, Germany, France, Spain and England. Drugstores had front window displays of violet rays.

When they became popular with the public, doctors and the FDA started to despise them. At first the *Journal of the American Medical Association* published promising therapeutic results in articles. Then it printed an article about a man who deliberately short-circuited his violet ray and electrocuted himself. This implied that the device was dangerous and should be outlawed. The Depression put the companies that made violet rays out of business and the devices became unavailable.

There is another reason why the device was forgotten. A stream of violet rays of light passes through a glass tube into the skin. Tiny sparks shoot out, and when the device is withdrawn, there are sparks causing the muscles to jerk. Using the device is very unsettling at first and slightly uncomfortable. After the initial sensation passes, the violet ray is easy to use.

Edgar Cayce was the "sleeping prophet" who gave 14,000 readings between 1920 and his death in 1945. Desperate people seeking help for medical problems consulted him, when doctors couldn't help them. In his self-hypnotic trances, he recommended the violet ray treatments over 900 times. He kept interest in this nearly forgotten device alive.

I wanted to tell the entire story of the healers who used electricity, and emphasize the violet ray era. It was a difficult job to locate and research books and journals with information about it. I visited medical libraries at Stanford, University of Washington, University of Minnesota, University of Michigan, Philadelphia College of Physicians and the National Library of Medicine. I am especially grateful to the Bakken Library and Museum in Minneapolis, which contains a collection of old violet rays and other electrical healing devices. The library has many rare books relating to all aspects of electrical healing.

In geopolitics there is a saying: "the winners write the history books." The winners wrote the history books and textbooks of medicine. They made certain that everyone knew about the glories of surgery and wonder drugs. They made sure that electric medicine was placed in the category dominated by cranks and frauds.

Robert Becker was the leading scientist engaged in regeneration work with electricity. He discovered the ideal currents for regenerating broken bones. As his research became more interesting and promising, he found that the National Institutes of Health denied him monetary grants to continue. He was so discouraged that he wrote: "The pigeons of Zeus cover new ideas with their droppings and conduct rigged experiments to disprove them."

The violet ray is a grandfathered device, meaning that it was produced before 1976 and is generally presumed to be safe and not subject to federal regulation. In spite of this, the FDA threatened leagal action against the companies that produce them and the people who use them. The climate of official intimidation has been so strong that only one journal *(Chinese Medical Journal)* has published studies in the last 70 years.

The violet ray is not a medical miracle, but it often produced remarkable healing in a short period of time. Those who use it should take the same precautions as with any electrical device. In any healing treatment, qualified medical advice should be sought. This book does not make medical recommendations, but it does tell the history and results of those who used electricity for healing.

There is more to be told of the story of medical electricity, but this is a beginning. I am reminded of the words of Winston Churchill in 1942. "Now this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning." If this book results in a new beginning for forgotten technologies, then I have accomplished my purpose.

Contents

1. THE CURE FROM THE SKIES

"From a thousand experiments, it appears that there is a fluid far more subtle than air, which is everywhere diffused through all space, which surrounds the earth and pervades every part of it. Such is the extreme fineness, velocity and expansiveness of this active principle that all other matter seems to be only the body and this is the soul of the universe. This we might term electric fire, but it is hard for us to separate the ideas of fire and burning. From this pure fire, which is properly so called, the vulgar culinary fire is kindled. For in truth there is but one kind of fire in nature, which exists in all places and in all bodies. This is subtle and active enough not only to be under the Great Cause, the second cause of motion, but to produce and sustain life throughout all nature as well in animals as in vegetables . . ."

Desideratum John Wesley.

In 1973, Chinese archeologists digging in the Hunan Province unearthed a book titled: *Prescriptions Against 52 Ailments*. It was buried about 200 years before the time of Christ. Twenty-seven prescriptions were spells chanted to cure the disorders. For one of the mystery ailments the writer remarks: "Wait for lightning in heaven and then rub both hands together. Face the lightning and chant to it: Sovereign of the Eastern Quarter, Sovereign of the Western Quarter, preside over the darkness and darken this person's stars."

Lightning is a mystery that was once believed to be the power of the gods. The laurel protected against it, so Roman emperors wore the laurel wreath. The oak drew the stroke, and Roman soldiers received their decorations of oak leaves as a reminder of heavenly power.

Prometheus brought lightning from the heavens, giving him the power of the gods. The prophet Zoroaster was killed by a lightning stroke in response to his own prayer. The "heavenly fire" furnished poets and writers with a sense of divine magic.

Moses saw the burning bush that was not consumed. Flames appeared upon the heads of the twelve apostles on the day of Pentecost. Renaissance artists attempted to depict the mystery fire by painting nimbuses circling the heads of the divine figures.

The town of Kulu in the Indian Himalayas has a temple on a hill dedicated to the god Shiva. A 60-foot iron rod attracts the "blessings of heaven." Lightning flashes through the mast and shatters the statue of Shiva at the base. The shattered pieces of Shiva are reunited and used for the next blessing.

A few people seem to have a fatal attraction for lightning. Charles Brown of Kenton, Ohio, was known as the human lightning rod. On May 20, 1946, he was stunned for the tenth time when a bolt struck the public library as he was checking out a book.

Major R. Sumerford of Vancouver, British Columbia, was on army patrol during World War I. A bolt of lightning killed his horse and left him paralyzed from the waist down. He eventually recovered enough to walk with the help of two canes. In 1924, he went fishing in the mountains. His friends left for supplies while he sat under a tree. Lightning struck it and paralyzed his right side. In 1930, he was walking in a Vancouver park. As a storm came up, he hurried towards the shelter area. He was struck by lightning and confined to a wheelchair. He died two years later. On a July night in 1934, a violent electrical storm struck Vancouver. A bolt of lightning struck a single tombstone in a cemetery and shattered it. It was the grave of Major Sumerford.

The famous meteorologist Heinz von Ficker was caught in a thunderstorm on the Matterhorn Mountain in the Alps. He was struck three times in the back by bolts of lightning, and his clothes were ripped to shreds. He remained fully conscious, but the fourth lightning bolt knocked him out for a short time.

Literature contains a number of cases in which lightning provided a healing impetus. In 1776, Mrs. Wynne went to Dublin to consult with several surgeons because she had a large tumor in the left breast. The surgeons didn't want to operate, so she returned home. She was looking out of the window of her home when lightning struck it and set fire to the roof. The stroke passed through her left shoulder and down her back. She tumbled to the floor and was found later that evening. Dr. Georgius Hicks visited her two days later and found that her breast tumor was smaller and softer. In a few weeks, it was completely gone. Thereafter, he decided to try electric shock to treat breast cancer. With electrical shocks, he was able to reduce the cancerous tumors and pain in two women.

In the summer of 1806, Samuel Leffers suffered a stroke. The left side of his face was numb, and he had great difficulty speaking. He was unable to close one eye and could hardly walk. Several months later while he was in his house, lightning struck and he lay senseless for about 20 minutes. When he recovered he began to feel much better. The next day he sat down to write a letter to a friend, and he found that he didn't need glasses. Although he lost part of his hearing, he looked 30 years younger, and his face acquired a remarkable smoothness and beauty.

Susana Watts was traveling home when a severe storm struck. The carriage broke down, so she had to walk the rest of the way. The cold weather was too much and her health failed. She was unable to use her arms and was confined to bed. Three years later a bolt of lightning struck the house and left a black large circle on the ceiling. She was unconscious, so the servants loosened her clothes and began to massage her. As she awoke, she was angry with them for touching her. Then she got up and began to walk. She stumbled and reached out for the handrail. The lightning had restored the use of her arm and cured her arthritis.

In 1822, Martin Rockwell was standing looking out of a window when lightning struck the building about ten feet away. He was briefly paralyzed and it took an hour for normal movement to return to his left leg and right arm. There was a burning sensation in his chest that continued for days. Rockwell suffered from asthma since he was a boy and was often unable to sleep. Since the lightning strike he was entirely free of asthma. He would feel it slightly when he had a cold or was fatigued.

In 1828, a ship was crossing the Atlantic with a passenger who had been paralyzed for three years. Lighting struck his quarters, and suddenly he jumped out of bed. He remained perfectly normal the rest of his life.

Another strange stroke of lightning aroused medical curiosity in 1846. Lightning struck a group of women, one of whom had been childless for years. In a few months, she was expecting. Another woman was 70 years old and had gone through menopause 20 years before. She began to menstruate, and continued for three years.

Around 1850, an English farmer developed cancer of the lower lip and chin. He agreed to have surgery, but before the scheduled date, he was out plowing his fields when he was struck by lightning. Both of his horses were killed, and his plow was shattered. A few weeks later, the cancer was distinctly less, and in months it disappeared. He enjoyed good health for the next ten years. The cancer then reappeared, and the man died.

Thomas Young was a farmer near Dukedom, Tennessee. Cancer began on his face, so the surgeon removed part of his lower jaw. The cancer continued to spread, and by June of 1932, he was nearly dead. He chose to spend his last days lying in bed or on a hammock under the trees. One day a sudden storm came and struck one of the trees to which his hammock was attached to. The bolt stunned him and ripped the soles from his shoes. In a few days, he began to feel better. The cancerous sores started to heal, and soon he was back to normal.

In 1971, Edwin Robinson jackknifed his truck in order to avoid hitting a car. As a result of the accident, he became blind and quite deaf. In June of 1980, he walked out into the backyard as a storm was brewing to call his pet chicken indoors. The next moment he felt as if "somebody cracked a whip over his head." He lay unconscious for about 20 minutes before he was able to go inside. After a good nap he went into the kitchen for a sandwich. Suddenly he realized he could see a little. His wife asked: "What time is it?" He was able to tell her that it was 5 p.m. Two days later he was able to walk about without his cane. His hearing returned and he no longer needed the hearing aid. He kept remarking about the strange feeling on the top of his head. A new crop of hair was growing over the bald area.

Two brothers in London were struck by lightning. The next day, the deaf brother recovered his hearing. A coal miner in Northern England had lost his sight after an explosion of gunpowder. After he was struck by lightning, the sight of his left eye returned. A woman with multiple sclerosis was struck by lightning. She had been slowly degenerating, but within months, she recovered most of her normal function.

Professor Stefan Jellinek was the pioneer of electropathology and founded the Electropathological Museum at the University of Vienna. The museum contains more than 100 watercolor paintings and objects showing the mysterious traces left by lightning or man-made currents. One exhibit is a tattoo made by the links of a golden chain on the neck of a woman who was struck by lightning. The professor wrote several books on the effects of electrical currents and lightning.

Jellinek wrote *Dying, Apparent Death and Resuscitation*. He showed that in most cases of electrical injury, it was possible to restore consciousness with artificial respiration. Before this, most doctors believed that nothing could be done.

Few of us are willing to stand on a hill in a thunderstorm hoping that a bolt of lightning might cure our problems. Lightning is more likely to be the final solution to all of our ills! But controlled man-made lightning might just be the ticket to good health.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

American Journal of Science 3:100, 1821 "Case of a Paralytic Affection, Cured by a Stroke of Lightning" D. Olmsted

American Journal of Science 6:329, 1823 "Cure of Asthma by a Stroke of Lightning" R. Emerson

Lancet 1:77, 1880 "Therapeutic Effects of Lightning Upon Cancer" A. Allison

Medical and Philosophical Comment 4:82, 1776 "An Account of the Effect of Lightning in Discussion of a Tumor of the Breast" A. Eason

Western Journal of Medicine and Surgery 13:162, 1846 "Effects of Lightning" J. Leconte

Unschuld, Paul *Medicine in China: A History of Ideas* Berkeley: University of California Press, 1985

2. BIOLOGICAL ELECTRICITY

"The sea torpedo is said by some to cure headache and *prolapsus ani* when applied. I tried both of these things and found neither to be true. I thought that the torpedo could be applied alive to the person who has the headaches. It could be that this remedy is anodyne and could free the patient from pain as do other remedies which numb the senses, and this I found to be so."

Claudius Galen *c*. +180.

"The live black torpedo when applied to the painful area relieves and permanently cures some chronic and intolerably protracted headaches, providing that the pain is localized and lacks feeling. However, there are many varieties of torpedo and it may be necessary to try two or three varieties before numbness is felt, as numbness is the sign of the cure."

Compositiones Medicamentorum Scribonius Largus *c*. +46.

Humans and other vertebrates have weak electric fields surrounding them. It may be that everything living has an electrical field. Certain fish have developed powerful fields and use electricity to locate food and stun it before they eat it.

The *Torpedo, Astroscopus, Malapterurus* and *Electrophorus* fish have highly developed electric organs. The organ consists of large numbers of disk-like cells called electroplaxes or electroplates arranged in orderly columns with the innervated sides all facing the same direction. The *Torpedo* has horizontal electrical plates forming thick cells. The cells discharge in parallel and generate currents of several amperes at about 50 volts. The electric fishes live in both salt and fresh water.

There are five species of the *Torpedo* in the Mediterranean. The most common is the "electric ray" *Torpedo torpedo*, which has an electric organ consisting of 800 to 1,000 cells connected with bundles of nerves. The top surface of the fish is positive and the bottom is negative.

The electric eel of South America has 70 columns of electroplates, each containing 6,000 cells in series. A large eel can produce 3 millisecond pulses of up to 600 volts. The nervous system is specially

configured so that all cells discharge in short bursts. The slowness of nerve conduction would normally be expected to produce a smaller, more spread-out pulse frequency.

The *Gymnarchus* fish responds to the presence of metals in water. When a copper wire rectangle was placed in a shallow tank, the fish appeared to be trapped within it. Every time it approached the wire, it halted, and then swam away. If a piece of wire is left in the tank for long enough, the fish will show no response. These fish do not bump into the walls of the aquarium when kept captive.

The first electric fish may have used electric pulses to locate food and navigate in muddy rivers. *Gymnarchus* discharges 300 pulses per second, but if another electric fish is nearby, shifts the frequency of the pulses, to be able to distinguish its own pulses from others. The fish hunt at night. When a microphone is put into the water, you can hear ticking, rattling, and whistling sounds. If the fish sense something around them, they raise the frequency of the impulses.

The ancient Egyptians were the first to picture the Nile catfish *Malapterurus electricus*. They probably ignored the shock and used it for food. There was a belief that the fish used its power to shock the fisherman and allowed other fish to escape.

Hippocrates recommended this fish for food, because it was soft and easily digested. He doesn't mention its shocking effects, but this might have been why he recommended it. The fish was prescribed for tuberculosis patients and for women suffering from menorrhagia.

Plato was familiar with the works of Hippocrates and talked about them in his famous dialogues. Socrates would really "electrify" his audiences, and Plato compares him to the torpedo fish. "The flat torpedo fish who torpifies those who come near him with the touch, as you now torpified me, I think. For my soul and my tongue are really torpid and I do not know how to answer you."

Theophrastus took over the school of Aristotle and wrote books on animals, fish and plants. He remarks that the torpedo could send shocks through clubs and spearing irons—numbing the hands of fishermen.

Plutarch compared the lives of famous Romans and Greeks in his well-known books. In *Moralia,* Plutarch remarks: "Swimming circu-

larly about his prey, he shoots forth the effluviums of his nature like so many darts and then infects the water. The fish around are neither able to defend themselves or escape, being held in chains and frozen."

At the time of Christ, Tiberius Caesar ruled Rome, where slavery was common among the wealthy Romans. Tiberius freed one of his slaves, Anthero, who later walked along the shore and stepped onto a flat fish, which gave him a numbing shock. The shock relieved his "gutta," which might have been arthritis.

Pliny wrote his *Natural History* around +70. He mentions several torpedo remedies, either eating the fish or applying parts of the dead fish. He mentions the "exhaltations" of the torpedo, but getting live fish was not easy for those who needed an electric cure.

The electric fish began to attract the attention of scientists around +1700. Francesco Rida and Stephano Loranzini dissected the torpedo and found that the electric organ was essentially a modified muscle. The invention of the Leyden jar in 1745 played a decisive role in establishing the electric nature of the fish. A weak static current could now be turned into a real shock. The scientists were puzzled over the nature of the fish. It didn't attract light bodies or electrify a Leyden jar, and there was no spark or crackling noise.

The eccentric scientist Henry Cavendish researched the electric fish. He never invited visitors to his laboratory, but on one occasion he invited a group of friends to witness his research. He constructed a model of the torpedo with electrical equipment and put it under wet sand. The visitors walked over it with bare feet and got the same sensation as the real torpedo. Cavendish estimated that one torpedo equaled 49 charged Leyden jars.

John Walsh continued the investigation of electric fish. He showed that an electrical eel would produce a visible spark in a dark room. He put two wires into the water of an aquarium in which his eel was swimming. When his friends would put their hands over the wires, the eel would sense this and give them a shock. His experiments stimulated interest in electric healing. A newspaper soon had an ad for getting healing shocks for two shillings and sixpence!

When the Europeans began to explore Brazil, they found the powerful electrical eel swimming in the rivers and ponds. Alexander

von Humboldt found that the eels were difficult to catch, because they buried themselves in the mud. The Indians drove horses into the muddy pools and the horses discharged the eels. Then the Indians speared the eels with harpoons fastened to dry wood handles.

A Jesuit missionary wrote: "In these rivers and lakes, the electric eel is found, which if any man holds in his hand, and it stir not, it doth produce no effect. If it move itself ever so little, it so tormenteth him which holds it, so his arteries, joints, sinews and all his members feel exceeding pain with a certain numbness. As soon as it is let go from the hand, all the pain and numbness are gone. The superstitious Abassines believed that it is good to expel devils out of the human body, as it did torment spirits no less than men."

The governor of Surinam, Storm Van s'Gravesander, wrote in 1754: "It has been observed that various people who had gouty pain and touched the torpedo were completely cured two or three minutes after contact. The experiment has been repeated at various times, but always with the same result."

The Dutch surgeon Frans Van der Lotte wrote in 1761: "An Indian had paralysis of the abdomen. After having used several external and internal medicines in vain, I tried an electric eel, in the presence of my friends, which had just been caught in the river and hence was in full strength, against the knees of the patient. The shock was so tremendous that two persons who were holding the patient under the arms on each side were knocked to the floor. After I had repeated this three times, the patient, who had to be carried from his plantation, walked back to the plantation without cane or crutches, completely recovered and was without need of assistance."

Abraham Van Doorn had a slave boy with crooked arms and legs. He had the boy thrown into a tub containing large black electric eels. After being shocked, the boy crawled out, but if he was unable to crawl, he was helped out. The boy completely recovered from his nerve disease, but his bones remained deformed.

Van Doorn also threw another slave with malaria into a tub with an electric eel. The slave's fever disappeared in a few minutes and didn't return. Van Doorn also tried this on an Indian boy with malaria. Once again, the electric eel cure worked.

Charles Darwin speculated about the evolution of the electric fish, because he didn't know of any transitional forms. All muscles are weakly electrical, and some people appear to be strongly electrically charged. The electric fish developed this ability and use it to locate food and stun prey.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

American Scientist 72:598, 1984 "Electric Fish and the Discovery of Animal Electricity" H. Wu
Bulletin of the History of Medicine 20:112, 1946 "The Part Played by Electric Fish in the Early History of Bioelectricity and Electrotherapy" P. Kellaway
Endeavour 15:215, 1956 "The Generation of Electricity by Fishes" R.D. Keynes
Journal of Experimental Biology 35:156, 1958 "On the Function and Evolution of Electric Organs in Fish" H.W. Lissmann
Scientific American 208:Mar/50, 1963 "Electric Location by Fishes" H.W. Lissmann

3. ELECTRIC PLANTS

"The physiology of plants gives a satisfactory explanation of the functions which most of their organs have to perform and good reasons for their existence and their varying forms. This is, however, not the case with the needle-like shape of the leaves in fir trees, and the beard on the ears of most cereals. Since nothing exists without purpose in all the infinite number of objects in nature, then the needle-shaped leaves and the beard must have their determined ends. In fact, they are very well fitted to be the means through which the electricity goes from the atmosphere into the earth, or vice versa; that is to say, they act in the same fashion as metallic points. To pretend that they really serve as a means of transmitting electricity because their form shows them capable of it would be to go too far. The presence of electricity in the air around them shows that they are, in fact, in a position to perform this function of transmission."

Selim Lenström.

The story of electricity and life may have begun some four billion years ago with lightning strikes. The electrical current formed the molecules of life and linked them into chains. Lightning has a major effect on the plant world by forming nitrogen compounds, which plants use to generate proteins. Thunderstorms do more than wet the ground; they also fertilize.

In 1890, *Scientific American* announced that an electric plant had been discovered in South Africa that gave you a shock when you touched it. Nobody could find the mysterious electric plant, so it was assumed that the story was a hoax. The story may have come from someone tasting a leaf of *Spilanthes africana*. The anesthetic in the leaf gives the person a distinct feeling of a shock on the tongue.

The first electrification of growing plants began in Edinburgh, Scotland, when Mr. Maimbray electrified two myrtle trees in 1746. The trees began to leaf and bloom sooner than others nearby. Abbé Jean Nollet heard about the experiment and planted seeds in two garden pots. He electrified one pot for two weeks several hours a day. The electrified seeds grew sooner than the other seeds.

In 1747, Jean Nollet was tutoring the Dauphin. A German professor told Nollet that if water in a thin glass tube is electrified, it won't drip, but would run in a stream. He electrified mustard seeds

with charged water, and the sprouts grew 3 centimeters taller than non-electrified ones.

Abbé Pierre Berthelon was a professor of experimental physics at French and Spanish universities. He had a gardener stand on a slab of insulating material and sprinkle the vegetables from an electrified water can. He tried to collect atmospheric electricity with an antenna and pass it into plants growing in a field. He believed that the best fertilizer for plants was electricity from the sky and in 1783 wrote *De l'Electricité des Végétaux*.

In 1770, Professor Francesco Gardini stretched a number of wires above a monastery garden in Turin, Italy. Many of he plants began to wither and die. When the wires were taken down, the garden revived. He theorized that the plants had been deprived of electricity or perhaps they had received an overdose. He wanted to attach wires to the newly invented hot air balloons to conduct electricity from great heights.

L. Grandeau experimented in France by putting tobacco plants in a cage to shield them from electricity. Plants outside the cage grew 1.87 meters tall and those under the enclosed wire cage grew 1.42 meters. There were 89 flowers on the outside plants and only 45 flowers on the shielded plants. He believed that electricity increased the height and strength of the plants.

William Ross tested the power of electricity by planting cucumbers in a mixture of manganese oxide, salt and clean sand. When he applied electric current to the beds, the seeds sprouted well ahead of those exposed to a non-electrified mixture.

John Freke was a surgeon at St. Bartholomew's Hospital and a curator of its museum. In 1746 he announced that the movements of the leaves of the sensitive plants were due to electricity. He put a potted plant on a cake of wax and attached it to a static machine. When electrified, the leaves stood out. He believed that this proved electricity was the agent behind the moving leaves.

Selim Lemström took four trips to northern Norway and Spitzbergen. He noticed the tremendously rich plant development of trees, flowers and even cultivated crop plants such as rye, oats and barley. Most botanists felt that the rich summer vegetation of the northern

climates was due to light and heat. But while days are long, the sun's light is oblique, and its illuminating and heating power is greatly lessened.

Lemström noticed that the northern tree rings showed strong 11-year sunspot cycles. The harvest cycle of the north showed a strong variation with the sunspot cycle. The greater the number of sunspots caused more auroras and a more abundant harvest of seeds, roots and grass. He felt that this was due to the greater circulation of electricity in the atmosphere.

Lemström noted that northern trees had needle-shaped leaves, and cereals had bearded points. He believed these points would serve as transmitters of electricity. In order to prove his theory, he sowed barley, wheat and rye grains in cardboard boxers. The boxes attached to a static generator yielded 40% more than the other boxes.

He tried dividing a field into plots and using wires above the plants attached to a generator. This increased the rye yield by 19% and the barley by 40%. He had great difficulty doing this, because he couldn't use the static machines in damp or rainy conditions. He found that added electricity didn't help plants in poor soils. Other scientists repeated the experiments, but didn't find any difference in the yields. They felt it would take a significant difference to repay the extra work and expense involved.

Patrick Synge traveled in Africa and noted that the plants of the "Mountains of the Moon" or the Ruwenzori of Uganda had unusual vegetation. There were heathers as large as trees and impatiens with flowers two inches across. He found lobelias on Mount Elgon growing 30 feet tall, but when he brought them to England, they didn't survive. He believed that light and electric currents accounted for the luxurious growth.

There was a great deal of interest in electric crop growing in England, and many experiments were performed. Usually a wire net was placed at varying distances above the field, fastened with insulated supports. A critical review of 20 years of experiments showed no increased growth caused by electricity.

Fredrik Elfving did another type of experiment. Various plants were grown in wet soil, and an electric current was passed through the

plant roots at right angles. The roots bent to follow the lines of current flow.

William Ross got a U.S. patent on this in 1844. He buried plates of zinc or copper about 200 feet apart. The plants were connected above ground with wires, thus forming a battery. He claimed to grow very large potatoes in his electrified fields.

It is known that plant roots show galvanotrophy. A small current will cause the roots of beans to grow towards the negative pole. When roots have a high concentration of salt they will grow towards the anode. Amoebas and most protozoa drift towards the negative cathode.

In 1934, William Osterhous recorded the electrical variation across the membrane of the giant cell of *Nitella flexilis* with an electrode placed in the cell. The inside of the cell had a negative charge with respect to the outside. When the plant was stimulated, sodium ions flowed into the cell and potassium flowed out. The process reversed itself, as the plant resumed normal function.

Dr. Alexander Sinyukhin cut branches from a series of tomato plants. He took electrical measurements around the wound. A negative current or a "current of injury" flowed from the wound for several days. During the second week, a callus formed and a new branch began to grow with a positive polarity. When Sinyukhin applied 2-3 microamperes of current, branches regenerated up to three times faster.

Jagadis Bose found that radio waves produce variation in the growth of plants. Feeble waves accelerated the rate of growth, but strong radio waves retarded plants. The effect persisted for a long time after the stimulation ceased.

Oskar Korschelt was a German professor of agriculture who believed that electricity and the cosmic forces stimulated the healing of plants and people. He wrote: "It is not only the life force, but also the character of the healer that is shared with the sick person. Conversely, the character of the patient flows into the healer."

Fritz Hildebrand was a Bavarian civil engineer who believed that he discovered growth waves with a length of 10-30 centimeters. When he exposed seeds to waves for only 15 seconds, larger plants with greater yields were produced. This is far higher than the violet

ray frequency. He used a complicated apparatus, but Surgeon General Alexander Heermann produced them with a simple circuit.

Bindo Riccioni devised a simple apparatus for treating large numbers of seeds electrically. He treated up to five tons of seeds a day by allowing them to flow between parallel capacitors hooked up to a resonating circuit. He reported harvest yields up to 37% above average. A seed processing plant was built in the Soviet Union using this technology. Corn yields went up by 15–20% and oat and barley yields increased from 10–15%.

In 1922, Alberto Pirovano published *La Mutazione Elettrica*. He invented the process of "ionolozation" in which pollen was subjected to high voltage electricity of 500–600 hertz. When used to fertilize flowers, it produced a wide variety of changes in plants. Plants were giants or dwarfs, and their seeds and fruit were changed. Flowers were markedly altered. He produced several new varieties of tomatoes, which became popular with gardeners. It is possible that the violet ray might be used to produce the same changes.

In 1964, Charles R. Keller received patent 3,120,722 for the treatment of sick trees. He used a current of 800 hertz and 6,500 volts placed about three-quarters out on the main branches. He claimed the electrical stimulus revives the immune system of the tree and overcomes the infection.

He would attach wires to the main branches and turn on the equipment. The higher the voltage, the shorter the treatment time. Sometimes he would treat the roots by pounding in metal stakes and attaching the wires to the tree branches. He treated avocado trees for canker and orange trees for scale and dieback. The terminal parts of the branches were apparently dead, and the whole tree had few or no new sprouts in the spring. The following spring, the trees would show new growth and the apparently dead limbs would return to life. Often they would bear a heavy crop of fruit.

In 1968, Dr. H. Len Cox read an article in the magazine *Aviation Week and Space Technology*. Satellite photos showed which field attacked by pests had a different "electromagnetic signature" from good fields. He decided to try changing the electromagnetic signature by adding particles of magnetite to the soil. He brought back a truckload

of ore from Wyoming and charged the particles with a strong magnet.

His garden didn't look much different until harvest. The radishes, carrots and turnips were large. He began selling ten-pound containers of magnetite to gardeners who reported that irises doubled the number of blossoms on a single stem and that their gardens were much more fruitful. It didn't seem to work in flowerpots; the magnetite had to go into the earth.

There is an ancient Pueblo prayer chant, expressing the effect of nature's electricity:

> My corn is green with red tassels,
> I am praying to the lightning to ripen my corn.
> I am praying to the thunder, which carries the lightning
> Corn is sweet where lightning has fallen. I pray to the colored clouds.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

Comptes Rendus de l'Académie des Sciences 87:939, 1878 "On the Influence of Atmospheric Electricity on Vegetable Fruiting" L. Grandeau

Journal of Comparative Neurology 27:270, 1916 "Experiments Concerning Phenomena of Tropism and Taxis in Plants and Animals" C.R. Kappers

Journal of the Horticulture Society of London 1:81, 1845 "The Influence of Electricity on Vegetation" W. Solly

Scherl's Magazin 10:1025, 1930 "You Can Grow Things How You Want Them" W. Stolting

Bose, Jagadis *Plant Autographs and Their Revelations*
New York: Longmans, Green & Co., 1927

Lemström, Selim *Electricity in Agriculture and Horticulture* London: Electrician Printing and Publishing, 1904

Riccioni, Bindo *Il Trattamento Elettrico del Seme di Grano "Sistema Riccioni" Del Laboratorio all'Agricultura Pratic* Gergamo: Instituto Italiono d'Arti Grafichi, 1940

Synge, Patrick *Mountains of the Moon* London: L. Drummond, 1938

4. ELECTRIC ATMOSPHERE

"The electric condition of the atmosphere is, I believe, not the least important of its properties with respect to its influence on health, though the mode of its operations is but very imperfectly understood as yet. The development of electricity in the air is the result of almost all the chemical and vital actions going on in the world around us. It is called into existence by the growth and decay of every form of animal and vegetable existence."

On Change of Climate Thomas More Madden 1864.

"It is clear that [the sun's] radiation produces the electrical current which operates adaptively on the organism as a whole, producing memory, reason, imagination, emotion, the special senses, secretions, muscular action, normal growth and the growth of benign tumors and cancers. They are all governed adaptively by the electric charges that are generated by the short wave or ionizing radiation in protoplasm."

The Phenomena of Life Dr. George Crile 1936.

During thunderstorms, we observe the powerful transfer of electrical energy generally from the sky to the earth. We don't realize that there is just as much electrical activity on clear days, only this time it is from the earth to the sky. Pierre Lemonnier discovered that the electrical activity on clear days balanced the electrical transfer of storms.

Another form of electrical activity apart from lightning is St. Elmo's fire. Pliny wrote: "Stars make their appearance both at land and sea. I have seen a light that forms on the spears of soldiers, keeping watch by night upon the ramparts. They are seen also on the sail-yards and other parts of ships, making an audible sound and frequently changing their places. Two of these lights forebode good weather and a prosperous voyage."

Julius Caesar described his military campaigns in *De Bello Africano:* "About that time there was a very extraordinary appearance in the army of Caesar. In the month of February, about the second watch of the night, there suddenly arose a thick cloud, followed by a shower of stone, and the same night the points of the spears belonging to the fifth legion seemed to take fire."

Robert Fox noted that the aurora borealis was at right angles to the magnetic meridian. "The aurora may therefore, I think, be considered an exhibition of electric currents at a great height, which are connected with others nearly parallel to them in the interior of the earth. Whether we regard terrestrial magnetism as the effect or cause of the direction of electric currents, it cannot be doubted that these phenomena are in harmony with each other."

Georg Bose (1710–1761) tried to increase the strength of his static generator. His modified apparatus produced a discharge that flowed, wandered and flashed. This gave him the idea that the northern lights were an electrical current wandering across the sky.

Other philosophers turned their attention to the cause of lightning and electrical phenomena in the atmosphere. In 1758, the Swedish physicist Johan Wilcke noted that he had seen clouds crashing into each other. He believed the friction between the clouds produced lightning and this brought the pouring rain.

The electrician Martinus van Marum had the idea that rain deposited electric fluid onto the ground. Electrified clouds affected the electrical balance of all objects over which they floated.

Signier Giambatista Beccaria found that high winds produced no electrification. In clear skies with calm weather, he always perceived signs of electricity. His apparatus was always electrified before the rain fell. When the rain ended, there was little sign of electricity.

The higher his rods reached or his kites flew, the stronger the sign of electrification. He found that clouds bringing rain carry moderate electricity. He noted several instances where rain without lightning had signs of electricity. He found that the large thunderclouds passing directly over his apparatus were positively charged. When the cloud passed, the apparatus indicated negative electricity.

Beccaria formed the theory that electrical matter escaped from the earth and ascended to the higher regions of the air, collecting vapors as it rose. The more electricity collected, the greater the amount of rain in the clouds.

He also believed that hail formed when electrical matter ascended to the cold upper atmosphere. He believed that snow was made by the action of electricity. Snow as well as rain electrified his apparatus.

In the 1880s, Julius Elster and Hans Geitel began the modern study of atmospheric electricity. They found that the soil emits electric ions into the air. In good weather, the earth has a negative electrical charge, while the atmosphere is positive. Electrons stream skyward from the soil and plants. During storms, the polarity is reversed: the earth is positive and the base of the cloud layer is negative. At any given day, there are some 4,000 storms recharging the lost electricity of the earth.

Elster and Geitel believed that the ions carrying the current were due to radioactivity. They shielded a sample of air with lead but it still carried a current. In 1911, Victor Franz Hess of Vienna University took measuring equipment up to 16,000 feet in a balloon. To his surprise, the ionization increased as he went higher, which he later found was due to cosmic rays. He was awarded the Nobel Prize in 1936.

In 1920, Scottish physicist C.T.R. Wilson linked the pieces of the puzzle together. In fair weather the negative current of the earth was being neutralized by positive ions. During thunderstorms, lightning regenerated the earth's supply of electricity. The thunderstorms were like the cells of a battery.

Thunderstorms become most active during the afternoon hours of 3 to 8 p.m. The earth has the strongest electric charge at 7 p.m. at Greenwich, England. This is just after the peak of thunderstorms in Europe and Africa, but numerous thunderstorms are happening in North and South America.

Physicists tested the theory by having specially equipped B29 bombers fly over thunderstorms to measure the positive current. They calculated that the total current flow between the earth and the sky was 1800 amperes. To maintain this current, the earth had to have 3,600 thunderstorms over the whole earth.

A normal person has a difference of about 200 volts of static electricity between the head and the feet. The top of a high skyscraper might be 40,000 volts. From the soil to the ionosphere is a whopping 360,000 volts. There is tremendous electrical energy here, but harnessing it is difficult and uncertain.

On a high mountain peak, this becomes apparent. The U.S. Army Signal Service kept an observing station on Pikes Peak, Colorado. They published their observations in 1889. During storms, blinding flashes of fire often entered both rooms of the station from the lightning arrestors. On several occasions, the hair and whiskers of observers were electrified. On June 7, 1882, a bolt charged the telegraphy wire, and it could be seen in brilliant light with rose-white scintillations. When observers got near the wire, there were violet flames the size of lead pencils streaming out from the wire.

During one storm, the cups of the wind-measuring anemometer discharged vivid violet flames accompanied by a sound like a carriage wheel rolling through hard packed snow. When the observer put his hands near the cups, the fingers became tipped with painful flames.

We know that sunspots are great electrically charged plumes of particles smashing into the earth. They create the Northern and Southern lights. During times of active sunspots, tree rings are larger, wines are better, and plant growth is greater. Is this due to greater atmospheric electricity?

In 1843, Heinrich Schwabe plotted an average number of spots seen per year and came up with a cycle of about ten years. Other observers refined the data and came up with a period of 11.2 years. It was widely assumed that this cycle continued on throughout history.

E. Walter Maunder was the superintendent of the solar division of the Royal Greenwich Observatory in London. In 1894, he published a paper with the title: "A prolonged Sunspot Minimum." He researched the old records and found that during a 70-year period from 1645 to 1715, there were virtually no sunspots.

In China, sunspots were observed for centuries with the naked eye, because the skies were so dusty. The western world didn't know anything about them until Galileo observed them with his telescope. There were good observers after the time of Galileo, but they didn't see sunspots. César Cassini discovered the dark division of Saturn's rings, and Saturn was found to have five satellites. Isaac Newton made his first reflecting telescope, but hardly anyone was seeing sunspots.

The sun's speed of rotation is known by studying its spots. Johannes Hevelius charted the spots on the sun from 1642 to 1644 and found a remarkable change. The equator speeded up and completed one rotation a day faster than in 1625. Was this the reason for the lack of spots beginning in 1645?

During a period of 37 years, not a single aurora was recorded anywhere on earth. When one was seen in England in 1716, the astronomer Edmund Halley wrote a paper on the phenomenon.

As sunspots became normal, scientists didn't know what to make of the missing sunspot years. Perhaps people didn't bother to record them, they thought. When the effects of sunspots on tree rings was known, a search of tree rings showed that there had been a real change in solar activity. When the sun is active, the extended magnetic field protects the earth from cosmic rays, and less carbon 14 is formed. When there are few spots, more cosmic rays enter the lower atmosphere and more carbon 14 is formed.

During the period of time when the sun had few spots, the temperatures fell by about 1° C. Glaciers advanced and the Norse colony in southwestern Greenland died out. They were locked in with pack ice that didn't thaw. Scientists studying records of the past have found at least 12 times that the sun stopped its electrically charged flares, and each time, the temperature on earth fell. These times lasted from 50 to several hundred years, and substantial amounts of ice may build up at the pole.

One of the great effects on health is caused by negative electrical ions in the earth's atmosphere. Hills contain more negative ions than valleys, and the bases of clouds generally have a strong negative charge. Waterfalls have a great density of negative charges, which falls off rapidly with distance. Air brushing up against a metal surface becomes positively charged.

The dry desert winds brush against the sand to produce large amounts of positive ions. These reduce human breathing capacity by about 30%. The strong desert winds like the Sharav of Israel have large numbers of positive ions which produce headaches and nausea in many people

Negative ionization produces feelings of calmness and peace in people. They sleep better and feel better. It is good to have a negative ion generator where two different groups such as labor and management meet to discuss grievances. Rats perform better on tests and resist disease better when breathing more negative ions.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

Medical Electricity 16:11, 1972 "The Researches of Dr. Martinus Van Marum (1750–1837) on the Influence of Electricity on Animals and Plants" W.D. Hackmann

Nature 42

Scientific American 236: May/80, 1977 "The Case of the Missing Sunspots" J.A. Eddy

5. THE ELECTRIC EARTH

"The earth and all the bodies we are acquainted with are without exception supposed to contain a certain quantity of an exceedingly elastic and subtle fluid which philosophers have agreed to term electric. The moment any body becomes possessed of more or less than its natural quality, very remarkable effects arise from it. The body is said to be electrified and is capable of exhibiting appearances which are ascribed to the power of electricity."

History and Present State of Electricity Joseph Priestly 1767

"Electricity is a quality universally expanded in the matter we know and which influences the mechanism of the universe far more than we think."

Charles Dufay 1737

When William Gilbert wrote his famous book on magnetism, *De Magnete* (1600), he coined the word "electric" from the Greek word for amber. Magnetism attracted small particles, and so did an electrified body. They didn't attract the same substances which puzzled the philosophers. Michael Faraday finally provided the missing pieces of the puzzle by showing that electricity creates magnetism, and magnetism can create electricity.

Gilbert had carefully constructed a globe of magnetic material to show that it represented the earth on a small scale. If our earth is a spinning magnetic field, then it must generate electrical currents. Is the great current known as the "northern lights" a product of the spinning magnetic field? This is partly true.

Nature had magnetic stones, but there were "electric stones" known as amber. The world's best deposits of amber were found on the shores of the Baltic Sea and carried to the Mediterranean across the great river route of Europe. Amber had the radiance of gold; it was part of the bracelet of Penelope and the shield of Hercules.

Spinners knew the electrical qualities of amber in ancient time. Syrian woman called amber "harpega," meaning "clincher" because it grasped light threads. In the dry climate the spinners found that they could harness its electrical qualities for practical use.

The holy priesthood of the Jewish people began with Aaron, the brother of Moses. The official clothing of his office was a breastplate

consisting of 12 stones worn during sacred duty. The seventh stone was the ligurian stone. The meaning has long been debated, for this is the word for Lynx. The sacred stone was probably amber.

Three hundred years before the time of Christ, Theophrastus wrote a book on the minerals of Greece. *De Lapid* notes that the property of amber is possessed by the mineral tourmaline.

The old lore of tourmaline was forgotten until the mineralogist Johann Lehmann noticed that a small crystal of tourmaline drew ashes to itself when placed on a burning coal. This curious behavior was known to Dutch and German jewel traders when they imported the stones from Ceylon.

Linnaeus mentions this stone in his 1737 *Flora Zeylanica* under the name of "lapis electricus." When it is dropped into hot water, one end turns positive and the other end turns negative. It could also be rubbed to generate an electric charge. Dr. William Heberden introduced tourmaline to English scientists.

Franz Aepinus (1724–1802) found if he immersed a tourmaline in hot water, it changed the electric field. The crystal acquires a positive electrical charge on one face and a negative one on the opposite face. If a crystal were heated on a hot surface or by focused sunlight, the natural charges of the crystal were reversed. Æpinus viewed tourmaline and magnetized iron in the same way. He was able to show that each magnetic phenomenon had a parallel in the electric realm.

Johann Schweigger was another curious figure in the early history of electricity. He believed that the ancients knew of two kinds of electricity in antiquity, designated by the names of Castor and Pollux. The inner nature of electricity was contained in the hieroglyphic pictures of the Dioscurae. The two stars represented the two electricities. He gave lectures at Erlanger, Germany, on his theory that the smallest particles possess opposite charged poles. Electronegative substances have more negative electricity in their negative poles.

William Gilbert found that diamonds, sapphires, amethysts, opals, Bristol stones and beryl crystals would attract light bodies when rubbed. Robert Boyle (1627–1691) began to work on electrical minerals. He found that minerals produced more electricity if they were warmed before being rubbed. He found that his electrical minerals

would attract smoke very easily. He believed that the electrical bodies emitted a glutinous effluvium, which grabbed small bodies and carried them back to the crystal.

Andrew Crosse believed that electricity formed minerals. He claimed that he produced crystals of quartz, aragonite and malachite. He displayed samples of the crystals at meetings of the London Electrical Society. In 1836, Cross announced that he had produced artificial life by passing electricity through a silicate solution. Little bugs came crawling from the solution as a result of the current. Nobody else was able to replicate the experiment.

William Stukeley had the curious theory that earthquakes were probably caused by electricity. He noticed that during the London earthquake of 1749, there were small fireballs in the air with a sulfurous smell. The weather had been dry and warm which got the earth ready. The dryness of the earth didn't allow the electricity to drain off. Before the earthquake, all fruits, flowers and trees were blooming early. Electricity had quickened the vegetation!

Stukeley noticed that in the days after the earthquake, many people had pain in the back, arthritis and nervous headaches. The same things happened after electrification. Earthquakes were electric quakes!

There is a curious theory that the earth is crossed with electromagnetic fields generated with running water. In 1931, Hartmann, Schneider and Schweitzer developed ideas about the relations between electromagnetic fields emitted by running water in underground faults. The best device to detect these electromagnetic fields is the lecher antenna, a metal loop of about 20 centimeters, open at one end, with handles.

Many people in Europe believe that health problems are due to sleeping or living above electromagnetic faults. If you can locate them and shift position, you can improve your health. Dowsers are able to locate such faults.

In 1958, Dr. Hans Hansche gave a lecture: "Research carried out quite a number of years ago has shown that earth is checkered with electric poles, and that there is a continuous energy exchange between heaven and earth. Many trees have been discovered that try to avoid

negative radiation fields and therefore grow elsewhere, or if they cannot do so, fail to thrive, or become completely deformed. If space has an electric field, it must follow that humans have one too. The eternal dream has been to make this aura visible."

The normal electric field of the earth may keep the direct current system of the body in bounds. After a cosmic ray decrease, more people come to psychiatric hospitals. There are disruptions in behavior with a change in the earth's electric field.

In 1844, the first commercial telegraph system was put into operation between New York and Washington D.C. The telegraph operators quickly discovered that other signals were traveling along the telegraph lines. The currents were strongest during displays of the northern lights and when compasses became erratic. During a big storm in 1859, it was impossible to send telegrams for seven days. At other times, operators could send messages without using batteries.

In 1922, the Carnegie Institute of Washington began systematically measuring the earth's currents. It was found that earth currents of all of the continents varied together. Electrical storms generally had a 27-day period, which is related to the rotation of the sun. When there were more sunspots, there were greater earth currents.

A study at Tucson, Arizona, showed that the weakest earth currents were about an hour before midnight. The electric flow was towards the southeast at midnight, but it veered eastward at 2 a.m. By 5 a.m. the flow was going northward, and the electrical current was strongest at 8 p.m.

Rutger Wever experimented boldly: he isolated people in underground caves from all clues to the passage of time, with constant temperature, light and sound. His subjects developed irregular body rhythms. Wever found that an electrical field of 0.025 volts per centimeter pulsing at 10 hertz dramatically restored persons to normal biological measurements. Ten hertz is close to the dominant alpha frequency of the brain in all animals. The weak electric field restored normal circadian rhythms. It may have been the frequency in Precambrian times when life evolved in the shallow seas.

In 1851, the German chemist Christian Friedrich Schönbein read a paper before the Royal Medical and Chirurgical Society. He showed

that a stroke of lightning forms nitric acid and also provides the deodorizing and oxidizing agent ozone. An engineer who was struck by lightning while camping on a mountain identified the smell of ozone as the same as Schönbein's artificially produced smell. We know that nitrous acid is the building block of proteins and is necessary to the nutrition of plants.

Life on earth may have started as a result of electricity. In 1953, Dr. Harold Urey and his graduate student Stanley Miller placed ammonia, methane, hydrogen and water in a jar without oxygen. Sparks went through the strange atmosphere, and amino acids were formed. A lightning flash might have been the beginning of earth's spark of life.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

Acupuncture and Electrotherapeutics Research International 20:284, 1995 "Local Electromagnetic Fields Influencing Health and Diseases" A. de Smul

Annals of Electricity 1:133, 1836 "Experiments Illustrative of the Influence of Voltaic Electricity on Copper Pyrites" R. Fox

Annals of Electricity 2:54, 136, 1838 "On the Formation of Mineral Veins" R. Fox

Isis 62:328, 1971 "J.S.C. Schweigger: His Romanticism and His Crystal Electrical Theory of Matter" H.A.M. Snelders

Isis 67:21, 1976 "Æpinus, the Tourmaline Crystal and the Theory of Electricity and Magnetism" R.W. Home

Wever, Rutger *The Circadian System of Man: Results of Experiments Under Temporal Isolation* New York: Springer-Verlag, 1979

6. ELECTRIC PEOPLE

"O Socrates, I used to be told, before I knew you, that you were always doubting yourself and making others doubt. Now you are casting your spells over me, and I am simply being bewitched and enchanted, and am at my wits end. If I venture to make a jest upon you, you seem both in your appearance and in your power over others to be like a torpedo fish, who torpifies those who come near him and touch him—as you have now torpified me."

Meno Plato

"Disease is a deviation from the state of health, implying some alteration in the functions, properties or structure of some organ or tissue and may be generally described as an abnormal performance of the processes constituting life. That being so, it would be illogical to imagine that one of the most delicate and most necessary of those processes, *i.e.,* the maintenance and regulation of the neuro-electrical system, could proceed without deviation in any disease area."

Studies in Electro-Physiology Arthur E. Baines 1918

A number of people have exhibited unusual electrical properties. Theodore Beza could be seen at night by the light from his eyebrows. Sparks would flash from the body of Charles Gonzago. In the early days of Jamestown, Virginia, sparks could be seen coming from the clothing of Mrs. Susanna Sewall.

Robert Boyle, one of the greatest early English scientists, investigated a woman whose hair locks persisted in sticking to her cheeks. He suspected a trick, but it was apparently static electricity. Another woman had the same problem when the weather was cold and frosty.

In 1846, a 14-year old French peasant girl displayed remarkable electrical phenomena for ten weeks. Her bewildered parents brought her to Paris where many scientists observed her powers. Pith balls or feathers hung from silk threads would be attracted or repelled by her electrical fields. At times the force was so great a 60-pound table would move if her apron merely touched it. The girl was afraid of the strange manifestations of her power.

An infant born in 1869 at St. Urbain, France, was charged like a Leyden jar. Nobody could touch him without receiving a shock. When he died after nine months, a luminous radiance appeared around his body, remaining visible for some time.

In 1895, a 14-year-old Missouri girl seemed to turn into an electrical generator. When she touched metal objects, her fingers gave off powerful sparks. When a doctor attempted to examine her, he was knocked unconscious for several seconds. Her electrical abilities eventually diminished and vanished by the time she was 20.

In 1920, a group of 34 convicts at Clinton Prison in New York were stricken with botulinum poisoning after eating canned salmon. Most of these men developed peculiar electrical powers. One man tried to crumple up a piece of paper and throw it into a basket, but it wouldn't leave his hand. A compass needle would rotate when it was near the convicts. As they got better, they lost their power.

During fair weather, natural electric current passes from the feet to the head. This minute current might be necessary to our health, but there are no studies on it. In 1922, George Quarrie published his ideas on the importance of this current. (Later, this topic is discussed related to the treatment of depression.)

There were mansions in Scotland with large lawns kept mown by horses, but the horses couldn't work more than several days in a row. They were always shod with leather or rubber shoes to prevent damage to the lawn. Quarrie believed that the insulation over the feet damaged the eyes more than a week of work.

He showed with a galvanometer that when the soles of the feet are connected to the earth, a current flows. He believed that we damage our health by wearing insulating shoes, and the feet get sore very quickly from wearing these shoes. If a metallic connection were added to the shoes, the feet would quickly feel normal.

Quarrie asked his readers to put 3-4 thickness of paper in their shoes, because that was a good insulator. In about four days, the feet would become painful and the eyes would be inflamed and sore. If your shoes are properly grounded, your eyes won't get sore, your feet will be healthy, and you won't get pain in your teeth!

The galvanometer is used to measure electric currents. In 1904, Erich Konrad Muller reported to the Swiss Society of Natural Sciences that he was able to discover the emotional content of words with a galvanometer. The report eventually got to the Swiss psychoanalyst Carl Jung who began to work with it. A list of words was read to a patient who reacted strongly to the words burn and pay. It happened

that his stove had overheated and ruined the floor. His paycheck wasn't enough to cover the damage, and he was concerned.

When we blush with emotion, the blood vessels dilate and skin flushes mildly red. Emotions are always influencing our electrical conductivity. The electrical resistance of the skin changes with slight changes in emotion.

Psychologists worked with this tool in the first decades of the 20th century. It was of real interest, but it did not seem to be of great use in treating disturbed persons. A simple type of galvanometer known as the "E meter" became a part of the teachings of Scientology. Founder L. Ron Hubbard believed that by focusing on words and situations with electrical disturbances, he would "clear" the mind. This became a kind of electrical scientific confession of "sins."

Arthur Baines made the most interesting studies of the body's current. He had patients hold silver electrodes in each hand. The patient was grounded first, then the deflection was measured from hand-to-hand. A strong hand-to-hand deflection indicated good health. With the old type of equipment he was using, he obtained a good hand-to-hand reading of 250 mm. in health. A weak defection corresponded with mental depression.

A 59-year-old man had a hand-to-hand deflection of 70 mm. He had many financial worries and was suing to try to get his money back. A cell with the negative current was connected to his spine and a one-millivolt current was run to his abdomen. After ten minutes, the hand-to-hand defection was 189 negative. Then the connections were reversed, and the hand-to-hand deflection became 260 positive. The patient felt better and was much more cheerful.

A woman used a large ear trumpet in order to hear. Her hand-to-hand deflection was only 25 mm. After using a weak continuous current to raise her hand-to-hand deflection, her hearing was immediately restored. The hearing continued to be normal.

Baines found that strong healthy active people have a positive deflection, and that people with a negative deflection are inclined to be lacking in determination. Most cases could be improved by means of a low continuous current applied by a belt around the middle.

Baines found that epileptic attacks were due to excessive electrical pressure in the brain. If hot salt water was applied to the head during the beginning, it would prevent the attack by allowing the electricity to escape. If a small silver plate was fastened to the area and connected to the midbody, it would allow the electricity to escape and there would be no further attacks.

One patient had fairly frequent epileptic attacks, which gradually got worse. He seemed dazed with his twisted right hand, and left hand clutching the breast. The bromides were stopped and a wire attached to drain off the nerve current. In the next five days, there were only two fits and his general intelligence improved.

Baines experimented with a carbon rod, which was the central part of a battery. He found that when people held the carbon rod in the right hand it produced an off-scale positive deflection; this was reversed when held in the left hand. He found that a rod magnet had exactly opposite effects. When it was held in the left hand, it produced strong positive deflections. By using these tools, he could restore the healthy positive electrical deflections.

Baines was measuring the microamperes between the right and left hands with an old style galvanometer, which used a mirror and light beam for extreme sensitivity.

I got a circular magnet and a hard carbon rod and gave them to an electrical engineer. He found that the silver electrodes holding either the magnet or the carbon rod generated a weak electrical current. Neither the magnet nor the carbon rods have a mystery effect —they are generating a weak electric current across the body. When people ceased to hold the magnet or the rod, there was no increased force. He did find a difference between people in the microamperage across the body. The experiments raise a question: would a weak electrical current across the upper chest increase the vitality and health of people?

Dr. Harold Saxton Burr (1889–1973) believed that electric fields were the organizers of life. He made a new type of voltmeter, which drew no current. He found that the precise moment of a woman's ovulation could be measured by the changes in her electric fields. He found that cancers could be detected in organs before any clinical signs were observed. He could locate the position of a chick's head in the egg during the first day of its incubation. He found that strong electric fields around seeds predicted good strong plants.

Leonard J. Ravitz Jr. measured the depth of hypnosis with the technique. He concluded that all humans are in hypnotic states most of the time. He found that the electrical organizing fields anticipate physical events around us and affect the mind.

Amphibians contain a sort of skin battery. Their skin is negative by 40-80 millivolts in relationship to their insides. This forms a regenerating current in salamanders. Frogs don't regenerate lost limbs, but when a negative electrode was hooked up to one, the limb began to regenerate. If the current was reversed, the stump was damaged and there was no regeneration.

The regenerating limbs depend on the sodium ion channels of the skin, and if the animals receive a sodium channel blocker drug, the limbs don't regenerate. Pure water means little electrical conductivity, but a little salt added to the water increases the rate of conductivity. The electrical pattern creates the pattern of the lost limb and determines the migration of the healing cells.

When the limb of a frog is removed, there is a positive electrical potential for the first three days and the stump doesn't regenerate. When a salamander has an injured limb, it develops a positive potential for the first three days, and then it develops a strong negative potential in the limb. The leg regenerates, which is of great scientific interest.

How does a clam get a shell or how does a coral organism surround itself with a rocky home? It appears that calcium deposition is electrochemical in nature. A weak electric current generated by the living cells deposits the calcium from the seawater.

The process has attracted a fair amount of commercial interest in building undersea structures. A wire mesh outline of the structure is made. Then a weak electric current is applied. Calcium carbonate begins to build up, and as long as the weak current continues, the structure keeps getting thicker.

If you suck on a lemon and then examine your teeth under a microscope you will find tiny pits. If you wait a few days and then re-examine them, the pits are gone. Several researchers worked on remineralizing solutions for the teeth. If cavities started to form in the early stages, prolonged use of remineralizing solutions and electrical current could fill them in without help from the dentist.

A measurement of eight human subjects showed that the surfaces of the teeth were 10-37 millivolts positive in comparison to the lip. The potentials were higher in the upper incisors and less in the lower incisors, and lower in the premolars and molars. Teeth that were badly decayed or dead had small or even zero potentials.

Rat incisors grow very rapidly with a well-developed capillary bed. Human teeth are supplied with blood vessels on the inside. If the teeth are not growing, what is the purpose of a good blood supply? Perhaps the blood is charging the teeth to become positive in relationship to the structures around them. By being weakly positive, electricity is acting as an electroplating mechanism. The surface is slightly alkaline. The calcium in the saliva is being electrically deposited on the damaged area of the teeth!

The implications of electrical calcium deposits are also apparent in arteriosclerosis. Calcium salts and cholesterol deposits on the artery walls. This is a real puzzle. Is diet affecting the electro-deposition? Could we use electricity to remove the arteriosclerosis? We do not have an answer to these mysteries at present.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

Annals of the New York Academy of Science 238:202, 1974 "Potentials and Calcification in Mammalian Teeth and Arteries: An Electrochemical Basis" P.S.B. Digby

British Journal of Radiology 3:128, 1930 "The Electric Field of the Human Body" W.E. Boyd

British Medical Journal 2:804, 1907 "The Galvanometer as a Measurer of Emotions" F. Peterson

Journal of the American Medical Association 50:1164, 1908 "Detection of the Emotions by the Galvanometer" E.W. Scripture

Medical Press and Circular 105:68, 1918 "The Interpretation of Certain Electro-Physiological Phenomena" A.E. Baines

New York Medical Journal 56:44, 1922 "An Electrical Novelty, Natural Electricity and Physiology" G. Quarrie

Practitioner 92:831, 1914 "Neuro-Electricity" J.H. Wilson

Baines, Arthur E. *Electro-Pathology and Therapeutics* London, 1914

Becker, Robert O. *Cross Currents* Los Angeles: Jeremy P. Tarcher 1990

7. MAGNETIC PEOPLE

"Tomorrow we shall arrive at a mountain of black stone called lodestone. The current is now bearing us towards it and the ships will fall into pieces and every nail in them will fly to the mountain and adhere to it. God has given to the lodestone a secret property by virtue of which everything of iron is attracted towards it. On that mountain is such a quantity of iron, as no one knows but God, whose name be exalted. Great numbers of ships have been destroyed by the influence of that mountain."

Arabian Nights

"As I was saying, this is not an art in you, whereby you speak well on Homer, but a divine power. This moves you like the stone which Euripides named Magnetis, but most people call Heraclea. This stone not only attracts iron rings but also imparts to them a power whereby they are able to do the very same thing as the stone and attract other rings. Sometimes there is formed quite a long chain of bits of iron rings, suspended one from another. They all depend for this power on that one stone."

Ion Plato

The word magnet comes from the city of Magnesia in Asia Minor. There is an old story of a shepherd who found that the iron nails of his shoes were pulled out. This story became legendary; it was said that ships passing near iron-rich mountains found their nails pulled, so they were wrecked.

The Chinese may have had the first magnetic compass, but their descriptions of it are poor. In +1242, Bailak Kibdjaki wrote about the first Arab compass, "The captains navigate the Syrian sea, when the night is so obscure that they cannot perceive any star to direct them according to the determination of the four cardinal points. So they take a vessel of water, which they place sheltered from the wind within the ship. They then enclose a needle in a piece of wood or a reed in the shape of a cross. They put it in water contained in the vase, so it floats."

Magnets were the subject of great mystery in medieval times. Sailors believed that garlic would destroy their power, so they didn't eat garlic. They also believed a magnet had no power in the presence of a diamond. Burglars carried magnets to help them pull in the treasure. Magnets carried in clothing were believed to cure cramps and gout.

They were supposed to draw the poison from wounds, prevent baldness, cure headache and facilitate childbirth.

The magnetic properties of iron led to great speculation in medicine. Pliny believed that iron stopped bleeding. It was an effective healer in shingles and St. Anthony's fire. Ætius, a physician of emperor Justinian I (527–565) wrote: "We are assured that those who are troubled with the gout in their hands or feet find relief when they hold a magnet in their hand."

D.S. Parasnis wrote: "Many strange and curious properties have been attributed throughout ancient times and the Middle Ages to the magnet. It was supposed to give comfort and grace, to be of value in disputes and to cure dropsy, hemorrhage, toothache and many other disorders and diseases. The magnet was also supposed to reconcile husbands to their wives. The belief in the supernatural properties of the magnet continued, in fact, down to the end of the last century."

William Gilbert made the mystery of the earth's magnetism seem simple with his scientific demonstration in *De Magnete* (1600). His work was one of the first real works of science. He also made an electroscope that pointed towards a charged source.

Several people have exhibited some strange magnetic properties. In 1879, a 19-year-old girl in Ontario was recovering from an unknown illness. She developed electrical discharges and also became an electromagnet since any metal objects she picked up would adhere to her open hand.

In 1888, a 16-year-old boy came to the attention of scientists in Maryland. He could suspend iron rods from his finger tips. He could lift a container filled with iron filings merely by pressing three fingers against the side of the container.

The Spanish priest Eusebius Nierembergius (1595–1658) believed that man was magnetic. If a person were placed in a boat on a still pond, the person would finally come to rest with his or her head facing north. Nierembergius noted that Jews buried the dead with the head placed to the north, while Christians buried the dead unnaturally.

Jacques-Arsène d'Arsonval (1851–1940) was one of the first people to observe magnetically stimulated phosphenes in 1896. He

put his head into a coil carrying 30 amperes of current at 110 volts and 42 hertz. It gave him such vertigo that he nearly fainted. With a smaller coil he saw phosphenes and experienced muscular contractions as well.

In 1910, Sylvanus Thompson headed the British Institution of Electrical Engineers. He independently discovered this same phenomenon and coined the word magnetophosphenes. He had a coil of 32 turns of thick copper wire wound around an eight-inch diameter circle. When he stuck his head into the high magnetic field, the flickering phosphenes were visible even in daylight. Several subjects noticed a strange taste after being in the field for 2-3 minutes.

Phosphene flickers were best perceived when the eyes were closed or the room darkened. When 480 amperes of current flowed through the coil nearly everyone could see a 25-hertz flicker. Below 15 hertz, flickers were seen as a series of flashes. At 20-35 hertz, light had a quivering flickering effect. Above 40 hertz, the light is more uniform and the flicker is rapid.

Two blind subjects were tested in the changing magnetic field. One was able to see phosphenes without persistent after-images. This had no benefit for lost vision.

Knight Dunlap believed that the phosphenes reported by Thompson might be due to suggestion caused by the loud hum. He eliminated the hum, but all his subjects still reported flickering. When the frequency was reduced to 25 hertz, the whole visual field appeared illuminated. The flickering could still be perceived with the head below the coil.

There was an early attempt to cure blindness with electrically generated phosphenes. Charles LeRoy was a distinguished French chemist and doctor who in 1755 discharged a Leyden jar through the head of a blind man and discovered phosphenes. He had a 21-year-old patient who became blind after a high fever. His parents took him to Doctor Leroy and implored him to shock their son. They had read an article about a 7-year-old boy cured of blindness by electric shock. A brass wire was attached to the patient's head and feet, 12 shocks were given from a charged Leyden jar. The young man could see flames descending rapidly before his eyes, but he remained blind.

Until 1820, magnetism and electricity were regarded as separate things. Hans Christian Oersted proved they were related, when he observed that a wire carrying an electric current deflected a suspended magnetic needle.

A strong magnetic pulse would produce an electrical pulse in the body. Since the pulse is not passing through metal coils as in a generator, the effect is weak. In 1964, Reginald G. Bickford and Bertil Frenning were able to produce a twitch in the muscles of frogs and rabbits by stimulating the sciatic nerve with a pulsed magnetic field. When they used the same techniques in volunteers. they obtained a twitch in muscles.

Magnetic stimulation produces the same effect as electrical stimulation. It begins a current resulting in depolarization and initiation of a nerve potential. The work goes back to Michael Faraday's experiments in 1831, when he found an induced current flowing in a secondary circuit.

A group of scientists in Sheffield, England, began to work on a magnetic stimulator. They made a unit, which had from 400 to 3,000 volts with a pulse lasting for a few milliseconds. A small magnetic coil would only stimulate the surface of the body, but a large coil would send a pulse deep inside the body.

The magnetic stimulator consisted of a pulse generator producing a discharge current of 5,000 amperes with a magnetic field strength of 1 tesla or more. The power output for a fraction of a second was five million watts. The great surge of power lasts only a thousandth of a second.

The pulsing magnetic field can be used on bruising that follows some types of surgery. It gives relief in peptic ulcers and there is marked relief in sprained shoulders and swollen joints. The treatment is useful in neuralgia, headache, muscular rheumatism, gout, angina pectoris and hyperesthesia of the gastrointestinal tract. There is no mechanical contact, and the patient doesn't have to undress.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

Journal of Clinical Neurophysiology 8:3, 1991 "History of Magnetic Stimulation of the Nervous System" L.A. Geddes

Journal of Clinical Neurophysiology 8:10, 1991 "Technical and Practical Aspects of Magnetic Nerve Stimulation" R. Jalinous

Journal of Clinical Neurophysiology 8:26, 1991 "An Introduction to the Basic Principles of Magnetic Nerve Stimulation" A.T. Barker

New Scientist 70:166, 1976 "Healing by Electromagnetism—Fact or Fiction" R. Bentall

Optometry and Vision Science 68:427, 1991 "Magnetostimulation of Vision: Direct Noninvasive Stimulation of the Retina and the Visual Brain" E. Marg

Philosophical Magazine 28:188, 1914 "Visual Sensations Caused by a Magnetic Field" C.E. Magnusson

Park, Benjamin *A History of Electricity* New York: John Wiley, 1898

8. STATIC ELECTRICITY

"Moreover a few weeks of static treatment scatters many of the little troubles of life that are not definite diseases. It is so comforting to mental and physical ills that have no medical name; it can tide us over so many emergencies that would otherwise leave the marks of age upon us. It can so marvelously conquer pain; it can bring such instant strength and rest to weary feet and aching backs that faint under burdens, it will quickly make light. It is so competent, so practical and so decisive when it is indicated that its effects must inspire the admiration of every beholder even as they command the grateful admiration of every beholder. They command the grateful affection of all who have rejoiced in the blessed benefits of this matchless handmaid of the physician."

Samuel Howard Monell (1857–1918)

The first unrecorded displays of static electricity resulted from petting a cat or stroking a wool garment. Thales of Miletus was one of the seven wise men of ancient Greece. Around -560, he discovered that amber, rubbed with a dry cloth, attracts light bodies to it. He believed that amber possessed a soul and was nourished by substances which it attracted to itself.

Otto von Guericke developed the first static generator in 1672. He was trying to disprove William Gilbert's ideas about the earth as a magnet, and he didn't care about the generation of static electricity. The discovery was not of practical value and was little known.

In 1675 Sir Isaac Newton found that when he rubbed a telescope lens with cloth, it would attract bits of paper which would stick after the rubbing ceased. The best results were obtained with a scrub brush of short hog's bristles.

Stephen Gray found that he could convey an electric current over a distance with a wet hemp string in 1729. Then he hung a 700-foot line on loops of silk and found that the electricity would pass the whole distance. This was the first experiment to introduce the idea of conductors and nonconductors. In 174,7 William Watson extended the distance of a Leyden jar shock four miles in order to prove the velocity of its transmission.

In 1742, a static machine was made from a glass cylinder, and it generated enough electricity to produce visible sparks. This was followed by the glass plate machine of Jesse Ramsden in 1768, which became the model for medical static generators. In 1784, John Cuthbertson constructed the first powerful static generator.

Around 1745, two men independently invented the electric condenser in Leyden, Holland. Petrus van Musschenbroeck was trying to electrify water. Ewald von Kleist knew that frictional machines generated electricity, and thought that he could store it in a glass bottle full of water. He took a bottle with a cork and pounded a nail through it, penetrating into the water. He turned on the static machine for a few minutes, then touched the nail and received a terrific shock. The water was then replaced by tin foil surfaces on the inside and outside of the jar.

The Holtz static machine of 1865 had 16 revolving plates and 16 stationary ones but no direct connection between the revolving and stationary plates. The machine has. It produced a static current of extremely high voltage and low amperage. The Toepler-Holtz model would charge and hold a charge under conditions where the Holtz model would go dead.

The static machines were fickle and would occasionally change polarity in the terminals. A round piece of dry pinewood was used to test for polarity by holding it at right angles to the output terminal balls. Positive current would follow the wood, but negative current wouldn't.

The positive pole of static electricity was soothing and quieting. The negative pole was stimulating or irritating. Static sparks were used on chronic conditions where strong stimulation was desired. They were used for only a short time, because patients didn't enjoy the sensation. The static director was a brass rod with a vulcanite handle. The end was applied directly to the patient's skin and caused red spots to appear, which lasted for hours.

Static electrical treatments were usually given as a brush discharge. The best discharge applicator was shaped like a pencil and tipped with sharp brass points. When the static generator was turned on high, the electrical current felt like a spray of hot sand.

The static baths charged the patient and caused a peculiar sensation all over the body. The treatment was sedative, but it had no specific effects. A strong static charge could make the patient's hair stand on end. People often fell asleep after a static bath.

The static wave current exercised the cells. It decongested the tissues rapidly and thoroughly. Flabby muscles became firm and active under its use. The currents gave remarkable help for underdeveloped youngsters. Tired workers became more active under static treatment.

A static current applied to the liver and gallbladder causes a flow of bile into the intestinal tract and stimulates it. When the static current energizes the liver, the brain becomes more active. The brain is the negative terminal of the body and the liver is the positive terminal, according to the theory of George Crile.

A seven-week-old baby suffered from acute diarrhea; medical help didn't work. The mother held her child on the static platform and received ten minutes of positive static spray. When she returned home, the child slept three hours, and the diarrhea ceased. The baby took more treatments and continued to get better.

An 18-month-old child was very sickly and thin, and the mother believed that her child would soon die. She gave it three static treatments a week, with cod liver oil. Soon the child became active and healthy.

The static wave current would often give prompt relief from pain when heroin or morphine wouldn't give relief. Normal Titus studied the treatment of 662 cases of sciatica with the static current. He found that the current almost always relieved pain.

A man smoked a dozen cigars a day and got cancer of the tongue. His brother had his tongue removed, and he died in misery, unable to speak. This man refused an operation, but the pain got worse, and cocaine no longer gave him relief. He suffered greatly for six months.

The static spray was tried without any promises. The first treatment removed most of the pain and soreness of his neck. The second treatment gave him some power of speech, and he was able to sleep three hours without whiskey or cocaine. The tumor shrank but was not cured and he had no pain. He felt so much better that he continued to take treatments several times a week until his death.

The static current was very useful in treating a hoarse voice. A man had acute laryngitis and could hardly talk above a whisper. He was treated with interrupted static current which restored his normal voice. Two weeks later he lost his voice, but it was restored after a static treatment.

Tuberculosis patients often have to struggle for breath and breathe very rapidly. When the static wave current was applied over the chest, the breath rate dropped markedly. A 30-minute treatment enables the patient to heal and absorb more oxygen.

A 36-year-old woman had a cough and bronchitis for five years and was gradually getting worse. Her health failed, and she could hardly walk across the room. She had to sleep in an upright position. She was constantly coughing and her throat was always irritated. Many doctors tried to treat her, without results.

Sparks were administered up and down her spine, and the static spray given to her back, leg and chest. She was treated every other day for four weeks. There was a remarkable improvement in all symptoms and the soreness of her chest nearly disappeared. She was able to sleep nearly all night and do general housework.

Another woman suffered from bronchitis; when she got up she had intense diffused pain over a large area of her side. She was placed on the static platform and connected to the positive pole with the negative pole grounded. Her spine was given needle sparks. After the first treatment, she was able to draw a full breath without pain. It took a week of static treatments to reduce her cough.

A large static machine could produce strong contractions. The patient begins the treatment when an electrode is placed on the abdomen and another on the back. When the voltage is raised, there is a feeling of terrific compression.

Fluid in the joints and tissues is easily removed with the static current. Static brush discharges keep down the swelling from injuries. When bursitis is combined with diathermy, it yields quickly to static brush discharge.

Myosis [excessive contraction of the pupils] is an eye condition that yields to the static current. Infrared or visible light was shone on the area, and then the static current was used to heal it.

David Yates treated some cases of deafness with static electricity. He would put the patient on an insulated platform and hold the negative pole against the deaf ear. The positive pole was held in the hand. If possible, he gave the patient two 30-minute treatments a day at first. In order to prevent sparking in the ears, cotton soaked in salt water was inserted into the ear. Some catarrheal cases showed remarkable improvement after a few weeks of treatment, while others had only slight improvement.

William Snow treated a 15-year-old boy with symptoms of fever, vomiting and pain in the back and legs. He was unable to walk in the morning and became completely paralyzed during the next 48 hours. Polio had caused his paralysis, and the boy was nearly helpless.

A Morton wave static current was applied to his spine, and sparks were applied to the entire surface of his body. Each day he was given a 40-minute treatment all over the spine. For the first two weeks, the treatments were daily, and then every other day. After the sixth treatment, he was able to walk about 30 feet. He continued to improve steadily, but his left hand and arm didn't fully respond.

When Bell's palsy paralyzed the face, Snow used diathermy on the patient for a day or two. Then he treated the paralysis of the face with the static wave current. In most cases palsy would cease.

Static treatments could stop a cold in its early stages. A woman began to catch cold and lay awake with nausea, headache and chills. She was put on a static platform with the negative pole grounded. After five minutes of treatment with the positive pole, her symptoms began to disappear.

The Morton wave current was a static pulsed current. It was used for sciatica, lumbago, nephritis, chronic arthritis and prostatitis. The current directed to the patient is always positive. The spark gap was adjusted to give the desired voltage.

Static currents were used in all pains and injuries. A woman had enlarged joints in her hands and ankles and walked with difficulty. She took three static treatments a week, her pain was relieved and nearly all her joints were reduced.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

Archives of Physical Therapy 8:229, 1927 "Static Electricity" N.E. Titus
Clinical Medicine 34:664, 1927 "The History and Therapeutics of Static Electricity" W.B. Snow
International Clinics 42:#3/63, 1932 "Static Electricity" N.E. Titus
Journal of Electrotherapeutics and Radiology 34:129, 1916 "Report of the Committee on Static Electricity" F.B. Granger
Physical Therapeutics 48:493, 1930 "Physical Therapy With Special Reference to Static Electricity" M.W. Kapp
Physical Therapeutics 50:1, 1932 "Physical and Physiological Actions and Therapeutics of Static Electricity" C.R. Brooke
Therapeutic Gazette 12:523, 1896 "Therapeutics of Static Electricity" E.J. Nickerson
Hambrecht, F. Terry *Functional Electrical Stimulation* New York: M. Dekker, 1977
Sampson, C.M. *Physiotherapy Technic —A Manual of Applied Physics* St. Louis: C.V. Mosby Company, 1923
Snow, William B. *A Manual of Electro-static Modes of Application* A.B. Chatterton and Co., 1903

9. THE FIRST ELECTRIC DOCTORS

"First let not the shock be too violent; rather let several small shocks be given. Secondly, do not give a shock to the whole body when only a particular part is affected. If it be given to the part affected only, little harm can follow even from a violent shock. For instance, in a palsy of the tongue, the shock may be given to the tongue only by applying one wire to the hinder part of the neck, and another to the tongue. And if in any case there be danger of too great a shock, it may easily be prevented."

The Desiratum John Wesley

"The master of technique secures his results with ease, while the unskilled owner of even the finest apparatus labors in vain to secure them. He does not know how, and he soon doubts their possibility. Like the blindfolded traveler taken to a hill top in a strange country and told to delight himself with the beauties of the landscape around him, so the average physician stares at the terra-incognita of scientific electro-therapeutics with the bandages of ignorance upon his eyes and sees nothing of all that research has made plain. To him electricity is electricity and nothing more."

Elements of Correct Technique Samuel Monell 1900

The first good static generator was invented in 1742, and the Leyden jar followed it in 1745. It is no surprise that the first case of electrical healing came along in 1748. Jean Jallabert was a professor of physics at Geneva, Switzerland. A locksmith had a stroke, leaving him with a paralyzed hand and only able to walk with a cane. Jallabert connected the paralyzed foot to a Leyden jar and drew sparks from the motionless hand. The sparks made his body tingle. The locksmith could flex his thumb a few days later, and in about ten weeks was able to return to work.

This case came to the attention of Jean-Antoine Nollet who got permission from the chief doctor at the Hotel des Invalides to electrify three paralyzed patients for weeks—but none improved. Nollet electrified cats and pigeons and found that they lost weight as a result. He was unable to find an increase in their pulse rates.

Abbé Pierre Bertholon believed that he could use electric shocks to cure malaria. The shocks had to be administered immediately before the expected return of the malaria attack. Several doctors found they could cure malaria with carefully timed electrical shocks.

Dr. Maddock wrote in the late 1800s: "In my experience I know of no more valuable feature of static electricity than its power to help eliminate malarious conditions from the system. Scientists have universally admitted that in malarial districts, the air is electrified negatively. Following this out, I reasoned that owing to the greater conductivity of the air, due to moisture, people residing in paludal districts were deprived of an adequate supply of positive electricity. Acting upon this, I have for years employed the static machine by positive insulation in every case of suspected malarial origin and the results have surprised myself."

When a person has a malaria attack, millions of parasites in the blood all divide and change forms in minutes. The patient develops a high fever and is severely ill. These attacks are so regular that the person knows within minutes when the next attack will come. Several southern planters found they could cure malaria by bathing in cold water immediately before the next attacks were due. The attack didn't happen, and they repeated the cold bath two days later and permanently disrupted the cycle of the parasites.

I conclude that malarial parasites have some sensitivity to the external environment of their host. The parasites reacted to the changes in the body brought on by electrical shocks by not dividing. When this was carried out for the next few expected attacks, the cycle of the parasites was broken, and the body disposed of them.

Other early reports exist. Dr. Friske directed shocks through the abdomen to kill tapeworms. In 1798, Dr. T. Gale used static electricity on convalescent yellow fever patients. Electricity was also used for impotence in men, and soon they appeared young and lusty.

John Wesley was born into a large family in Epworth, England. When he was three, his father was imprisoned for debt. At the age of six, he narrowly escaped being burned to death and was rescued a few minutes before the roof fell in. He became a missionary to America and then returned to England. He found that the Church of England didn't meet his spiritual needs, so he founded the Methodist Church. The people who came to his meetings were often poor and in need of medical help.

Wesley started a fund to provide the poor with clothing, and in 1746, opened a dispensary in London to practice medicine. The clinic was very successful and soon was crowded with patients. He wrote a book on medicine, *Primitive Physic* (1747), and in 1758 he published *Advice With Respect to Health*.

He developed an intense interest in electricity, which he regarded as the source of life. He tried applying sparks from a generator to a dark spot on the eye caused by a blow three days before. The spot disappeared in about 15 minutes. He applied sparks to the toe of a man who experienced chronic pain for some eight years, and the pain left.

In 1765 Wesley had a bad accident when his horse reared and fell on his leg. He was badly bruised in the right arm, breast, knee and ankle, which swelled greatly. He was electrified morning and night, and the lameness slowly healed.

Wesley recorded in his journal in 1773 that he had pains in his left side and shoulder. He had fibrosis with an inflamed throat six days earlier. He wrote: "I could scarcely lift my hand to my head, but after being electrified, I was so much better that I preached with tolerable ease in the evening."

Wesley was stricken with bronchitis, which didn't clear up. In 1783 he tried electricity on himself at the age of 80. "Finding still some remains of the fever with a load and tightness across my breast and a continual tendency to the cramp, I procured a friend to electrify me thoroughly, both through the legs and the breast several times in the day. God so blessed this that I had no more fever or cramp and no more load or tightness across my breast. In the evening, I ventured to preach three quarters of an hour and found no ill effect at all."

He published a book on healing with electricity and described many cases. Mr. Greenfield was reported to be dying of gout of the stomach, which was probably angina pectoris. After he was electrified through the breast and the violent symptoms immediately ceased, he fell into deep sleep. A man affected for weeks with constant headache was twice electrified with a few light shocks and was entirely cured.

Wesley mentions a long list of disorders which he cured by electricity. It cured St. Anthony's fire, blindness, burns, coldness in the feet, *etc*. At the end of the list he remarked: "The best method is to

give 50 or even 100 small shocks each time, but let them be so gentle as not to terrify the patient in the least. Drawing sparks removes the furrows on the eyelids called barley-corns by exciting local inflammation and promoting suppuration."

Pierre-Jean-Claude Mauduyt turned to Benjamin Franklin as the starting point of his electricity treatments. He studied the weather and found that the north wind increased atmospheric electricity, and the south wind destroyed it. Northern winds are more likely to be dryer, and static sparks are easier to produce at this time. Southern winds are apt to be damp, and static machines were of little use at the time.

He had three electrical treatments. The first type of treatment was putting the patient on an insulated wooden platform to keep the fluid from running off. Then a static generator was used to give the patient an electric bath. In one case, a 17-year-old girl had not experienced menstruation, but after a few baths, it came.

The second treatment was using electricity to remove blockages. The doctor drew sparks from the charged patients with a grounded rod. This was used to treat nervous conditions and epilepsy.

The third type of treatment was the "commotion." This was sending sparks through the affected area with the discharge of the Leyden jar. It was used when drawing sparks didn't work.

Jean-Paul Marat was a scientist, philosopher and revolutionar born in Neuchatal, Switzerland, in 1743. He studied medicine in Bordeaux, Paris, Dublin, Edinburgh and Amsterdam before practicing medicine in Soho in 1765.

He was a strange man with a large head who stood about five feet tall. He made one of the most detailed and objective accounts of electrotherapeutic practice in the 18th century.

Marat selected three patients with different disorders. He electrified the room in which they were seated. In order to keep the patients around, he hired someone to tell them stories. He tried to ask them objective questions, without influencing their answers. He had the air so heavily charged with electricity that cork balls suspended on a ten-inch string spread apart by two inches. The first experiment with air ionization didn't appear to help the patients that much.

He thought that a young man with gravel and dysuria was suffering from too much electricity. He decided to try electrifying the air every two minutes in the bedroom for five hours a night for 2.5 weeks. To his surprise, the man got better.

He tried using electricity by "commotion." This was the jerking of muscles by shock. He wanted to find out if their body temperatures rose, so he had subjects hold a thermometer. After 15 minutes of shocks, the temperature rose by half a degree.

Marat found that cancer patients didn't get help, and he believed that electricity might even stimulate the tumors. Electricity usually didn't help kidney disorders. Electricity did help arthritis, cramps and paralysis. He published *New Discoveries on Fire*, then *New Discoveries on Light* and finally *Discoveries on Electricity*.

When Jean-Paul Marat worked in London he was poor, so he robbed the Ashmolean Museum of Oxford of some medals. He was captured in Dublin and returned to Oxford for trial. He was sentenced to hard labor rather than being hanged.

At the beginning of the French revolution of 1789, when the Bastille fell, Marat joined the radical Jacobeans. His health failed and he became sensitive to sunlight and developed an unquenchable thirst and itching skin. He became a radical revolutionary and contributed to the French terror. When Charlette Corday stabbed him to death, there was hysterical grief among his followers which became a rallying point for the Jacobeans.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

American Journal of Electrotherapeutics and Radiology 39:309, 1921 "Three Electrotherapists of the Eighteenth Century: John Wesley, Jean-Paul Marat and James Graham" W.J. Turrell
Archives of Physical Therapy 12:737, 1931 "William Gilbert, the Father of Electrotherapy" F.H. Krusen
Bulletin of the New York Academy of Medicine 46:932, 1970 "Application of Electrotherapy to Noncardiac Thoracic Disorders" D.C. Schechter
Clio Medica 15:159, 1981 "Reverend Wesley, Doctor Marat and Their Electric Fire" F. Schiller
Medical Instrumentation 13:226, 1979 "Marat Electrique" N. Roth
Hill, A. Wesley *John Wesley Among the Physicians* London: Epworth Press, 1958
Stillwell, G. Keith *Therapeutic Electricity and Ultraviolet Radiation* Baltimore: Williams and Wilkins, 1959
Wesley, John *Desideratum* or *Electricity Made Plain and Useful* Bristol: W. Pine, 1771

10. BENJAMIN FRANKLIN CLEARS THE AIR

"I say, if these things are so, may not the knowledge of this Power of Points be of use to mankind; in preserving houses, churches, ships, etc, from the stroke of lightning? This directs us to fix on the highest parts of those edifices upright rods of iron, made sharp as a needle and gilt to prevent rusting. From the foot of those rods a wire is put down the outside of the building into the ground, or down around one of the shrouds of a ship and down her side until it reaches the water. Would not these pointed rods probably draw the electrical fire silently out of a cloud before it came nigh enough to strike, and thereby secure us from that most sudden and terrible mischief!"

Benjamin Franklin

In 1773, Charles Dufay found that wax rubbed with cat's fur was electrified, but it differed from a glass rod electrified by rubbing with silk. It attracted an electrified body, which was repelled by glass, while it repelled an electrified body that was attracted by the glass. Dufay discovered the "insulator" and called the two kinds of electricity "vitreous" and "resinous." Benjamin Franklin would solve this mystery by designating the "two electricities" as positive and negative electricity.

Although Franklin established the modern science of electricity, Robert Symmer published articles about the two electricities in a convincing manner. By 1790, most continental electricians were dualists, and they regarded Symmer as the restorer of the two-fluid theory of electricity. He based his theories on silk stockings. One cold winter night, he threw his socks against the wall and found they stuck. He believed that the electrical properties of his socks arose from two distinct fluids that counterbalanced each other.

There was a second mystery that remained to be solved about electricity. Abbé Jean Nollet had wondered if there was a way to prove the identity of lightning and electricity. Several early electricians suspected that lightning was the same thing as their static sparks, but they didn't know how to prove it.

Benjamin Franklin was a successful printer of almanacs and newspapers in Philadelphia. He gained his success from good writing coupled with wonderful bits of wisdom. We still remember "A stitch in time saves nine" and "There is nothing certain in life, except death and taxes."

Franklin became interested in electricity after hearing a lecture by Dr. Archibald Spencer. He obtained some electrical apparatus through Peter Collinson in England and began to repeat Spencer's experiments. He sent letters to the Royal Society describing his experiments, and Peter Collinson read them to the society.

In 1747, there were big troubles between England and Spain over the right to gather salt at Tortuga, an island in the West Indies near Haiti, and to cut logwood at Campechy, a Mexican state on the Yucatan Peninsula. Volunteers were recruited in Pennsylvania for an invasion of Cuba, but the city of Philadelphia was Quaker and the people didn't believe in fighting or in providing the means for others to fight. A French privateer sailed up the Delaware River and raided outlying settlements, and Spanish privateers followed. Philadelphia was stricken with terror, and nobody would defend themselves.

Franklin stopped his electrical experiments and wrote *Plain Truth*, a pamphlet depicting the horrors of war in such a way that triggered the people of Philadelphia to raise money and organize a regiment to defend themselves. The war between England and Spain ended in 1748 with the treaty of Aix-la-Chapelle.

Now that Benjamin Franklin had done his civic duty, he devoted himself to the study of electricity. He sold his newspaper, almanac and printing house to David Hall, which gave him enough money to live the life he desired, with leisure to read, study and make experiments.

Franklin began his experiments by assuming that "electrical fire" exists as a constituent of all matter in an unelectrified state. Charles Dufay had assumed that matter was made of equal amounts of two weightless fluids. Franklin decided to call any body positively electrified if a glass rod rubbed with silk repelled it. Rubbing cat's fur with sealing wax electrified it negatively. His work became the basis of the work of the French physicist Charles Coulomb. Coulomb's law states that like poles repel and unlike poles attract one another.

Franklin explained the phenomenon of the Leyden jar and showed how points attracted electricity. He declared that lightning was the same as static electricity. The Royal Society wouldn't publish his letters, but Peter Collinson did publish them.

In 1748, Benjamin Franklin wrote to Peter Collinson, reasoning that if lightning was electricity, then pointed conductors could channel it and thus avoid damage to buildings. In 1850, he recommended that houses, churches and ships have pointed rods on top and a wire to conduct lightning to the ground. He found that a single lightning rod had a limited area of protection and recommended multiple rods for large buildings.

He noted that it was dangerous to take shelter under a tree during lighting. "It has been fatal to many both man and beasts. It is safer to be in the open field for another reason. When the clothes are wet, if a flash on its way to the ground should strike your head, it may run in the water over the surface of your body. Whereas if your clothes were dry, it would go through the body, because the blood and other humors containing so much water are more ready conductors. Hence a wet rat cannot be killed by the exploding electrical bottle, but a dry rat may."

Thomas Dalibard tested Franklin's idea about lightning rods in France. He used a sharp pointed iron rod 40 feet high, insulated at the base and resting on a table. When a thunderhead passed over, sparks flew from the rod. Dalibard was so alarmed that he sent for a priest! Then he reported to the French Academy of Science: "Franklin's idea is not just a conjecture, here it has become a reality."

There was speculation that the Temple of Solomon in Jerusalem might have had lightning rods. The Jewish historian Josephus records that there were many points and pipes on the roof running to caverns in the hills, but there is no suggestion that the temple was struck by lightning or that King Solomon knew about lightning rods. The only function of the pipes was to drain off and save the scarce rainwater.

New England had many more electrical storms, and the lightning rods worked wonders in tall buildings. Churches had been especially hard hit, because of their tall towers. It eventually became law that all tall buildings had to be protected from lightning.

In June of 1752, Franklin made a kite with two crossed sticks and a silk handkerchief. He put an iron point on the upper part by the string. Rain began to fall as he stood under a shed and raised his kite. A cloud passed over and still there was no trace of electricity. The falling rain made the string a conductor, and the fibers began to fluff out. He put a key next to the string and drew sparks from the skies. This dangerous experiment attracted the attention of scientists in Europe.

Professor Richman of St. Petersburg, Russia, erected an iron rod in his observatory for the purpose of repeating Franklin's experiments, but unfortunately a lightning flash struck him on the head and killed him. Signor de la Garde of Florence, Italy, was struck by an unexpected stroke, but recovered.

In 1752 Benjamin Franklin treated a 14-year-old girl stricken with epileptic fits. She had such violent fits that three strong people could hardly keep her in bed. She had cramps throughout her body with general convulsions and choking. She had suffered this way for ten years.

The girl wrote: "At length, my spirits were quite broke and subdued with so many years affliction and indeed I was almost grown desperate, being left without hope of relief. About this time there was great talk of the wonderful power of electricity, and I happened to think it might be useful to me. Accordingly I went to Philadelphia in the beginning of September 1752 and applied to B. Franklin, who I thought understood it best of any person here. I received four shocks morning and evening, they were what they call 200 strokes of the wheel, which fills an eight gallon bottle and indeed they were very severe."

"When I went home, B. Franklin was so good as to supply me with a globe and bottle, to electrify myself every day for three months. The fits were soon carried off, but the cramp continued somewhat longer, although it was scarcely troublesome and very seldom returned. I now enjoy such a state of health as I would have given all the world, for this time two years before and I have great reason to hope it will continue."

In 1757, Franklin wrote to Benjamin Cowell: "People were brought to me from different parts of Pennsylvania and neighboring

provinces to be electrified, which I did for them at their request. My method was to place the patient first in a chair, or on an electric stool and draw a number of large sparks from all parts of the affected limb or side. Then I fully charged six two-gallon jars, each of which had about three square feet of surface coated; and I sent the united shock through the affected limb or limbs, repeating the stroke commonly three times each day."

The patients usually had some improvement at first, but often there was no improvement after the 50th day. The patients generally returned home and didn't apply for further treatment. He admitted that he had doubts whether the exercise provided by the walk to his house or the electric treatments provided the temporary improvement. He wished that he had the help of a skilled physician to help him work with patients.

Benjamin Franklin used a static generator and a Leyden jar to give spark and shock treatments; the therapy became known as Franklinism. The static generator that he used may still be seen at the Franklin Institute in Philadelphia.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

British Journal for the History of Science 6:131, 1972 "Franklin's Electrical Atmosphere" R.W. Home

Medical Instrumentation 10:27, 1976 "A Medical Electrical Cure by Benjamin Franklin" D. Stillings

Medical Life 33:120, 1926 "Early Electrotherapeutics in America" G. Betton Massey

Philosophical Transactions 50:481, 1759 "An Account of the Effects of Electricity in Paralytic Cases" B. Franklin

11. GALVANI'S ELECTRICITY

"Many distinguished scholars published the same theory long ago. We were amazed at our good fortune in being the first to hold in our hands this electricity, which is concealed in the nerves and to draw it forth from the nerves and to set it practically before our eyes."

Luigi Galvani

"When Galvani touched the muscles of a frog with different metals, and noticed their contraction, who could have dreamt that all Europe would be traversed with wires, flashing intelligence from Madrid to St. Petersburg with the speed of lightning? In the hands of Galvani, and at first even in Volta's, electrical currents were phenomena capable of exerting only the feeblest forces. Only the most delicate apparatus could detect them. Had they been neglected, on the ground that the investigation of them promised no immediate practical result, we should now be ignorant of the most important and most interesting of the links between the various forces of nature."

Hermann von Helmholtz 1873

In 1678, the entomologist Johannis Swammerdam covered the muscle of an animal with a small silver wire. When the nerve touched a copper wire, the muscle contracted. He showed his experiment to the Grand Duke of Tuscany, but it was just a curiosity and the experiment was forgotten.

Frans van der Lott studied the "fluid emitted by the electric eel." It passed through iron, tin, silver and gold, but was stopped by sealing wax. He concluded that it was electricity. The early physiologists did not believe in animal electricity. They *knew* that electricity couldn't pass from the nerves to the muscles without spreading to all neighboring muscles.

Luigi Galvani became a professor of obstetrics at Bologna, Italy, and exhibited a growing interest in physiology. He published papers in 1773 and 1774 on the muscles and the effects of opiates on frogs. In the next two years he published papers on the structure of the ear and physiology of hearing. In 1783 he published a paper on the structure of a bird's ear with drawings.

He began to work with electricity in 1780 using a static machine and a Leyden jar. He dissected a frog and placed it on the table with

the electric machine. He induced violent contractions in the muscles of the frog. He noted that muscular contractions occurred even when a spark passed a short distance from the static machine. He enclosed a frog in a glass jar and covered the bottom with a conducting material. The frog jumped just as quickly as if it was in direct contact with the static machine.

Abraham Bennet invented the electroscope, a glass cylinder covered by a brass cap with an enclosed tube with two strips of gold leaf. Galvani used the electroscope and found that silver and zinc excited the strongest contractions. He thought that these were the best metals for discharging the animal electricity.

Galvani found that increasing the power of the spark didn't result in a stronger contraction. As he reduced it, there was a sudden complete disappearance of the contraction.

He began to wonder about atmospheric electricity. One stormy evening he connected the frog nerve to a long metallic wire pointing towards the sky. He obtained strong muscular jerks during the storm. He tried the same experiment on a clear day, hanging his frogs on the iron railing of his house and waiting. When he pushed the metallic brass hooks into the frogs attached to the iron bars of the railing, the legs began to contract.

The contractions of the frog legs didn't seem to have any relationship to the electricity in the sky. He got the idea that muscular contractions accumulate in the air and then are discharged when the hook came into contact with the iron railing.

He brought the frogs inside, placed them on the iron plate, pressed the brass hook against the frog and got the same muscular contractions. He repeated the experiments with various metals and obtained both stronger and weaker effects. He even tried glass, stones and dry wood, but nothing happened. He held the idea that electric fluid exists within the tissue, and the right metals are a stimulus for it to be discharged.

He developed a theory that atmospheric electricity, static electricity generators and Leyden jars were various aspects of the whole. In 1791, he published his famous paper: *Commentary on the Effects of Electricity on Muscular Motion.* All of the electrophysiology of the next two centuries sprang from the frogs of Galvani.

Alessandro Volta initially accepted Galvani's view that animal electricity was conducted with a metallic arc and began to experiment with metals without the frogs. In 1792, Volta published a letter stating that electricity didn't come from the frogs. "Animal electricity" was "metallic electricity."

Volta was wrong in almost all of his conclusions about animal electricity. There is real animal electricity, and it is involved in all fundamental processes. Animal electricity is a complex system of ion pumps and ion channels. They create concentrations of sodium and potassium and convert concentration gradients into an electrical potential. Current is a movement of ions originating from cellular activity.

A nerve fiber a few feet long has as much electrical resistance as several million miles of copper wire. The body solves the problem of poor conductivity by a chain battery reaction in which the difference between the electrical potentials of sodium and potassium provides the current. The speed of electricity in wire is the same as the speed of light —which is 300,000,000 meters per second. In 1850 Hermann von Helmholtz showed that the nerve conduction speeds are less than 30 meters per second.

Galvani seems to have realized that he was wrong and ceased to publish in the electrical area. However, he still sought ways to demonstrate animal electricity and his notebook for 1795 contains a series of experiments on the electrical properties of the torpedo fish.

Galvani continued to try proving that there was animal electricity. He found contractions could be elicited by using a nonmetallic arc and connecting nerve and muscle tissue through a tissue cut. When the surface section of the nerve touched the muscle, the leg contracted. In 1797 he proved that a section of the right sciatic nerve touching the surface of the left sciatic nerve would contract both muscles. The secret of this turned out to be contact between injured and noninjured tissues.

A slight injury to living cells causes the injured area to become negatively charged with respect to healthy cells. The injury voltage can amount to 50 millivolts. An injury potentially can become large enough to stimulate the nerves. C.L. Nobile constructed a galvanometer and detected the injury current of the frog.

There is real animal electricity, and it is linked with life. The greatest manifestations of it in nature are the torpedo, the electric catfish and the electric eel. At the time that Luigi Galvani was working, there was no way to understand or detect the weak electrical currents of animals or humans.

In 1850, Du Bois Raymond showed experimentally that a current of electricity was generated by the muscular excitement of a living human being. Reymond had to wind 3.2 miles of wire onto his galvanometer coils in order to get enough sensitivity to detect animal electricity.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

Annals of Science 44:107, 1987 "Luigi Galvani and the Debate on Animal Electricity, 1791-1800" N. Kipnis

Clinical Orthopaedics 88:2, 1972 "The Classic: The Effects of Artificial Electricity on Muscular Motion A.L. Galvani" E.M. Bick

Journal of Historic Medicine 24:140, 1969 "The Role of the Voltaic Pile in the Galvani-Volta Controversy Concerning Animal vs. Metallic Electricity" A. Mauro

Trends in Neurosciences 20:443, 1997 "Luigi Galvani and Animal Electricity: Two Centuries After the Foundation of Electrophysiology" M. Piccolino

Matteucci, Carlo Essai *sur les Phénomenes électriques des Animaux* Paris: Carilian-Goeury, 1840

12. VOLTA'S ELECTRICITY

"The apparatus to which I allude and which will no doubt astonish you, is only the assemblage of a number of good conductors of different kinds arranged in a certain manner. Thirty, forty, sixty or more pieces of copper, or rather silver, applied each to a piece of tin, or zinc, which is much better, and as many layers of water, or any other liquid which may be a better conductor, such as salt water. Lay pieces of pasteboard, well soaked in these liquids and interposed between every pair or combination of two different metals in an alternate series and always in the same order of these three kinds of conductors. This is all that is necessary for constituting my new instrument, which, as I have said, imitates the effects of the Leyden flask."

Alessandro Volta 1800

There were only two ways of detecting weak electric currents when early scientists did their experiments. In 1753, Sulzer found that two dissimilar metals in contact with the tongue gave a bitter taste. The metals by themselves produced no sensation. Scientists could feel the current with the tongue or they could make frog legs contract. In 1788, William Nicholson described a "doubler" of electricity. Alessandro Volta saw the article in *Philosophical Transactions* and he made one. Using the doubler, he was able to detect weak electric currents resulting from two different metals.

Volta believed that the soul controlled the body through the nerves by means of the electric fluid. He thought the organs controlled by the will are easily excited by electricity, while organs like the heart, whose activity didn't depend on the will, reacted less to electricity. In 1792, Felice Fontana showed that the heart also reacted to electricity.

In 1795, Volta published a table of metals arranged according to their ability to "push" the electrical fluid into conductors. The series began with zinc as the most active; charcoal was the least active. He used contact with different metals between a wet interface to measure the amount of "electric fluid."

Volta wasn't thinking about the idea of a battery, until the spring of 1799; he was just experimenting and developing his own ideas about electricity. Then he read an article by William Nicholson who taught the anatomy of the electric fish. The nerve plates that generated a pulse of electricity gave him the idea of the battery.

The new way of generating electricity completely eclipsed Galvani's ideas. Anyone could take a series of dissimilar metal plates and place cloth or papers soaked in salt water and wire them together. The more plates were wired together, the more electricity was generated.

The first doctor to use the Volta pile was Carl Grapengiesser (1764–1846). He was the first to use the term "battery" instead of "pile." He applied a battery made of silver and zinc plates to a young girl who lost her voice. The doctor recommended trying the battery on patients suffering from deficiencies of vision, hearing and also for sciatica and rheumatism. It was even tried for dissolving gallstones, when surgery was extremely risky.

Volta became friends with Gabriel Lavernine, the surgeon-general of the French army in Italy. He built some electrical devices for him in 1802, and they were used on the troops at the hospital in Como, Italy. Lavernine applied a metallic belt consisting of 90 cells around the midsection of his patients.

Lavernine was the first to treat epilepsy with 400 strong shocks. This delayed the convulsions for 12 hours. Lavernine wrote: "To be certain that the delay was due to voltaism, I did no electricity to the patient. I waited several days, during which the same periodic attacks recurred. Seeing that this approach was effective, I persisted in the voltaism and gained a diminution of epileptic attacks, the second time for 14 hours, the third for 28 hours, another for two whole days and on one occasion for eight days. When I left Como, the man had rejoined his regiment."

Stefano Marianini was Volta's favorite pupil and began working with the battery. In 1827, Countess Sandi went to a party in good health. She was walking across a room when she fell to the floor. She was unable to use her legs and doctors failed to help her. Marianini used a battery of 58 pairs of copper and zinc discs. He gave her 150 shocks to each leg per treatment. Then he increased the battery to 75 pairs of discs and gradually increased the number of shocks to 800. In three weeks, the Countess was able to stand, and in two months able to walk.

The early batteries didn't last long and the amount of current quickly declined, so doctors couldn't use them for long without a sig-

nificant loss of voltage. John Daniell made the first good battery with a fairly constant current for a long period of time. His "gravity cell" made the telegraph a commercial possibility. The Grove battery was invented in 1839 and the Bunsen battery in 1842. The new batteries enabled doctors to use them for some time before they had to be replaced.

The idea of the battery spawned some interesting healing ideas. First to be patented were "magnetic tractors." These were rods of dissimilar metals that were drawn over the skin. They were very popular for a time, but they did absolutely nothing.

In 1853, Dr. Victor Burq wrote *Metallotherapie*. He developed a system of therapeutics in nervous diseases based on the action of metals on the body. He applied different metals to mental patients and did have some results. Most doctors believed that the effects were due to imagination.

A woman had no feeling on one side of her body. Zinc, copper and gold applications proved worthless. When iron was applied for 20 minutes, there was a feeling of sensation again. The patient continued to progress until feeling was restored to her whole side.

In 1878, Burq tested a woman suffering from hysterical symptoms. All treatments failed, including surgery. The left leg was sensitive to gold and copper. The application of gold relieved the sensitivity, but when it was removed, the patient returned to her previous condition. When she was given subcutaneous injections of gold chloride, her symptoms subsided.

Another woman complained of eye problems with swollen eyelids. When copper was put on her body, the puffiness of her eyes went down. After 11 days, she was able to read for an hour. She felt she was cured after a month of treatment, but her trouble returned. This time copper alone didn't work, but copper and zinc quickly relieved the eye problems.

Most doctors believed that Dr. Burq was simply deceiving himself. Jean-Martin Charcot was willing to study unpopular ideas. He found that the effects usually didn't last more than a few hours, and patients showed no signs of permanent improvement.

In 1878, Herbert Tibbits founded the "West End Hospital for Diseases of the Nervous System." He translated G.B. Duchenne's 1856 book on medical electricity and added notes of his own. Then he began to make high-priced electropathic belts. They were lined with different buttons of metals with the idea of creating a tiny electric current when worn. His fellow doctors criticized him for promoting worthless healing devices. He sued his critics in 1893. The witnesses for the defense were numerous electrical engineers and even the president of the Royal Society, Lord Kelvin, testified. Tibbits lost badly, and his electrical healing career ended.

Cautery is a brief burn to areas of the body that need healing. It was very common to use a controlled burn especially with arthritis and gout. In 1850, John Marshall began to use "galvano-cautery." This was the use of electricity to heat a wire or a piece of metal to burn the patient. His patient had a chronic fistula in the cheek, which resisted treatment for a year. Several operations had failed, so he decided to cauterize it. A platinum wire was passed through the opening. After nine seconds of heating, the fistula was essentially cured, although it took 11 days to heal together.

Archaeologists and historians have discovered at least two postscripts to Volta's battery. During the years of 1938 and 1939, Wilhelm König found a number of earthenware jars in Iraq. They were lined on the inside with copper cylinders. They had an iron rod extending through the lid. He thought they might be batteries and he described his find in *Neun Jahre Irak* (1940).

In 1946, Willard Gray made a duplicate of the 2,000-year-old batteries, filling the inside with copper sulfate instead of the unknown electrolyte which might have been vinegar or lemon juice. The battery worked. It might have been used for electroplating.

In India, an ancient manuscript 3,800 years old, known as the *Agastya Samhita,* describes putting a copper plate into an earthenware vessel. Next copper sulfate and moist sawdust are added. Then a zinc sheet with amalgamated mercury is put over it. The two metals produce "mitra-varuna." This energy will split water into pranavayu and udanavayu. These are obviously oxygen and hydrogen.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

Historical Studies in the Physical and Biological Sciences 21:123, 1990 "Electricity and Life. Volta's Path to the Battery" G. Pancaldi

Burq, Victor *Metallotherapie* Paris: Germer-Bailliere, 1867

Dibner, Bern *Alessandro Volta and the Electric Battery* New York: F. Watts, 1964

Potts, Charles *Electricity: Its Medical and Surgical Applications* New York: Lea and Febiger, 1911

13. DIRECT CURRENT THERAPY

"Polarity is the secret of success. You must know your poles —their quality; what each one does. You will then see the indication for each in actual use. If you get this firmly founded in your understanding, if you remember to be doctors first, always, and never consent to be anything else. If you use your medical knowledge to show your patient's need and then your knowledge of the galvanic current to supply that which is the indicated remedial measure, then I can promise you, from a long and successful demonstration in my own employment of it, that both you and your patient will be pleased. The proof of the pudding is in the eating. It is the END RESULT that counts."

J.U. Giesy 1933

Galvani touched the new world of electricity with his frogs, but failed to understand what he was doing. Volta understood what Galvani missed and drew on the model of the electric fish to create the first battery. Battery electricity is best known as "direct current." When applied to medicine it is known as "galvanism."

The *volt* became a unit of pressure created by a copper-zinc battery cell. The *ohm* became the measure of resistance, while the volume of electrical flow was the *ampere*. Voltage divided by resistance determines the amperage. The ampere was a large unit, and a thousandth of this, the *milliampere*, was the unit of therapeutic use.

The galvanists used several rules. Any rapid change of current made patients uncomfortable. If current were suddenly decreased to the ear, the patient would get dizzy. Overweight patients took more voltage to produce a reaction; thin patients took less. Unless electric shock was used, the current was always slowly increased at the beginning.

Every battery has two poles. The positive pole contracts blood vessels and reduces circulation. It inhibits bleeding and reduces inflammation. It produces an acid reaction that can destroy tissue when there is high current density. The negative pole increases blood flow and widens blood vessels. It sets up an alkaline tissue reaction and can destroy tissue by becoming too alkaline in high current density.

The galvanists used the positive pole to stop bleeding and shrink tumors. When they needed to widen something, they used the negative pole. The pole used was generally applied to a narrow area to focus the electric current. The other pole was called the dispersive electrode. It was generally a large pad applied to the back or abdomen. The treatments were usually less than 15 minutes to avoid tissue damage from direct current action.

In treating hemorrhoids, an electric doctor might insert a needle and then connect it to the positive pole. The hemorrhoid would begin to shrink, as the blood supply was reduced from the current.

In 1870, George Vivian Poore showed that a galvanic current passing through a fatigued muscle gave it relief from fatigue. Chronic fatigue was treated by putting a cathode (negative) over the forehead and the anode over the lower neck. The current begins at 2-3 milliamperes and is increased until it reaches 12-15 milliamperes at the end of the treatment. After several treatments, fatigued patients began to feel exhilarated. This was used to treat fatigued soldiers during WWI.

A busy doctor suffered from loss of physical and mental energy. The cathode was applied to the back of the neck and the anode to the front. Then the electrodes were reversed. He found great relief after the first sitting and had better sleep with progressive improvement.

In one form of migraine, the person had a cool face with dilated pupils. The anode was applied to the face and the cathode was held in the hand or attached to the neck. The current was gradually increased and then gradually diminished.

A railroad engineer dislocated his right elbow 20 years before. Then he developed numbness in the little finger, and the ulnar nerve was swollen at the elbow joint. The positive pole was placed on the swelling, while the negative pole was placed over the fingers. After 15 treatments, there was a great deal of improvement.

Russian doctors treated 45 cases of deficient gastric secretion with galvanism. A large cathode of 8 × 9 inches was placed on the back and an anode of 6 × 7 inches was put on the stomach. The anode increased the secretion; the cathode reduced it. The doctors claimed that pyloric spasm, pain, discomfort and flatulence disappeared. The treatment used 80-100 milliamperes over a 30-minute period.

Moritz Meyer put an anode of about 15 volts to the thoracic part of the spinal cord and the cathode to the prostatic part of the urethra. In about half a minute the face and surface of the body assume a death-like pallor from the contractions of all the small arteries. This was tried in a seven-year-old boy who had constant epileptic attacks. The parents consulted several famous doctors and even took the boy to Charles Brown-Sequard, but the epileptic attacks continued. After a few treatments the attacks stopped, and the doctor reversed the poles to increase the blood flow in the arteries.

A 40-year-old man suffered for three years with epileptic attacks with complete loss of consciousness and intense headaches. His intellect steadily gave way, and he had a hard time at work. He couldn't read at all during this time, it was impossible for him to express ideas, and his memory was gone. His brain was treated with galvanic current, without result. Then the sympathetic (the nerves in the lumbar and thoracic of the back) were galvanized, and after no trace of the disorder remained, the treatment ended. The patient recovered his mental functions after treatment.

A 60-year-old man had paralysis on the left side of the face and tongue. Galvanization of the brain produced only a slight improvement, but galvanization of the sympathetic was followed by a beneficial effect. After a few applications, the facial paralysis had considerably diminished. He was able to speak, dress himself and walk without crutches, although with some difficulty.

A woman suffered from headache, sleeplessness, indigestion, agonizing pain in the back and severe dysmenorrhea. Many noted gynecologists treated her without benefit. A few days before menstruation, she was galvanized in the splanchnic nerves, followed by an immediate beneficial effect. The headaches and pains in the back disappeared, and she was able to sleep through the night. Another galvanization of splanchnic nerve three days later resulted in painless menstruation. She previously spent days in bed; now she was able to work normally.

The first attempt to treat asthma was by Dr. Alexander Wilson Philip in 1817. He used about 8-16 volts and applied one metal plate to the back of the neck and the other to the epigastrum (abdominal area). He allowed the current to pass until the patient said that his breathing was easier. This might be up to 20 minutes.

The anode (positive) was applied to the vagus nerve on the neck in asthmatics, and the cathode was applied to the stomach or lower back. Mrs. C. was affected with severe asthma. Galvanization of the vagus 15 times completely cured her.

Mr. P. developed asthma when he was nine. Each year the asthma attacks increased in severity and frequency. The least cold or sexual intercourse was followed by an asthma attack. Galvanization of the vagus nerve was followed by a beneficial effect. After the first treatment, he didn't have a single attack during the remainder of the winter.

Mr. J suffered from severe asthma and was treated by many doctors. Then he had a severe attack, which lasted for two weeks. He wasn't able to sleep during the long attack. After the first application of galvanic currents, he slept comfortably for the night and his problem disappeared.

Mr. N. suffered from severe hay fever in August and spent whole days sneezing and dripping with tears. He had a fever at night and struggled for breath. After the current was used for a week, all his symptoms disappeared.

Dr. Charles Russ found that nearly all germs were carried towards the positive pole of an electric current. The weak current was usually lethal to the bacteria, and there was no need for zinc or copper ionization. His discovery was applied to wounded men during WWI.

A soldier had a perforated gunshot wound of the leg, which was badly infected. It looked like the leg would have to be amputated. The leg was put in a bath, and an electrode was connected with the positive pole. The negative pole was connected to an indifferent electrode made of salt-water soaked cotton on the back. The current was slowly turned up to a reading of 25 milliamperes. He was given daily half-hour treatments, and in five days there was healthy granulation of the wound.

A doctor in India experimentally treated rabies in mice by passing a direct current through them. He put the negative electrode on the forehead and the positive clip to the tail. After 15 minutes of passing 200 microamperes through the body, the virus was displaced from its cellular attachment and swept from the brain. This discovery has implications for treating viral infections.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

Archives of Physical Therapy 8:27, 1927 "Galvanism —General Principles" J.U. Giesy
Archives of Physical Therapy 8:530, 1927 "Galvanic Technic" J.U. Giesy
Berliner Klinische Wochenschrift #22 1870 "Moritz Meyer's paralysis cured by Galvanization of Sympathetic"
British Medical Journal 2:433, 1915 "The Treatment of Septic Wounds by the Electrolytic Bath" F. Fowler
Medical Hypothesis 24:291, 1987 "Negatively Charged Nature of Some Viruses and Toxins Forms the Basis for Direct Current Therapy" N. Annal
Neftel, William *Galvano-Therapeutics* New York: Appleton & Co., 1871

Additional material in one version:

Professor Rossbach believed that the anode soothed pain. He applied the anode to the severe sciatic pain he suffered and it helped, but he was surprised to find that the cathode was much more effective. In 1878, a gentleman suffered from pain around the right eye. He took quinine and injections of morphine without any benefit. After the first application of current to the eye, the pain disappeared.

A man suffered from pain on the right side of his face, which came in spells lasting about an hour several times a day. The anode was applied over the painful spots, and the cathode was applied to the neck. He had immediate relief without pain.

Edgar Cayce gave several psyshic readings for people suffering from multiple sclerosis. He recommended the wet cell, which was a low voltage battery. He recommended that gold, silver or camphor be put into the battery. I believe that he picked up this procedure from the "universal mind." Some practitioner was successfully treating people in this way. I believe that these substances in the battery did nothing.

In effect, Cayce recommended low voltage positive current applied to four points on the back. These points were the 1-2 cervical vertebrae, the 1-2 dorsal vertebrae, the 9th dorsal and the 4th lumbar vertebrae. The negative electrode was applied over the area of the solar plexus and the navel. A weak current applied from the back to the front of the body stimulated the nerve centers. There are several cases in which desperate multiple sclerosis patients used the readings to heal themselves over a period of months.

14. ELECTROPUNCTURE

"Electropuncture is in my opinion the most proper method of treating rheumatism, nervous afflictions and attacks of gout, when the inflammatory symptoms that sometimes accompany them have been sufficiently subdued, which calls for a well-understood medical approach. One attacks the illness directly at its root; one changes the mode of being of the very nerves that make the pain felt. You force pain to disappear by the power of the electrical vibrations and administer shocks gradually and in reasonably intensity. In this operation, one is making use of an agent whose strength always surpasses that of the nervous activity, and overcomes it, no matter how tenacious it may be. One can always be sure of attaining the goal desired; namely of changing the defective mode of sensibility and the defective mode of action of the affected part."

Mémoires sur l'Electropuncture Jean-Baptiste Sarlandiere 1825

Acupuncture in China was developed thousands of years before the time of Christ. At first, sharp stones were pressed against body points to bleed the patient. Then the idea developed that the special bleeding points could be influenced by moxibustion, which is burning little cones of dry plant material.

Writers combined the mythology of the Yellow Emperor into a series of books. The *Nei Ching* describes the Yellow Emperor and 160 points used for moxibustion and acupuncture. As more doctors adopted acupuncture, more points were added.

When the Dutch began trading with Japan and China, they brought the art back to Europe. The first medical writer to discuss acupuncture in Europe was Wilhelm ten Rhyne in 1683. Louis Berlitz revived it in 1816 for the relief of pain. In 1821, James Morss Churchill wrote a tract on it, which created considerable interest.

The mysterious points were believed to be channels for the chi, which was the life energy. By needling the points, you were regulating the energy flow. After President Richard Nixon's visit to China, there was a great deal of interest in acupuncture. Dr. Felix Mann used acupuncture anesthesia in 100 cases and found it worked well in about 10% of the patients. There was some analgesia in 65% and no help in the remaining 25%. He had tried acupuncture anesthesia on himself, but it failed on all three occasions, so he had to use regular anesthesia.

Dr. Robert Becker received a grant to study acupuncture after Nixon's visit. His group of researchers found that the acupuncture points were surrounded by electric fields. He believed that the lines marked by acupuncture points might be the body's natural electrical system. They carried messages to the brain, which changed the amount of current necessary to stimulate healing in the troubled area. The poking of metal needles might be a way of regulating the body's natural electrical current lines. Just when he began making progress towards this end, his grants were cut off. The National Institutes of Health told him that acupuncture was no longer of interest.

There is a theory that blood is a fixed electrical reference point and tissues are fluctuating positively or negatively in relation to the blood. Water moves towards areas of negativity and moves away from positive potentials. The idea here is that acupuncture readjusts the electrical currents towards normal through needle conduction. A puncture made by a hypodermic needle instantly reduces the body's resistance from a level as high as a million ohms to nearly zero. When the doctor gives you a "shot," perhaps the acupuncture effect is doing more good than the medication.

There is another theory that the benefits of acupuncture are due to releasing morphine-like substances, which reduce the pain. An electrical stimulus increases the pain threshold by two to three times. In 1844, Edmond Hermel employed electroacupuncture for the treatment of sciatic and lower back pain. He used two needles and put the positive needle over the site of pain.

The pain clinic at the Osaka Medical College treated 30 patients for pain who hadn't had help from nerve block or acupuncture. They were able to obtain 42% long-term pain relief. They found that a current produced by 12 volts was the most effective for pain relief.

The electrical current may also increase the activity of the cells. An experiment was done using needles placed 4 mm. below the skin of rats. Using four pulses of direct current per second at 0.75 volts, the liver microsomal activity increased greatly.

When a direct current passes into the body, it forms alkaline ions at the positive pole and acids at the negative pole. If the current is too intense, the body can be damaged at the electrodes. In 1800, William

Nicholson and Anthony Carlisle were the first people to do electrolysis of water. This liberated hydrogen at the negative pole and oxygen at the positive pole. Sir Humphrey Davy used this reaction to produce sodium and potassium in 1807.

Louis Berlitz was the first to write about electricity in acupuncture, in 1816. He used needles made of different metals to produce an electric current without the need for a battery. He found that this heightened the effect of the acupuncture.

The first person to write about the idea of "electrolysis treatment" was Gustav Crussel (1810–1858). He submitted a number of papers to the French Academy of Science beginning in 1841. Since electrolysis decomposed water, he felt that he could use it to decompose undesirable tissue. He later abandoned the treatment in favor of galvanocautery. A resistance wire was put into the tissue and a current passed. Heat destroyed the unwanted tissue.

Dr. William B. Neftel of New York was the first person to treat cancer with electropuncture. His patient healed slowly after an operation, but then another growth the size of a fist developed. He didn't want another operation, so in 1856, Neftel put a positive needle into the tumor and several negative needles at a distance from the tumor. He began by applying electricity for two minutes from ten cells. He increased this daily until it was ten minutes at 30 cells. The tumor increased after the first treatment; then it began to shrink. The patient had been very feeble, but became stronger day by day. In three months, there was no sign of the tumor. The patient died three days later of a different cause.

Dr. Julius Althaus carried out the first systematic work on the therapeutic possibilities of acupuncture electrolysis in 1867. He inserted needles connected to the terminals of a battery. The negative electode formed alkaline materials and released bubbles of hydrogen. His first experiment on electrolysis was to destroy a pea-sized naevus of the eyelid in 1866. The lady was so nervous that she was put under chloroform. A needle was inserted into the right half of the growth and connected to the negative pole of a ten-volt battery. The positive pole was connected to a moistened electrode applied to the skin of the neck. The current was passed for two minutes, then the needle was withdrawn. It was repeated with the left half of the tumor and the result was satisfactory. He treated other growths this way, too.

Althaus treated a woman with cancer of the breast. It was surgically removed, but five weeks later, a new growth formed and many smaller nodules sprang up. She steadily got worse until she was thin, weak and in great pain. He inserted a cathode needle into the cancerous nodules on the right side of the chest and placed the anode on the left shoulder. The current was gradually raised for ten minutes. The woman was relieved of her pain and the cancerous nodules disappeared. She looked well, but she got pneumonia after a winter cold spell and died.

Althaus treated a man with a growth on the left side of his neck. The man had lost his voice and couldn't swallow. After the needles were inserted in a growth and attached to a 15-volt battery his pulse went down and he was able to eat. The tumor nearly disappeared in a month.

Bjorn Nordenstrom developed an electrochemical theory of cancer. He used electropuncture to alter the ionic composition of fluids around the cancer. He treated a group of 26 lung cancers that had been rejected for surgery and didn't respond to chemotherapy. He put two platinum needles under local anesthesia through the chest wall. One electrode was put into the cancer and used as the anode. The other was placed two to three neoplasm diameters from the anode. Then he applied 5 to 20 volts to the electrodes for one to two hours. Usually one treatment was enough to destroy the cancer.

A woman had a large malignant lump in her left breast. She refused both surgical and nonsurgical treatments and asked for electropuncture. A platinum needle was inserted into the growth and connected to the anode while the other needle was placed 10 centimeters away and connected to the cathode. Ten volts were applied resulting in a 15 ma. current. This was gradually increased over a two-hour period. Two days later the tumor was shrinking, and then it disappeared. She had regular medical checks every six months, and there were no signs of the cancer.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

Acupuncture and Electro-Therapeutics Research International Journal 8:111, 1983 "Electropuncture and Its Effect on Rat Hepatic Functions" A.K. Chakrabarti et al.
American Journal of Acupuncture 3:140, 1975 "Effective Pain Control with Electroacupuncture" J.F. Bumpus
American Journal of Clinical Oncology 12:530, 1989 "Electrochemical Treatment of Cancer" B. Nordenstrom
Annales Médico-Psychologiques 3:209, 1843 "Research on the Neuralgias and Their Treatment" E. Hermel
British Medical Journal 2:606, 1875 "Further Observations on the Electrolytic Dispersion of Tumors" J. Althaus
British Medical Journal 1:1231, 1889 "On the Treatment of Uterine Tumors by Electricity" T. Keith
Clinical Radiology 43:84, 1991 "Radiological Evidence of Response to Electrochemical Treatment of Breast Cancer" E. Azavedo et al.
Journal of Medicine 13:247, 1982 "Studies with Electro-Acupuncture" R.C. Rice et al.
Lancet 2:1085, 1976 "Electro-Acupuncture and Endogenous Morphines" B. Sjölund et al.

15. ELECTRICITY IN GYNECOLOGY

"Electricity in any form, when applied to the cure of disease, is set down as pure quackery by many medical men, simply because they know nothing about it, and won't take the trouble to learn for themselves what, to many, is a hard study. My confidence in its powers and in its capabilities in relieving the disturbing symptoms of uterine fibroids, as well as in curing many chronic inflammatory conditions in the pelvis, continues to increase. I venture to predict that the gynecological bag, as at present filled, will have soon to be reconstructed and that most of its present contents will be thrown out. I have no fear for the future of electricity."

Thomas Keith 1889

"Electricity is a powerful constitutional tonic according to the method of its application and can be used as a sedative or a stimulus to the nervous system. It is therefore beneficial in cases of nervous exhaustion. It is also used very largely in the dispersion of tumors in diseases of women and is especially valuable because we can bring the central nervous system under its influence."

New York Times 1892

The era of electrical gynecology began in 1755, when Anton de Haën began treating amenorrhea (lack of menstruation) with electricity. In 1764 Christianus Ludovicus Alberti published *De Vi Electrica in Amenorrhœam*. Only static electricity was available at this time.

In 1837, Thomas Addison published a study of treatment with electricity of women's problems. The patient was placed on an insulated chair and connected to a static generator. A grounded brass ball was passed about an inch over the spine at a distance of about an inch for five to ten minutes, which resulted in a red eruption. The treatment was used for all forms of uterine disease.

Uterine fibroids and irritation of the uterus known as salpingitis have long been known to cause problems for many women. The cause of these conditions is not known. The areas are subjected to alternating waves of estrogen, which proliferates the tissue, and progesterone, which maintains the pregnancy. Uterine tissue reacts with small growths, which result in a painful condition. When the condition is relatively severe, it is usually treated by hysterectomy, which involves surgically removing the uterus.

The first application of electrotherapy to gynecology occurred in 1859 when Auguste Tripier used faradic current to treat lesions of the uterus. He did not have great success, but there was no satisfactory medical treatment at the time.

In 1889, Willis E. Ford experimented on electrical treatment for uterine fibroids. He put electrodes into eggs. He found that the albumin coagulated around each electrode with fine filaments extending between them. Homeopathic physicians closely followed his experiments, because they did not believe in surgical operations.

George Apostoli got interested and he began to experiment in alternating current, faradism, intrauterine direct current and "galvanopuncture." This is acupuncture with a needle in the inflamed area and a dispersive electrode.

Fibroids, uterine irritation or childbirth may cause unstoppable bleeding. A 40-year-old mother had severe uterine bleeding. Her husband used tampons soaked in vinegar, but the bleeding wouldn't stop. The woman was taken to the nearest hospital in an ambulance. Positive current was applied at a level of 2 milliamperes for an hour. A large negative electrode was applied to the abdomen. After an hour, the bleeding stopped and fresh tampons were inserted. By the third electrical treatment, the bleeding was entirely stopped. She begged to go home for Christmas with the family and was released from the hospital.

A woman suffered from backache and bleeding for seven years. A fibroid the size of an orange was causing the problem. Positive current was applied to the cervix at a level of 5 milliamperes for 30 minutes three times a week. A dispersing electrode was placed on the abdomen. After the second treatment the hemorrhage ceased and the backache was gone. Eight months later the patient remained free of backache and bleeding.

George Apostoli used a carbon electrode in the uterus and a negative belly pad of potter's clay. He claimed that he always arrested hemorrhages after one to three treatments. He would put a needle into the area above the fibroid and apply positive current. He used large dispersive electrodes made of clay on the abdomen or back. This enabled him to pass a fairly high current level into the fibroid. He

began the treatments at 20-40 milliamperes and then increased this to 100-150 millamperes if the person could stand it. The treatments were normally given twice a week.

Apostoli believed that hysterectomy was morally wrong and an incurable sexual mutilation. He expressed himself so strongly that a flood of women flocked to take his treatment. He remarked that surgeons know only how to do hysterectomies for fibroids, and this is what they would recommend. His treatment was slow and required patience. During this period of time, every fifth woman died from this surgery, for there were no antibiotics or good sanitation.

A 34-year-old woman came to Apostoli's clinic. She had long periods every two to three months. Menstruation was marked with severe pain and vomiting. She spent days in bed, often crying involuntarily. He treated her with a negative intrauterine electrode with a large dispersive pad. She was able to take 100 ma. of current for five minutes. The condition could still be felt under deep touch, but her painful menstruation was gone.

A woman suffered from endometriosis. She was given negative galvanopuncture for five minutes at a treatment. After six treatments, the pain was almost entirely gone. Instead of a hysterectomy, she had three more children.

Franklin Henry Martin wrote the story of his life in *Fifty Years of Medicine and Surgery*. He once attended a meeting of the Chicago Medical Society in which George Apostoli demonstrated his work on uterine fibroids. Most of the doctors there were complete skeptics, but Martin got the equipment and tried it out on a woman. She had great relief of discomfort to his surprise. After treating several patients, he wrote: "One of the most astounding features of this treatment in the case of an old fibroid, was the almost invariable immediate relief from pressure and so-called neuralgic pain, nervousness and distress."

A 34-year-old woman had PMS, which made working difficult, and she had severe vomiting. She was treated with six negative puncture treatments at a depth of one centimeter. This rapidly reduced pain, and a year later all symptoms disappeared.

Painful menstruation was treated by putting a negative electrode in the uterus with a 12-inch dispersive pad on the lower abdomen as the positive pole. There was usually marked relief from pain in three to four treatments and long-term relief from pain. This was used as a treatment for sterility. One woman had been married for five years and was anxious to have a family. She was given four treatments and conceived two months later.

A woman suffered from irregular menstruation. When menstruation stopped, she became depressed and suffered severe headaches. Negative galvanism was applied to the vagina and the positive pole was placed over the lumbar spine. This brought the cycle back to normal. This therapy was also used to treat dysmenorrhea.

A 22-year-old woman had a swollen right breast that was a deep purple color. Several doctors advised a mastectomy. Negative galvanism was applied to the entire surface of the affected breast with a salt-water pad with iodine. A large indifferent pad was applied to the abdomen. Three treatments a week with 10-15 ma. of currents were applied for 30 minutes a day. The breast softened and in five weeks, became a normal color with several small nodules. Dr. Massey felt that this treatment could distinguish benign from malignant nodules in the breast.

A woman suffered a severe blow to the right breast. Two months later, it had a small lump, which became as large as an orange; she had severe pain in the breast after arm movement. An anode was moistened with 10-15 drops of iodine and applied to the breast over the tumor, and the cathode was put over the opposite side of the breast. A current of 15-20 ma. was applied for five minutes. The treatments were given twice a month until the tumor was reduced to half its size.

A 43-year-old woman had a tumor about the size of a hen's egg causing her darting pains. The current could not be stronger than 10-15 ma. without causing her too much discomfort. It didn't completely remove the tumor, but the pain disappeared, and a soft swelling remained. Another swelling began in the right breast, but the same treatment caused her relief and its disappearance.

It is now known that free iodine has a strong effect on breast cancer when taken internally. It seems probable that this could be a valuable treatment of breast cancer, but no further studies were done.

Electrical treatment was found to relieve vomiting during pregnancy. A large cathode was placed on the stomach area. Two smaller anodes were applied to the vagus nerve on each side of the neck. Henri Bordier applied up to 15 ma. of current. Any time there was a sign of vomiting, the current was turned on. It was only applied for a few seconds and then gradually reduced to zero.

A 22-year-old woman had long suffered from urinary incontinence, and all measures proved useless. The patient was greatly inconvenienced by the affliction during the day. A short wire electrode was put into the entrance of her urethra and connected to the cathode. A sponge electrode was connected to the anode and put over the area. After the eighth treatment the patient was completely cured.

Dr. Francis Katona of Budapest, devised a urination reflex stimulator. This was a special catheter with a silver tip connected with wires to a special direct current stimulator. The repeated stimulation through this catheter for 90 minutes a day is said to have developed normal micturition reflex. This method requires no surgery and appears to have no complications.

Dr. Henri Bordier used this method of treating urinary incontinence. He used a short sound [sic] to touch the urinary sphincter muscle. A series of weak shocks were applied for five minutes a day. He continued treatment until the patient was cured, which normally wasn't very long.

The era of electric gynecology ended just as quickly as it had begun. In 1897, Dr. Hiram Vineberg tabulated the literature of 372 cases of fibroids. He found that only nine were completely cured. Five deaths occurred during from the treatment, but 242 women were cured or much improved. This started a real debate on the efficacy of the treatment.

At the 1898 meeting of the American Gynecological Society, the delegates argued the question: "Has electricity ceased to be a useful therapeutic agent in gynecology?" Egbert H. Grandin testified that he abandoned this method of treatment after a decade of exploring it. Another doctor testified that after keeping careful records for years, and reviewing them, he was convinced that he was wasting his time.

Another electrotherapist offered his equipment to anyone who promised him "not to use it on a human being." These people had been greatly discouraged by the long period of treatment and the frequent failures. They used clumsy electrical equipment, because electricity had not yet been wired to homes and hospitals. By 1900, surgery was considered to be the only way of dealing with uterine fibroids. Despite the abandonment of nearly a century of work, several of the techniques may prove to be of interest to doctors of the future.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

American Journal of Electrotherapeutics 42:43, 1924 "Electrical Treatment in General Practice With a Report of Selected Cases" F.T. Woodbury
British Medical Journal 2:699, 1887 "The Treatment of Fibroid Tumors of the Uterus by Electricity" G. Apostoli
Bulletin of the History of Medicine 60:343, 1986 "Electrotherapy in Gynecology: The American Experience" L.D. Longo
California State Journal of Medicine 17:78, 1919 "Electricity Applied in Gynecology" O. McNeile
Clinical Medicine 38:42, 1931 "Galvanism and the Female Pelvis" J.U. Giesy
Journal of the American Medical Association 13:109, 1889 "The Treatment of Salpingovaritis by Electricity" G. Apostoli
Journal of the Arkansas Medical Society 14:59, 1917 "Electro-Therapeutics" J.K. Smith
Journal of Electrotherapeutics 11:175, 1893 "Treatment of Two Cases of Tumor of the Breast by Electricity" W.L. Jackson
Journal of Radiology 6:436, 1925 "Electricity in Pelvic Diseases of Women" H.W. Grote
Revue de Gynecologie 4:111, 1900 "Critical and Historic Treatment of Fibromas with Electricity" A. Zimmern
Martin, Franklin *Fifty Years of Medicine and Surgery* Chicago, 1934

Additional material in one version:

George Apostoli knew that the positive pole shrank the tissue and stopped bleeding.

A 36-year-old woman suffered from a prolapsed uterus and could scarcely walk more than a few steps. A current was applied to the lumbar region and the solar plexus. She was now able to stand steadily with her eyes closed. Her uterus returned to its normal position.

16. ELECTRICITY AND MENTAL CONDITIONS

"It is a great recommendation of the study of electricity, that it now appears to be, by no means, a small object. The electric fluid is no local or occasional agent in the theater of the world. Late discoveries show that its presence and effects are everywhere and that it acts as a principal part in the grandest and most interesting scenes of nature. It is not, like magnetism, confined to one kind of body, but everything we know is a conductor or non-conductor of electricity. There are properties as essential and important as any they are possessed of, and can hardly fail to show themselves wherever the bodies are concerned."

History and Present State of Electricity Joseph Priestly 1767

Arthur E. Baines was a submarine cable engineer. He used sensitive galvanometers to measure the signals from the long cables. While testing, he found that the electricity of his own body threw off the readings. He found that his fellow workers changed the readings. He began testing his friends and found variations, which he linked to health and energy.

He used the galvanometer to study plants and found that they have a negative and positive end. He believed that the waxy bloom on peaches and apples was part of the dielectric insulation of the plant to alter the current flow. He felt that cholesterol was part of the dielectric system of the body. He found that wounds would heal rapidly when coated with wax to alter their electrical properties.

Using a sensitive galvanometer, he began to measure the deflection between the index fingers of the right and left hands. A normal healthy person had a deflection of 1.5 microamperes. He reasoned that people with lower electrical deflection were often unhealthy. He attributed the lower voltage difference to a lack of nerve energy. Country air, moderate exercise and good food increased the electrical deflection. He found a big change in electrical deflection when people were near power lines.

He found that he could greatly increase the electrical deflection by holding a hardened carbon rod in the right hand or by holding a magnet in the left hand. Baines traveled in Egypt and noted a number

of statues of the Pharaoh holding a short rod in the right hand. He believed that they were increasing their electrical deflection and thus their personal power.

Baines and his medical friends tried treating people by having them hold hard carbon rods in their right hands. The galvanometer quickly went off scale. He found that nerve deafness, severe fatigue and many cases of paralysis were due to inadequate body electricity. One case of paralysis recovered after 13 years by this simple technique.

I doubt that the magnet or the carbon rod had anything to do with the treatment. Rather, a weak electrical current was being passed from one side of the body to the other. The experiment should be redone and perhaps could indicate a major help for problems that are now difficult to treat.

A number of early attempts were made to treat mental states with electrical currents. Dr. Julius Althaus (1833–1900) believed that electrical currents would retard old age and improve the mental state. He wrote a number of books on electrical treatment around 1860. He once treated a judge for facial paralysis, but the man kept coming back for more treatments because they made him feel so much better. "I feel lighter; my ideas are more clear. I can concentrate my attention much better, and I can better resist the somniferous effect of lawsuits. I can retain more easily the arguments to compare and weigh them up. In short, my intelligence is more acute, and work is easier."

A 26-year-old woman was insane, and many remedies were tried on her without success. A positive electrode was applied to her head, and the negative electrode was applied to her feet. The treatment gave her a headache, but she became more rational and was able to do needlework. A study on 11 patients claimed cures for three, benefits for another three, with five receiving no help.

Dr. Alford Newth began to treat the mentally ill with electricity at the Sussex Asylum. He put their hands and feet in a basin of water with a little acid for conductivity. Electrodes were applied to the top of the head or the top of the spine. He found that nine of the 15 cases he treated benefited.

A woman suffered from depression with a propensity to commit suicide. She was electrified 26 times with the positive pole applied to the head and the negative to her feet. After treatment the woman appeared to be much brighter, conversed rationally and was now able to do needlework. She was discharged as cured.

In 1884, Christian Engelskjon reported on the case of a 50-year-old man suffering from depression for three months. He had a single treatment of faradic current applied through electrodes to his head, when he smiled and said: "Now it is gone." He was depressed the next morning, but another treatment relieved him. After a third treatment he returned to work.

In 1887, Joseph Wiglesworth treated 11 women in the Rainhill Asylum with electricity. He claimed to cure three and improve three. A 23-year-old woman suffered from dementia. The cathode was applied to her forehead and the anode to the nape of her neck during 60 treatments over a three-month period. The current began at 3 ma. and increased to 25 ma. as the patient slowly got better.

Static electricity was tried on the insane, especially after the powerful Holtz machine was introduced in 1865. Robert Chase treated a woman suffering from incurable melancholia. She was so timid and nervous that he had to use the static breeze at a distance for 20 minutes. She slowly improved, and her depression left.

Another woman was confined to a hospital bed after suffering from delusional melancholia. She was treated with static sparks over the stomach, liver and abdomen three times a week. She complained a lot, but her weight began to increase as she was able to take solid food. After six weeks, she was discharged as near normal.

Depression is one of the major problems of modern society, although we cannot say that there is more depression now than in previous centuries. In early centuries the problem was called *melancholy*. The doctors of the 19th century wrote articles and books on "neurasthenia," and many people claimed to be suffering from it. This catch-all word was not only depression, but also bad nutrition and the lack of opportunity that prevailed at the time. In modern society, we have increased demands in the workplace, little job security, insecurity in marriage, and our lives are so filled with tasks that we can't get ourselves centered.

Physiologists experimented with passing a weak current over the forehead and then studying the apparent brightness of a light while current was being passed. The subjects being tested noticed something else. When the electrodes over the eyebrows were positive with respect to the legs, there was an increase in alertness, an elevation of mood and sometimes a tendency to giggle. If the electrodes over the eyebrows were negative, the subjects became silent and withdrawn.

The physiologists recruited 32 volunteers to see if observers could figure out if positive or negative current was being applied over the eyebrows. The observers were able to score this correctly in 26 cases. These remarkable findings resulted in a study of 29 patients with long-standing cases of depression. The current improved 13 and gave 11 temporary improvement. Most patients had some relief of depression while the current was passing. The treatment involved a current of 150-300 microamperes for four to six hours a day. They could not feel the feeble current. Most patients had a reduction in depression that lasted for hours or days.

A 54-year-old woman had to nurse her mother-in-law during a terminal illness. It affected the woman, who developed ulcers, lethargy and severe depression. She was given 50 microamperes on each side of her head for ten hours. By bedtime, she felt relieved; the improvement lasted two or three days. The electrical treatment was given twice a week, steadily improving her mental health. When it was discontinued for two weeks, she lapsed back into depression.

A 49-year-old woman had nine years of continuous depression resulting in five admissions to the hospital. She would talk in whispers and continually wring a handkerchief. After two and a half hours of weak current, she felt lighter and more relaxed. When the current was turned off, she felt weak and tired. After another treatment, she felt nearly normal.

A woman suffered from depression and claustrophobia, necessitating many periods off work and frequent changes of occupation. Shock treatment and drugs failed to help her. She couldn't get a job and felt very depressed. After a six-hour treatment of 40 microamps above each eyebrow, she began to feel better. She took two treatments a week, in which the current was increased to 200 microamperes on each side of the eyebrows. Soon she no longer needed treatment and was able to hold a regular job.

If the positive electrode produces an elevated mood above the eyebrows, then could a negative electrode in the same place calm down those who needed it? This was studied in four persons with manic states. They were given 250 microampere currents for two to three hours. After ten days of treatment, three patients had their excited behavior and elevated mood restored to controllable levels.

A 55-year-old housewife began exhibiting aggressive behavior. She took off her clothes on the street and wept bitterly, and therefore she was admitted to the hospital. Shock treatment and drugs gave her little help. A treatment with negative current brought her mood to normal, but she relapsed after stopping the treatment.

The demon theory of mental illness passed away with the coming of the medical revolution of the 19th century. According to the theory, people hearing voices in their heads and people with multiple personalities had valid reason for believing that they were possessed by demons. The Bible said that true believers could cast out the voices. The theory faded after priests and preachers failed in their attempts to exorcise the "bad spirits."

Reverend Joseph Priestley, the leader of a Presbyterian Church in Leeds, England, in 1770, experimented with electricity. It was rumored that he could perform miracles. A woman who believed that an evil spirit possessed her came to him and begged for help. He didn't want to treat her, but he finally sat her on an insulated stool and charged her with static electricity. He ended the session by giving her a good shock. The woman explained: "There, the devil's gone. I saw him go off in that blue flame, and he gave me such a jerk as he went."

Carl Wickland (1861–1945) used electricity to drive out demons. He and his wife—a spirit medium—worked together. The patient would sit on an insulated chair next to a large static generator. The demon or spirit would be frightened by the static shock and enter his wife's body, where it would converse with him. He would then try convincing the bad spirit to leave the patient.

The scene went something this: After the initial shower of sparks, the controlling spirit stamped furiously and spoke angrily in an excited childish voice. "No, no! I do not like you. You have so much

fire. I am afraid of that fire." So, the patient became free of the voices within, thanks to electricity!

Electricity has been used to treat addiction and mental conditions. If you really want to quit something, but you just can't break the cycle, you can treat yourself, but it is best to have professional help. An apparatus can be made from a nine-volt battery stepped up to produce a 70-volt AC shock. The first treatment is done with professional help.

A schoolteacher smoked for 20 years, and just couldn't quit despite encouragement and help from her doctors. In consultation, she was given a shock as soon as she inhaled. The treatment continued this way for two weeks. She was able to quit and had no problems resisting the temptation to smoke.

A teacher kept having negative thoughts about his wife's character. These thoughts happened after a joking remark, but there was no reason for him to be suspicious. In treatment he was asked to imagine the remark, and then give himself a shock. After ten days of imagining it and shocking himself, the negative thoughts vanished from his mind.

A graduate student was troubled with strange sexual fantasies, which disturbed him. He was told to imagine them and signal by hand when he had a clear image in his mind. When he did so, a shock was administered. He found it more and more difficult to conjure up the fantasy. By the tenth treatment, he reported that he had no more interest in fetish and masochistic practices.

Researchers have been experimenting with cranial electrostimulation. The CES units are very similar to electrosleep units. They are set at 100 hertz with a pulse width of two milliseconds. The electrodes are placed just below the ears and a pulse is applied for 40 minutes a day for several weeks.

The initial results are very promising. In certain head injury accidents and alcoholism cases, memory and reasoning are gone, and there is no good way to restore them. The people in the test lost their ability to learn new associations and were confused and bewildered. The pulsed current gradually increased their memory and ability to function.

The violet ray was often used to treat fatigue and depression, usually by passing it over the spinal cord. It was also used to give short stimulating sparks by passing it over clothing. The sparks strongly stimulated the nervous system and raised the blood pressure.

A testimonial of the Marvel Violet Ray Company read: "I am glad to inform you that I got a Super Marvel Violet Ray and it has done me more good than weeks and weeks of taking medicine. I had a nervous breakdown, and it seemed I could not get my strength. At one time a nervous weakness came over me, including stomach trouble. I was in the home of a friend, and she gave me a treatment with the violet ray, and I felt such a change that I went and got one for myself."

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

British Journal of Psychiatry 110: 773, 1964 "A Preliminary Account of the Clinical Effects of Polarizing the Brain in Certain Psychiatric Disorders" J.W.T. Redfearn *et al.*

British Medical Journal 1:151, 1964 "Aversion Therapy by Electric Shock: A Simple Technique" R.J. McGuire *et al.*

Irish Journal of Medical Science 2:133, 1969 "Negative Polarization of the Brain in the Treatment of Manic States" M.W. Carney

Medical Times 42:547, 1914 "Neuro-Electricity: The Electropathology of Disease and Therapeutics" J.H. Wilson

Philadelphia Medical Journal 4:800, 1902 "Static Electricity in the Treatment of Insanity" R.H. Chase.

Southern Medical Journal 59:932, 1966 "Treatment of Depression With Low Voltage Direct Current" J.C. Ramsay *et al.*

Wickland, Carl *Thirty Years Among the Dead* Los Angeles: National Psychological Association, 1924

17. ELECTRICAL MUSCLES

"It must be conceded that we are passing into the dawn of a day of physical methods in medicine. Not only does the physician of 1904 give fewer and less drugs than his brother of 1804, but the patient is, I believe, less inclined than formerly to take large and frequent doses of physic. Whether or not this is altogether as it should be, will probably be better known to the practitioner of 2004. Being neither an electrician nor an electrotherapist, still as a dermatologist I have found myself drawn into the employment of a variety of physical methods during the past few years, several of which have to do largely with electrical currents."

Charles W. Allen, M.D. 1904

Static machines were used for the first electrical treatments of the muscles. The first reports of dramatic cures in paralysis aroused a great deal of interest. Most people had no benefit from the static currents and shocks then used.

In 1762, Sir William Watson reported on a seven-year-old girl with tetanus. Her jaw was locked and muscles rigid. Her right wrist and hand remained pliant and the muscles controlling speech were unaffected. She could only be fed through a gap created by the extraction of two teeth. No treatments worked, so Watson decided to try electricity. At first it didn't seem to work, but he continued. After six weeks, she was back to normal.

Guillaume-Benjamin-Amand Duchenne began practicing electrotherapy and found that the faradic current was better than direct current for testing muscles. Every morning he went around the Paris hospitals looking at cases which interested him and performing electrical tests on them. Duchenne was the first to stimulate individual muscles for general diagnosis. He wrote a book in 1855 about his muscle tests: *De l'électrisation localisée*.

In 1857, Hugo von Ziemssen carefully mapped out the entire surface of the body showing the location of the motor points. He marked these with silver nitrate and proved by dissection immediately after death that his clinical charts corresponded with the entrance of the nerves into the muscles. He published anatomical charts showing where to stimulate the motor points, and the facial expressions resulting from the stimulation of the individual facial muscles.

Hugo von Ziemssen found that these points vary slightly between people and that they are the junctions between the nerves and the muscles. When an interrupted galvanic current is applied to a point on the body, there will be a minimum voltage where the muscle contracts. This is called the "cathode closure contraction." If the polarity of the electrodes is reversed, a higher voltage at the anode is required to contract the muscles.

Faradic current is a pulsed uneven alternating current. It produces a mild prickly sensation when the stimulation is of fairly short duration. If the muscle reacts to a pulse of faradic current, the motor neurones are intact. When the pulses are repeated more than 20 times per second, there was no time for muscle relaxation and the contractions became tetanic. When the current is interrupted, the muscle contractions begin and end suddenly.

The negative pole of electrical current produces muscle contractions most easily. Sine wave current produces a marked prickling stimulation, because the stimuli are of longer duration. The marked stimulation produces vasodilation and the skull reddens with the increased flow of blood to the tissues. The sine waves are not as comfortable as the faradic currents.

Muscle contractions increase the demand for oxygen and food. This dilates the capillaries, and there is an increased blood supply to the muscle. As the muscles contract and relax they exert a pumping action on the veins and lymphatic vessels.

The French doctor Henry Bordier was the first to try using electrical currents to develop the muscles. He used a metronome to interrupt a direct current. The pulsed current was applied to the arm muscles for one second and then interrupted for one second. The treatments were done for six minutes three times a week at an intensity of 10-15 ma. After two months, the circumference of the upper arm rose from 26.5 cm. to 29.2 cm. The muscles of the entire arm increased by about 2 cm., and the subject was much stronger.

These experiments were redone in the 1980's by sports trainers eager to increase muscular strength. The Russians used a pulsed 2500-hertz current for athletic training. Russian sources reported a muscle strength gain of 20-40% after 20 days of maximal muscle constric-

tion. The muscle has to be overloaded to obtain an optimal increase in strength.

In 1872, Dr. George Vivian Poore treated a man who had a severe case of writer's cramp and spasms of his right arm. The patient was a writing clerk in the days before the typewriter, and because his handweiting was so good, he had long hours of work. His handwriting suddenly began to degenerate and in a few days he couldn't use his right hand. He was able to do some writing with his left hand; then it degenerated. He had to quit work and live on his savings, which were nearly gone. He had taken five different medical treatments without results. Dr. Poore tried strychnine, and then potassium bromide, which helped his sleep, but didn't improve his hand. Then Dr. Poore got a battery of 23 cells and attached them to salt water sponges on either side of the deltoid muscle. He counted "one, two," like a drill sergeant, and the spasms subsided. All of the muscles of the arm were exercised in the same way.

The next day the man noted that his arm had very few spasms; within two days he was able to use the arm for dressing himself. Every day the muscles were exercised with the direct current, and there was marked improvement. When Dr. Poore started, the patient's handwritten name was an unreadable blur. In a week it appeared more legible. In six weeks it had returned to a beautiful handwriting again.

Dr. Poore gave a friend a pound weight and had him stretch his right hand out straight and hold the weight until he could no longer hold it out. After about four minutes, the man had muscle pain and had to lower the weight. Then Dr. Poore put a positive pole in the axilla [armpit] and a negative pole further down the arm. The patient remarked "All the fatigue is gone, and I feel as strong as when I began." Other friends had the same reaction; when the current was flowing, muscle fatigue was apparently gone.

Most people could hold the weight at right angles to the body for about three minutes. A strong friend was able to manage six minutes with great effort. The next day Dr. Poore had him hold the weight out and passed the current for the whole time. The friend was able to last more than 13 minutes.

Dr. Poore had friends squeeze a dynamometer eight times, resulting in a combined effort of 388 pounds. When a current was applied through the muscles, the next eight squeezes registered 477 pounds. The next day he reversed the sequence. Six squeezes with a current yielded 431 pounds of effort, and the next six squeezes without current yielded 279 pounds. He tried alternating the squeezes with and without current. A normal squeeze was about 60 pounds and a squeeze with current flowing was about 80 pounds.

Physical therapists used electrical stimulation to increase local blood flow. Increased blood flow would aid athletes and it could help injuries heal, and restore the area. The theory was evaluated in 12 healthy subjects who received pulses of the maximum tolerable voltage that they could stand for ten minutes. Their blood flow was measured and graphed in relation to the duration and voltage of the pulses. The study found that a voltage lower than the maximum and 32 or 128 pulses [sic] per second had the best effect on increasing blood flow. A negative polarity had the greatest effect, but broader evaluation was needed to establish the clinical effect.

Before polio vaccination, thousands of people found themselves paralyzed every summer. They often thought they were coming down with flu. When they woke up the next day, they found they could no longer walk or use their arms. The polio virus is carried by flies and is still around, although most children are now immune.

Dr. Poore treated an 11-year-old girl whose left leg was powerless. He attached the positive pole to her spine and used a wet sponge electrode over the entire surface of the leg as the negative pole. It took four months of treatment before the muscles began to react. With a little more treatment, the girl was able to walk without problems.

Jean Bergonié found that successful paralysis treatment depended on the degree of stimulation. He treated a child with a paralyzed arm with a pad electrode at the shoulder level. The arm jerked, but the child played and slept during the treatment. He used a faradic current varying from 24 to 36 volts interrupted and reversed 40 times a second. The first treatments were for 30 minutes and then were increased to 90 minutes. He believed that the most serious case of polio paralysis could be cured if the electrical treatment was intensive.

Stephane Leduc used intermittent currents to treat muscle paralysis. His direct current pulses caused 12 muscular contractions a minute for about five minutes. The treatment was given twice a day.

Franz Nagelschmidt used surged sinusoidal current. In one instance, a brother and sister were taken ill with polio. The boy died; the girl had paralysis of the legs and back. After a few months of electrical stimulation, she was able to walk without limping, and dance.

A 21-year-old man suffered from polio at the age of 19. His legs gave him no support, and he could only walk on crutches. With the surged sinusoidal current, he gradually improved over a two-year period so that he could walk without crutches.

Paul Oudin used the violet ray to treat atrophied muscles. He used sparks to make the muscles contract. When it was used for treatment this way, it was passed over clothing instead of skin, so the distance produced a spark.

Oudin treated a 30-year old engineer with muscle atrophy of the Charcot Marie type. Walking was difficult and the use of his hands was nearly impossible. After every treatment, walking was easier for him. After six weeks of treatment. his walking became near normal, and he was able to resume his occupation. Then his hands became relatively paralyzed, and he couldn't extend his fingers. After five treatments, his fingers could be extended.

A 19-year-old woman suffered from Duchenne paralysis, and her arms, hands and fingers were nearly useless. After five weeks of treatment, she was able to put her hands on her head. The strength returned to her arms day by day. When her father had to leave Paris, the treatment stopped, so it was not known if the improvement lasted.

A medical student suffered from a locked left knee and the upper leg muscles atrophied. He was hardly able to walk, and he couldn't walk upstairs. After a month of treatment, he was able to resume medical studies, and after two months, he was nearly back to normal.

Athletes are constantly trying to get the winner's edge. Doctors tested TENS electrical stimulation on 21 well-trained competitive athletes. The stimulation of muscles was done 30 to 45 minutes before competitive exercise. When athletes were subjected to an increased workload on a bicycle ergometer, it increased the maximum capacity by 9%.

A long-distance woman runner was tested ten times over four weeks. Five tests were made following electrical stimulation and five with placebo stimulation. The woman gained a mean time of 5.5 seconds. Two runners had a reduction of 2 seconds in 800-meter races. Competitive swimmers shaved nearly a second off their times. Electricity may be the athlete's best friend!

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

Annales d'Electrobiologie 11:233, 1908 "Action of the Effluve on Atrophied Muscles" P. Oudin

Annales d'Electrobiologie 12:349, 1909 "On the Electrical Treatment of Paralysis of Atrophied Muscles by Intermittent Currents" S. Leduc

Archives d'Eléctricité Médicale 10:331, 1902 "Effects of Pulsed Current on the Nutrition and Development of the Muscle of Man" H. Bordier

Archives of Physical Therapy, X-ray and Radium 17:404, 1936 "Low Voltage Currents" F. Nagelschmidt

British Medical Journal 1:461, 1927 "The Electrical Treatment of the Paralysis of Poliomyelitis" R.J. Morris

Clinical Science 81:607, 1992 "High-Voltage Pulsed Galvanic Stimulation: Effects of Frequency and Current on Blood Flow in the Human Calf Muscle" M.E. Heath *et al.*

Journal of Sports Medicine 26:60, 1986 "Effects of 2500 Hertz Sinusoidal Current on Fiber Area and Strength of the Quadriceps Femoris" D. St. Pierre *et al.*

Proceedings of the Royal Society of Medicine 66:18, 1973 "The Achievement of Duchenne" E. Campbell

18. ELECTRICAL BONE HEALING

"It is useless to argue whether electricity is harmful or useful, for it is both since these are attributes which are not mutually exclusive. Every therapeutic agent will be harmful if used improperly. What physician would refuse to use vomitives or purgatives because some ill-advised physicians have take the heart or even the lives of patients by their use? Let us assume that my prophecy comes true, that we shall be able to administer electricity with such strength that it will break an arm or leg. The break would result only from an overdose of electricity, but this would not exclude the use of small amounts of electricity for medicinal ends. I have said for the first time in the present work that eventually we shall be able to attack diseases by electrification."

Thoughts About Electricity Johann Gottlob Krüger

When a bone is broken, we immobilize it for several months and expect the arm or leg to be as good as new. On many occasions, the bone simply refuses to heal, and the person can be crippled for years. Often it is a problem of advanced age, where the body has lost its regenerative capacity. This is a major medical problem; it is estimated that nearly 100,000 fractures a year fall into that category.

Bone is about as strong as cast iron in resisting compression. Bone is the mineral apatite, which is a mineral mixture of calcium phosphate. About 20% of the bone is live bone cells. Bone doesn't heal as such, but new bones are formed from other tissues to fill the gap where the fracture is.

When a crab generates a new shell or a seashell grows, it uses a weak electrical current to form a calcium skeleton. Our bodies form bone in the same way a crustacean forms a shell. The mitochrondia are the powerhouses of the cells. Their ATP sequesters adenosine calcium phosphate and deposits it into to bones.

The first mention of using electricity to heal bones is contained in Alexis Boyer's book on surgical disease, *Traité des maladies chirurgicales et des opérations qui leur conviennent*. In 1812, he described a case in which a fracture didn't unite after 13 months. The leg below the fracture could be moved easily in any direction without causing much pain. A current was applied and after two weeks, the limb became less flexible. After six weeks of electrical current, the man was able to walk.

In 1850, Frederick D. Lente wrote an article on using electricity to cure three people whose bones didn't unite. He noted that many doctors used a seton to irritate the area, in hopes that the bone would begin to unite. Mary Waters made a false step on the street and broke both bones of her left leg. No healing had taken place two months later. Lente gave her ten-minute treatments with electricity. A month later, the union was quite firm, and the patient was discharged.

Lente wrote: "Electricity is easy of application, not very painful and in no way dangerous. But to be effective, it must be applied in connection with acupuncturation. It appears to have little or no effect when the poles of the battery are applied merely to the soft parts on either side of the fracture as the current does not appear to reach the bone at all."

In 1853, Dr. Marlz Holl had a man with a leg fracture which didn't unite. A year had passed, and there was no sign of healing. Dr. Holl put a needle into the interspace and passed a direct current into the break for the next two weeks. The leg began to heal, and he felt that he had made an important discovery.

In 1860, Dr. Alfred Garrett treated a ship captain who fell and broke his thigh while building a ship. The fracture didn't heal for months. Garrett put the leg in a splint and inserted long electropuncture needles. A needle was put into the upper inner edge of the femur muscle so the point would touch the bone near the fracture. The needles were insulated, except at the tip, so the electricity wouldn't escape into the flesh.

A ten-cell Daniell battery was connected to the needles for five minutes a day. This was repeated every third day for three treatments. Then the current was applied daily from large sponge electrodes applied to the legs. Three weeks later the patient was freed from the splint, and the thighbone was knit together and the leg was stiff. Three months after he was released, the old captain was on a ship heading towards the East Indies.

Large numbers of fractured limbs occurred during WWI. Dr. Alfred E. Barclay reported on a number of men with ununited fractures, which were treated with electricity.

Old literature records one instance in which the violet ray was used to stimulate bone healing. A railroad worker broke the bones in his forearm. They were set in a hospital, but three years later, they still didn't unite. He went to specialists who couldn't help, but after using high frequency electricity, the bones united.

Robert Becker and his research team did studies on the amount of current necessary to start bone formation. When Frederick Brown dropped the current applied to test batches of frog blood to 700 picoamps, the cells began to change, first at the negative electrode, then at the positive electrode. This is far less current than humans can feel.

Bone breaks did not respond to high currents. They did respond to a current in the range of 5 to 20 microamperes. This is little more than the current that it takes to run a watch. The bone cells did not multiply to bridge the gap. The red blood cells dedifferentiated and became primitive cells, which began to generate bone!

An infection in the bone area is the most difficult to heal. Often it will remain for years, draining pus and stubbornly refusing to heal. Robert Becker made a small electrode of silver, which released ions into the fracture area. The silver ions killed off the infection and stimulated healing.

In experiments the fibula bone of rabbits was cut with a fine saw. A current of ten microamperes was applied to half of the bones. Accelerated healing occurred only when the cathode was situated within the fracture gap. After 18 days, the healing was advanced enough to permit mechanical stressing of the fracture.

Several experiments suggest that healing is accelerated with pulses. A 15-hertz field generated 20% more tone. Another study involved pulsed electromagnetic fields. All but two of the delayed healing fractures healed within ten months using a field of pulses of 300 microseconds separated by 1500 microseconds.

A two-year-old boy had surgery on the tibia, the leg bone. Eleven years passed and the tibia still hadn't healed properly, leaving him a virtual cripple. The surgeons inserted two 10-microampere electrodes

at the site of the pseudarthrosis site and left them in place for 14 weeks. Nine months later, x-rays showed that the fracture had united.

A 50-year-old woman fractured her collarbone in a car accident. Two weeks later pins were inserted to hold the bone in place. The fracture didn't heal, so the pins were removed and an electrode was inserted into the break. A weak current was applied for seven weeks and the bone united.

In 1979, the FDA approved clinical use of electrical treatment for nonunion of bones. The treatment can be invasive by inserting needles into the fracture area. A second way is by using a powerful magnetic field, which stimulates an electric field. The magnetic treatment induces a current and can last as long as necessary. The success rate for inducing rapid healing by the electrical modalities is generally from 70-90%.

One of the major problems of aging is osteoporosis. The bones become thin and brittle, and when broken, take a long time to heal. The hind legs of young rats were immobilized, which resulted in bone loss. An hour of pulsed square-wave current resulted in marked formation of new spongy bone. This has promise for the treatment of osteoporosis.

In 1917, Cornelius Kappers elaborated the theory of neuro-biotaxis growth. He found that the cells and nerves reacted to an electric current in the growing embryo. In 1920, Dr. Sven Ingvar published a brief report showing that growing nerve fibers reacted to electricity.

It would be wonderful if, when we lost a finger or a foot, we could regrow it. If children under age ten lose the end of a finger, and it isn't stitched up, the entire finger will regenerate. As a boy, I cut off the end of a finger with a corn knife. I have to look very closely to tell which finger it is.

The newts, salamanders and axolotls naturally regenerate their lost limbs. They are unable to regenerate their limbs in pure water with poor electrical conductivity. An electrical current begins flowing through the missing area. The cellular debris is transported away; the uninjured cells begin to lose their specific characteristics, which they used to identify themselves as muscle or bone. They begin to divide and become the parts of the tissue needed to produce the new limb.

Scientists have been studying electrical regeneration in the legs of frogs. Frogs can't regenerate limbs, but they are related to the creatures that do. When a microcurrent is applied to the lost frog limb, stumps are produced which have large amounts of nerve tissue. The anode destroys the muscles, but the cathode stimulates regeneration. However, complete regeneration is not obtained.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

Annals of the New York Academy of Science 238:530, 1974 "Mechanism of Electrical Stimulation of Bone Formation" L. Klapper *et al.*
Annals of the New York Academy of Science 238:564, 1974 "Electrical Fracture Healing" Z.B. Friedenberg *et al.*
Archives of Radiology and Electrotherapy 23:205, 1918 "Electrical Stimulation in War Injuries with Respect to Ununited Fracture" A. Barclay
Calcified Tissue Research 18:111, 1975 "Electrical Modification of Disuse Osteoporosis" G.H. Kenner *et al.*
Clinical Orthopedics 161:4, 1981 "A Brief Historical Note on the Use of Electricity in the Treatment of Fractures" L.F. Peltier
Journal of Biomedical Engineering 10:301, 1988 "Treatment of Delayed- and Non-union of Fractures Using Pulsed Electromagnetic Fields" D.J. Colson *et al.*
Journal of Bone and Joint Surgery 63A:2, 1981 "A Multicenter Study of the Treatment of Non-Union With Constant Direct Current" C.T. Brighton *et al.*
Journal of Bone and Joint Surgery 74A:920, 1992 "The Effect of Low Frequency Electrical Fields on Osteogenesis" K.J. McLeod *et al.*
Journal of Experimental Zoology 200:403, 1977 "Bioelectricity and Regeneration" R.B. Borgens
Medical Instrumentation 8:258, 1974 "Healing Fractures Electrically" D. Stillings
Nature 224:1113, 1969 "New Mechanism for Calcification of Skeletal Tissues" F. Leonard *et al.*

19. ELECTRICAL WEIGHT REDUCTION

"It [electricity] induces an acceleration of the pulse, it is singularly *calmant*, eases the respiration, develops animal heat, augments cutaneous transpiration, makes more active the urinary secretion, disperses nervous irritation, and gives tone to the whole organism. It is the great disperser of equilibrium to the disturbed balance of the system, it increases the vital forces, and augments the energy of absorption. In a word, it excites and facilitates the play of all the functions. It is regarded by those who use it as the greatest regulator of menstruation. The well-being which it instantaneously produces causes those who have once experienced it to wish for a repetition of its beneficent effects."

A. Arthuis *Traitement dei Maladies Nerveuses* 1871

In 1892, Theodore Guillez treated obesity with a high intensity direct current. He used large flat sponges applied to the buttocks, thighs and abdomen. The current was gradually raised to 150 milliamps and maintained for about 30 minutes. Each treatment was terminated with a series of current interruptions designed to provoke energetic muscular contractions. Patients were said to lose from 8 to 15 kilograms in a month.

In the same year, Jules Larat and Georges Gautier of Paris tried treating overweight patients with a sinusoidal electric bath. All of the muscles were tetanized [continuous muscle contraction] for 35 to 40 minutes. These alternating currents tended to accelerate the heart, and the patients felt anguish.

In 1903, Henry Head studied the sensory nervous system. He found that a direct current pulse with a duration of 5 milliseconds gave a painful electrical sting. He decreased the pulse length and found that there was no sensation at all at 2.5 milliseconds. He worked with Lewis Jones to produce induction coils, which produced no sensory effects.

In 1903, Stéphane Leduc showed that an intermittent direct current could replace the faradic current for medical purposes and was particularly valuable in diagnosis. He designed a mechanical interrupter driven by an electric motor that varied the duration and

frequency of the resulting pulses. He found that the voltage necessary to give a minimal muscle contraction was lowest when the length of the pulse was 1/10th of the stimulation cycle.

Dr. S.C. Damoglou tried treating abdominal obesity with Leduc's currents using electrode cushions. A current intensity of 40-60 ma. contracted the abdominal muscles without any unpleasant symptoms. The treatments were done three times a week and lasted 15 minutes. By the 12th treatment, the abdominal girth of a 45-year-old man had diminished nearly three inches and the patient lost 9 pounds. Another patient measured almost four feet around the abdomen. He was treated three times a week, and by the 20th application, he had reduced more than five inches.

Over half of all Americans are overweight, and many are seriously overweight. Our remote ancestors were once peasant farmers, who dug roots and gathered berries. Life was hard and their bodies learned to conserve every calorie for lean times. Now we are city dwellers who sit behind office desks and peck away at computers. We don't walk to work; we ride in comfortable cars. Every street corner has a fast-food restaurant with pictures of large, affordable, calorie-ridden meals.

Ultraviolet light causes some stimulation of the metabolism, and many people lose weight after being exposed to the summer sunshine. Ultraviolet light treatments were given to a man who weighed 238 pounds. He complained of heart palpitations and difficult breathing. He did a lot of walking, but it didn't lower his weight. He took two ultraviolet treatments a week without undertaking a special diet. This reduced his weight to 212 pounds.

Jean Bergonié studied physics and science before becoming a doctor of medicine at Bordeaux in 1883. He studied electrical medicine in Germany and Austro-Hungary from 1885-7. He was a champion bicyclist who held records on several tracks and a member of many scientific societies. In 1895 he founded *Archives d'Electricite Medicale* and his wife edited the journal. When World War I broke out, he became an army doctor in field hospitals. After the war, he began working on cancer treatment.

In 1909, Professor Bergonié read a paper before the French Academy of Sciences on the electrical stimulation of muscles for weight

loss. He used a mechanical interrupter, giving about 30 to 50 pulses of direct current per second which produced muscular contractions without pain or fatigue. During the first quarter of a second, the muscles were rested, then they were excited by anode current for a quarter of a second, then a quarter second rest and finally a quarter second of cathode current. Since direct current forces ions through the body, the current was periodically reversed every quarter second so this would not happen.

The people treated were asked to avoid fatty foods and not eat for four hours before treatment. A medical history of the people was obtained. (Many obese persons have sugar in the urine and enlargement of the liver and intestinal autointoxication.)

Bergonié was struck by the large proportion of patients who had made pilgrimages to the great American and European spas. Often they lost 20-30 pounds during their trips, but they gained it right back after they returned home.

Professor Bergonié found that most people could tolerate a half-hour of electrical treatment, and this could be gradually increased to last an hour. Some patients could take two treatments a day, but generally one treatment a day was enough.

The subject would take off nearly all clothes except shorts, bra and socks and lie down on the chair. A wet salt-water towel was applied over the back, arms, buttocks, thighs and the legs. At first the electrical shocks were feeble and the first treatment was generally kept to 20 minutes. After ten minutes, the shocks were gradually increased to a comfortable tolerance and eventually to cause vigorous muscular contractions.

The first sensation was that of mild tingling, which disappeared as the strength of the current grew and induced muscular contractions. In general, five parts of the body were treated at one time. Each group of muscles was made to rhythmically contract with increasing intensity. The current retoned the muscles, and as the treatments continued, it took less current to restore good muscle tone.

The equipment was a reclining chair with an adjustable footrest, constructed of wood for insulating purposes. A series of ten electrode plates cover the body, and cotton towels soaked in salty water were

wrung out and put over the plates. The top electrodes were held in place with rubber bracelets. Sandbags were often put over the patient to make the contracting muscles work against extra weight. This developed the muscular system, and most patients found that they had much less fatigue.

The Bergonié device was connected to a rheostat, which controlled the level of voltage to each area being stimulated. Since he had no modern electrical equipment, the result was a very complex device. The apparatus had a series of dials that varied the current to the different areas of the body. The amount of current varied with the patient. A muscular patient might require about 25-30 milliamps, while a fat patient might need 70-80 milliamps to excite efficient contractions. Some areas of the body might require higher voltage in order to get normal muscle contractions. It took more current to contract the abdominal muscles than the muscles of the extremities.

The contractions of the muscles could be timed, and doctors were advised to set them 10 beats per minute below the pulse rate in cases of rapid pulse. The intermittent pressure on the veins stimulates the blood flow towards normal, and the heart beat falls after the treatments. The breathlessness, which was frequently present in these cases, was relieved. The blood pressure often came back to normal.

The first treatments might last 20 minutes in a seriously overweight person, given every other day. The first month, the treatments might be daily and then every other day. Bergonié asked his patients to drink plenty of salty water before and after the treatment to help the body get rid of the toxic waste products released by the muscle treatment.

The treatment was not only for weight loss. During WWI, it was used to treat men who had lain in hospital beds for months. Their muscles and bones had atrophied during the long period of time it took to heal their wounds. Treatments in the Bergonie chair restored their muscle tone and will to live.

Professor Bergonié used a faradic coil set at 24 volts with a rate of interruption of about 100 pulses per second, and reversed every 30 seconds. The current density was only 0.01 milliamperes per square centimeter. It was not necessary to use diets or any special preparation while doing electric weight loss.

A typical treatment would take off about half a pound, and a long treatment could take off as much as two pounds, although this was not considered desirable. Adolph Veith modified the equipment and used it to treat German patients. He used a surged sinusoidal current, which didn't affect the muscles quite as much.

Another interesting aspect of the treatment was that it caused weight loss in specific areas of the body. If the thighs or stomach were unusually fat, the weight could be reduced in that area alone. It was not necessary to connect the electrodes to the other parts of the body.

Patients with high blood pressure found that the peripheral vessels dilated and their blood pressure fell. Patients with low blood pressure found it rose towards normal during the treatment. Many patients who complained of insomnia commented that they had a return of normal restful refreshing sleep. People became more active with the course of the electrical treatment, and felt energetic.

A 28-year-old woman who was 5 feet 4 inches and weighed 219 pounds had followed many diets with only temporary results. With six weeks of electrical treatment, her weight fell to 193 pounds. She discontinued the treatment and then took occasional treatment. Her hips and thighs were reduced eight inches and her stomach was reduced seven inches.

A doctor's wife went from 175 pounds to 160 pounds after four weeks of treatment. She felt more energetic and continued to lose weight without treatments. Her asthma was better, and she had regular bowel movements.

A 40-year-old woman took electrical treatment for four weeks and lost 15 pounds. Her low blood pressure had been 106/78, which went to 126/78. She lost six inches on the abdomen and five inches on the hips. Her poor health began to improve.

There has always been a demand for weight loss equipment, but there was less demand in the early years of the 1900s. When World War I came along, Professor Bergonié's equipment was forgotten. The Sanax Company of New York City sold it in the U.S. At the time of the war, the concern was getting enough to eat, and weight loss was not a concern. Electrical weight loss was buried in the pages of the old medical journals. Some would be of interest to revive now.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

American Journal of Electrotherapeutics and Radiology 38:73, 1920 "Modern Treatments of Obesity" E.C. Titus

Archives d'Eléctricité Médicale 19:308, 1911 "The Cure of Obesity by Electrical Exercise Provoking Technique" J. Bergonié

Archives d'Eléctricité Médicale 20:209, 1912 "Electrotherapy in the Treatment of Obesity" E. Speder

British Journal of Physical Medicine 6:113, 1931 "Therapeutic Uses of the Faradic Current" L.D. Bailey

International Clinics 26:#3/36, 1916 "The Treatment of Obesity With Special Consideration of the Results That May be Obtained by the Use of the Naegelschmidt-Bergonié Method" B.B.V. Lyon

Journal de Radiologie et d'électrotherapie 9:113, 1925 "Professor Jean Bergonié (1857-1925)"

Lancet 1913 "Abdominal Obesity and Its Treatment by Low-Frequency or Leduc's Currents" S.C. Damoglouy

Lancet 1:231, 1982 "Treatments of Obesity by Ultraviolet Rays" C.L. Williamson

Scientific American ***Supplement*** 83:142, 1917 "Electrical Treatment of the Wounded" W.J. Turrell

20. ELECTRICAL NARCOSIS or SLEEP

"You know yourself the property of the torpedo or cramp fish, which not only benumbs all those that touch it, but also strikes the numbness through the very net into the hands of them that go about to take it. And some that have had greater experience of this fish report that, if it happen to fall alive upon the land, they that pour water upon it shall presently perceive a numbness seizing upon their hands and stupefying their feeling, through the water affected with the quality of the fish. And therefore, having an innate sense of this faculty, it never makes any resistance against any thing, nor ever is it in danger. Only swimming circularly about his prey, he shoots forth the effluviums of his nature like so many darts, and first infects the water, then the fish through the water, which is neither able to defend itself nor to escape, being (as it were) held in chains and frozen up."

Morals Plutarch

In 1858, Benjamin W. Richardson tried to prove that constant current could possess anesthetic properties. Morphine is not absorbed through the skin, but Richardson dipped a sponge in a morphine solution and backed it with a copper plate connected to the positive pole of a battery. The negative pole was placed on a wet sponge placed a little lower on the arm. After several minutes passed, there was no sensation when the arm was pricked with a needle.

The next year he shaved the hind leg of a dog and wrapped a copper band around it with a sponge soaked in aconite and chloroform. He wrapped another sponge covered with a copper plate around the lower part of the leg. After 11 minutes, it was insensitive to pain and Richardson proceeded to amputate the leg. The animal gave a minor indication of pain.

In 1902, Stephane Leduc produced brief pulses of low voltage direct current with 100 interruptions per second. He found that a 12-volt current interrupted 200 times per second would produce local and general anesthesia. The pulsed DC current became known as the Leduc current.

Leduc placed the cathode on the forehead and the anode over the spine in the region of the lower back. The first trial was carried out

on small dogs with a current of three volts. After three minutes, the dog was completely anesthetized. In order to produce narcosis, it was necessary to start with a relatively high current, which knocked out the animals, and then reduce the current. A minute after the current was turned off, the dog was apparently normal.

During the next experiment, the dog woke up under the current, so it was necessary to increase the current. There was a stage of excitement, but the experiment was completed without any further reaction. When the current was turned off, the dog staggered a little, but walked normally.

Experiments with dogs showed that the best way to put them under was a relatively strong current of 300 milliamps for 30 seconds. Then the current was reduced to 50 milliamps. After the shock of the current, the legs flexed and the standing animals fell. There were spasms in the legs after 5-10 seconds. Then the breathing stopped. Sometimes there was urination or a bowel movement. The heart stopped for a few seconds and then began to beat at a slower rate.

When the current decreased, there was twitching which receded spontaneously. In the state of electronarcosis, dogs could stand if placed on their feet. Their eyes were closed, and there were no righting reflexes. Pinching or pricking the skin produced no reaction. If the current was high, respiration was difficult.

Two doctors helped Stephane Leduc try electronarcosis on himself. He felt unpleasant sensations as the current was increased. He couldn't speak, and then he was unable to move, although still conscious. His perception was dreamlike.

Leduc described his experiences: "When the current was at its maximum we could still hear as if in a dream what was said around; we were conscious of our inability to move or to communicate with our colleagues. We did feel contacts, pinching and pinprick in the forearm, but the sensation was blunted as if the extremity was numbed. The most unpleasant feeling is to be aware of the disassociation and progressive disappearance of the faculties."

If the electrodes were placed on the frontal part of the skull, the pupils become constricted and didn't respond to light. If they were placed in a low position, there was profuse secretion of saliva and tears.

When Leduc announced that he had produced electrical sleep, Nicola Tesla remarked that he passed a current 5,000 times stronger through his head and didn't lose consciousness. He did fall into a deep sleep when he lay down. Tesla remarked that it might be dangerous to apply strong currents to the brain.

The first medical experiment was done with a man who suffered for years with congestive headache, although he took many medicines to relieve it. The negative electrode was placed on the top of the neck and the positive was placed over the lower back. The experiment started at 4.5 volts and 1.5 milliamps of current. There was a fluttering or palpitating sensation. The headache was not relieved, but it shifted to the left side of the head.

Then the electrode on the upper neck was placed on the forehead. The patient experienced a dull heavy pressure extending across the entire frontal region. As the current increased, there was a fluttering or palpitating sensation. There were sensations of pressure, palpitating and rushing currents. There was a soothing feeling that seemed to underlie the other sensations, which seemed to be internal. The headache was reduced. When the current was shut off, he felt confused and then exhausted. He slept for a few hours, and when he awoke, the headache was as bad as ever.

Electrodes were placed in the same position on a woman. The current was set at 6,000 interruptions per minute. When the voltage was increased to six volts, the woman went to sleep. Her pulse was regular, but her breathing was irregular. When the current was shut off, the woman felt like she was waking from a refreshing nap. She felt rested and energetic for the rest of the day.

Leduc felt that the only really useful current was a frequency of about 100 hertz. The pulse width of one millisecond was useful in electronarcosis. German researchers found that a 50-hertz alternating current pulse would work nearly as well. It slowly became apparent that any current capable of stimulating the central nervous system could produce electronarcosis.

Researchers attempted to use electronarcosis in mentally ill patients. Nine schizophrenics who had been ill for more than four years were given more than 100 treatments. The initial current strength was

maintained for 30 seconds and then decreased to the level supporting normal breathing.

The electrode's position on the head altered its reactions.

When the switch was thrown, the arms jerked forward and outward, while the legs flexed. The current stopped the heart for a few seconds, then it began to beat initially at 20 beats per minute. The respiration stopped briefly, then shaking and twitches began, and breathing returned to normal. Some patients became restless after about seven minutes, and the experiment was terminated. If the current was slowly increased, the patients remained in the electronarcosis state.

The first experiments didn't go well, but later experiments with Russian electrosleep equipment produced better results. If the illness was less then two years in duration, it could cure the patient. Electronarcosis was applied to 47 schizophrenic patients with short-term illness. In this series, there were 19 recoveries, and 16 social [sic] recoveries.

A 17-year-old boy developed delusions two weeks before admission into the Navy. He was given seven electrosleep treatments and adjusted so well he was able to enlist in the Navy. The 28-year-old wife of a naval officer developed delusions and began hallucinating. She was given 29 treatments and recovered.

A group of 12 patients with depression and insomnia were treated for five to ten times for 30 minutes. The current was set at 100 hertz with a pulse duration of 1 millisecond. The voltage ranged from 12 to 20. The effect was marked in 9 of 12 patients with immediate improvements in sleep and improved feelings.

The use of electrosleep units produced mixed results. The first results might be difficulty sleeping and waking up frequently! With continued use, the sleep usually became deeper and more regular. Patients often felt an increase in energy while awake with mild euphoria.

Sedac units using weak currents proved to be quite useful in treating phobias. The electrodes were placed over the bridge of the nose and the current was switched on. The forehead electrode was positive and the negative pole was attached to the wrist.

An 18-year-old college student became increasingly fearful and obsessive. She had episodes of acute panic and delusion about the end of the world and flying saucers. She took Sedac treatments three times a week and then twice a week for three weeks. The phobias declined and she was able to resume college.

A woman with three children suffered from attacks of sudden fearfulness with trembling and she made several visits to the hospital emergency room. She was given Sedac treatments for three weeks, which brought about dramatic improvement.

Electrosleep proved to be useful for getting people off of methadone addiction. Two groups of 14 persons were studied. The 14 receiving electrotherapy had marked reductions in anxiety. Half had normal anxiety function. After eight treatments, nine patients were able to get along without methadone.

A hospital at Bordeaux did an experiment with detoxifying heroin addicts. The Sedac unit was attached to the patient for 48 hours. The patients could detach the unit to take a bath or walk about. It proved to be quite helpful in detox treatment. The psychiatric team tried placebo stimulation, but this produced no results.

In 1951, an Italian doctor made an attempt to do surgery on a patient under electrosleep. This didn't work well, and higher currents made it necessary to give injections of a muscle relaxant drug beforehand. Minor surgery could be done under electrosleep. The French dental surgeon Aimé Limoge used a special unit to do surgery on patients. He put the cathode between the eyebrows and the cathode behind the ears. The 77 hertz current passed through the sides of the brain.

Modern electrosleep units produce a relaxed state with a low intensity electrical current. Batteries power the device making it independent. The patient lies on his or her back with an electrode over the upper face. The cathode [negative] is applied over the eye and the anode is applied over the mastoid process, the bone behind the ear. The treatment starts at 100 pulses per second with a pulse duration of 1 millisecond. The voltage is raised until a mild tingling sensation starts.

The treatment lasts 30 minutes and may be repeated for up to three weeks. The patients may not fall asleep, but may experience blurred vision and a mild headache. Others report being extra alert, with improved sleep afterwards. There seems to be a curative effect in a variety of clinical conditions.

A Somniatron unit was tested on 32 neuropsychiatric patients. The pulse rate of this experiment was synchronized with the 11 cycles per second of the brain's alpha rhythm. Attainment of sleep during treatment was not pursued directly, but there was emphasis placed on getting a good night's sleep afterward. It generally took 3.3 sessions to reach a restful sleep.

Bibliography

The journals in this bibliography are listed in alphabetic order. Most large medical libraries shelve them in this manner. All foreign titles of articles have been translated for the benefit of my English readers. The authors of books are listed after the journals.

Annales d'Electrobiologie 5:526, 1902 "Production of Sleep and General and Local Anesthesia by Intermittent Currents of Low Tension" S. Leduc

Archives of Neurology and Psychiatry 51:232, 1944 "Electronarcosis in Animals and in Man" J.P. Frostig *et al*.

Archives of the Roentgen Ray 12:46, 1907 "The Electric Sleep" S. Leduc

Diseases of the Nervous System 31:56, 1970 "Sedac Electrotherapy in Phobias" E. Friedman

L'Encephale 13:225, 1987 "Opiate Withdrawal and Electro-stimulation" F. Ellison *et al*.

Nebraska Medical Journal 58:9, 1973 "New Frontier: Electrosleep Therapy" J.A. Pleitez

North American Journal of Homeopathy 23:504, 1908 "The Leduc Current in Anesthesia and Therapeutics" W.H. King

Proceedings of the Society for Experimental Biology and Medicine 49:530, 1942 "Current Control in Electroshock Therapy" M.S. Plesset