Therapeutic Electricity and Ultraviolet Radiation

THERAPEUTIC ELECTRICITY

AND

ULTRAVIOLET RADIATION

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Preface

At least a thousand books have been written on electrotherapy. We have not discovered quite that many titles, but, if we count the different editions (sometimes equivalent to new books) and those we have missed, the list undoubtedly exceeds this number considerably. Since the publication of the first book on the subject in 1744, the average output has been about five books a year. Until the rate drops to less than one new book a year, the subject cannot be ignored or dismissed as "of historic interest only". During the last decade at least one book has appeared each year on electrotherapy. This indicates an interest even if it does not mean that the field is important. Is electrotherapy important? Is it sufficiently important to warrant another book?—a new book? For this is the first *new* book, covering all aspects of electrotherapy, in English in over a decade. The editor does not know the answer to this sequence of questions, but he does know that the number of electrotherapeutic devices manufactured and sold remains high. This does mean that some—quite a few—people want and sometimes demand electrotherapy.

There is discouragingly little evidence that electrotherapy is better than other forms of therapy for the treatment of any disease. But medicine has not yet advanced to the point where treatment is always based on science. Aspirin, a most widely used drug, has not been proven to relieve headache, but its enormous sales prove that people and their physicians think it does. Electrotherapy is something that some physicians and their patients consider worth trying after, and sometimes even before, other methods fail. Why?

Electricity is closer to the supernatural than almost any force man can manipulate. It can give pain or a sort of "therapeutic sensation" almost at will. It is a positive force which can be felt at once; it is so different from *negative* advice or an imperceptibly slow-acting medication. It is available in many and sometimes dramatic forms and it is applied from apparatus which may have as many controls as an airplane dashboard. Electricity can make a paretic muscle move as no other force can. It can contract a muscle against the will of the patient to resist it. It is closely associated in the minds of many with such high-sounding but meaningless expressions as *dynamic* or *atomic*—magic words when applied to therapy. Electricity can be given with precision impressive to all. Its effects can be immediate or readily apparent through movement, sensation, color change and, sometimes, following the application of the faradic current, the relief of pain.

From the time of its first use over two centuries ago it has had a tremendous psychologic advantage: immediacy. It has always had appeal and even glamour. Electrotherapy is not only better than no treatment, its use may renew or elicit hope. It is often used as a *reaction therapy*. Until we have a specific for every symptom and ailment, electrotherapy will have a place in patient management.

During World War II, and soon after, the emphasis in the field of physical therapy shifted to *active* participation by the patient. Electrotherapy rapidly diminished in importance, especially in the United States where it was regarded by some as old-fashioned. It became difficult to find "progressive" physiatrists willing to associate their names with chapters on electrotherapy. Since "progressive" usually means "young", our problem was to find highly qualified men young enough to be progressive, old enough to be experienced and broad-minded enough to write about a sparkling subject dispassionately. As any reasonable reader may discover for himself, we have achieved this goal.

In summary: there are times when the honest physiatrist is left with nothing to try but electrotherapy—often to the satisfaction of his patient and himself. At such a time and at other times he will find the chapters of this book as sound as any ever written on the subject.

Most people will agree that light is something which can be perceived by the human eye. Thus, in the strictest sense, the electromagnetic energy called ultraviolet should not be called light. In this book we shall speak of ultraviolet rays, radiation, energy and therapy. We cannot hope to change a long established custom among many of calling ultraviolet *light* but we hope that with the advance of time physical medicine specialists will recognize the inaccuracy of such an expression.

The history of ultraviolet therapy is markedly different from that of electrotherapy. From the beginning, ultraviolet was "specific" and even more dramatic—so dramatic that Finsen, one of its earliest protagonists, was granted one of the first Nobel prizes in medicine for his use of it. But time after time the triumphs of ultraviolet were replaced, or displaced, by drugs—in non-pulmonary tuberculosis, rickets, erysipelas and furunculosis, in fact, thus far, in almost every disease except psoriasis. Whereas electricity has been with us for more than two centuries and has virtually exhausted its therapeutic possibilities, ultraviolet, the newcomer, remains the subject of continuing scientific examination. Relatively few articles appear each year about its use, but clinicians, especially dermatologists, use and rely on it far more than their literary output would indicate.

There have been many good books on ultraviolet therapy in the past. The multivolume work of Brody and the thorough book by Mayer are but

two examples. We are of the opinion that the chapters on ultraviolet radiation in this book are the best ever assembled under one cover.

In previous volumes of this series, the method of treatment expressed in the title has been applied to diseases or disabilities, for example, heat in arthritis or exercise in heart disease. This approach was avoided in the present volume because the length of chapters so arranged would be too short, in the light of current usage. Nevertheless, the use of all physical agents, particularly their integration with each other and with nonphysical agents, is of such importance that we hope one day to bring out a volume on the physical treatment of disorders. Comments on this plan would be most welcome and helpful.

This is the fourth volume of Physical Medicine Library. The published reviews of previous volumes and the adoption of them as required texts by several of the leading schools of physical therapy in the United States are reward enough for the editor. The reward for contributors, however, poses a problem. The amount of money each receives in royalties for his efforts in behalf of the field of physical medicine is pitifully inadequate (a result of the very nature of a multiauthored book in a field where a book sells poorly if low in sensationalism and lay interest and high in technical words). We can only hope that the contributors will receive the same joy as does the editor from the unmistaken approval of the small but elite audience that appreciates attempts to improve the acceptance of physical medicine through better books.

Many physicians were given the opportunity to correct errors in this book. Again, as in the past, a handful of dedicated specialists in the field have responded to our call. We express our heartfelt gratitude to the following physicians for their valued help: André Denier, Jean Meyer and Jean Torlais of France, Jozef Jankowiak of Poland, Egill Snorrason of Denmark, and, in the United States, Alfred Ebel, Frank H. Krusen, Joseph B. Rogoff and Arthur L. Watkins.

Dr. Herman L. Kamenetz of New Haven gave his accustomed great assistance in checking references and spelling. Dr. Raimunds Pavasars of Connecticut translated the chapter on Electrosleep Therapy.

In previous volumes of Physical Medicine Library the editor did not ask any one physician to review the entire book for serious errors of omission or commission since to his knowledge there was no one physician who could rightfully be called the best informed on the subject anywhere. On the subjects of this book, however, there is one physician whose contributions are unchallenged as the finest. We asked Dr. Philippe Bauwens of St. Thomas' Hospital in London to read the entire manuscript for critical appraisal. We have not been able to incorporate all of his excellent sugges-

tions into the final text, but we have used so many of them that discerning readers will appreciate in this book a quality not achieved by the editor in previous volumes.

Treatment with electricity and ultraviolet energy is diminishing as newer remedies are discovered, but patients will continue to benefit from them for a long time to come. This book was assembled for those physicians who will keep an open mind toward these methods until they are proven or disproven to the satisfaction of all.

SIDNEY LICHT, M.D.
New Haven, Connecticut
January, 1959

PART ONE

Therapeutic Electricity

Contents

CHAPTER ONE

History of Electrotherapy

SIDNEY LICHT

Discovery of Electricity

The first written reference to magnetism, in 1186, by the British monk Alexander Neckham, does not refer to it as something new[1]. The most important early reference to magnetism occurred almost a century later. In 1269, Charles of Anjou lay siege to Lucera in Apulia. In the trenches outside the town, on August 8, sat the "perfect mathematician", Pierre de Maricourt of Picardy, called *Peregrinus* (*Pilgrim*, because he had taken part in the Crusades). The soldier monk was writing a "letter" to his friend Sigerus on how to build a perpetual motion machine with a natural magnet. In the letter he set down the principles of experimental research and described for the first time a compass with pivoted needle (the prototype of many electrical measuring instruments). He named (incorrectly but permanently) the needle ends or the poles of a magnet and suggested the conversion of magnetic energy into mechanical energy (an electric motor)[2]. As remarkable as its contents was the fact that the letter was preserved and its ideas widely disseminated two centuries before the invention of movable type.

The subject of magnetism was revived by two physicians before the primary presentation on electricity by still another physician. The first, Georg Bauer (*Agricola*), summarized all that was known about amber up to 1544. The second, Girolamo Cardano, seven years later published a work on the wonders of nature in which he called attention to the attractive properties of rubbed amber. In 1543 Nicolaus Copernicus asserted for the first time that the earth moved; it was this doctrine, brought to England in 1583 by Giordano Bruno, which started Gilbert on his attempt to discover why the earth moved, and there was no better approach to the problem in his opinion than that of using the artificial earth

[1] Whittaker, E. A History of Theories of Aether and Electricity. London, 1951.
[2] Benjamin, P. The Intellectual Rise in Electricity. London, 1895.

magnet proposed by Peregrinus. In his long book on the earth as a magnet[3], only a small section is given to the properties of amber, as a digression, to show that amber was quite different from natural magnets. He found that not only amber but many substances when rubbed possessed the "amber force". Amber is *electron* in Greek and *electrum* in Latin. Gilbert used the words "vim electricam", the amber force. In 1646 Sir Thomas Browne, another physician, used the word "electricity" for the first time.

Progress in the development of electrical knowledge was slow. Otto von Guericke, inventor of the air pump, preferred the political life to one of just law, mathematics and engineering in which he was trained, hence his renown as the Burgomaster of Magdeburg. He rotated a globe of sulfur[4] principally to disprove Gilbert's ideas on the earth as a magnet. Since his efforts were directed at trying to prove a sort of gravitation effect of the earth rather than something about electricity, little attention was paid to the fact that he had invented a static electricity machine. The next inventor of an electrical generator was Francis Hauksbee, who set out to produce a glow with friction. In 1709 he mounted a glass globe on a sort of lathe, set it whirling with a crank and held his hand to the surface to apply friction. He obtained the glow (in the globe); but more important, he developed a machine to produce electricity in London, where Stephen Gray lived.

Gray, a resident of the Charterhouse, began experiments in electricity in 1720 and, during the next decade, showed that it could be conducted and transmitted. In 1730 he suspended a boy from the ceiling with silk cords and showed that the human body is a conductor. In 1732 he proved that electricity could be induced in a parallel conductor.

A contemporary of Gray, Charles François DuFay of Paris, an army lieutenant at the age of 14, became an exceptional experimenter and engaged in the pursuit of the six sciences recognized by the French Academy. Stimulated by the reports of Gray, he applied himself "with wonder and admiration" to the study of electricity. He discovered and named insulation and, in 1733, the two kinds of electricity (vitreous and resinous), which Benjamin Franklin[5] later called positive and negative. The published

[3] Gilbert, W. De Magnete, Magnetisque Corporibus et de Magno Magnete Tellure. London, 1600. English translation by P. F. Mottelay. London, 1893.

[4] von Guericke, O. Experimenta nova (ut vocantur) Magdeburgica. Amsterdam, 1672. "If you would like to make this experiment take a glass globe the size of a child's head and fill it with crushed sulfur. Then place the globe over a fire until its contents are quite liquid. When the liquid has solidified, break the glass, remove the ball and keep it in a dry place. Then drive a hole through the ball and insert an iron rod into it to serve as a sort of axle". The axle was then supported on two notched wooden uprights so that it could be turned and rubbed.

[5] In 1746 Franklin's British correspondent Peter Collinson included in his regular

works of Gray and DuFay stimulated experimental research on electricity in Germany. Improvements were made in the machine by Winckler[6] of Leipzig in 1733 and especially by Bose[7] of Wittenberg in 1738, but, when the Scottish monk Gordon replaced the revolving globe with a cylinder at Erfurt in 1742, the quantity of electrical force which could be developed fired the minds of many, including the glass-blowers of Leipzig. They turned out large quantities of glass cylinders which were sold in the shops as toys for adults who amused their friends with static sparks; it became a sort of parlor game. By merely rubbing a glass cylinder, one could produce a noise, a shock or a spark strong enough to ignite a glass of brandy, and more glass was being rubbed in Saxony than anywhere.

Medical Electricity

No wonder that the students at Halle in 1743, in search of a question[8] to pose for the professor, asked him to give his thoughts on the new wonder, electricity.

The new professor was 28-year-old Johann Gottlob Krueger[9] who had

shipment of new books to the Library Company in Philadelphia a glass rubbing tube such as Franklin had seen used earlier in Boston by a Doctor Spence. Franklin became so interested in electricity that two years later he retired from business to devote all his time to its study. He called the two kinds of electricity plus and minus.

[6] Johann H. Winckler, professor of Greek at Leipzig, replaced the dry palm of the hand with a leather cushion held against the spinning glass by springs in 1733. The glass was rotated by a treadle and pulley arrangement and revolved at a speed of 680 turns per minute, enough to develop a very large charge.

[7] George M. Bose went from a teaching post at electricity-conscious Leipzig to Wittenberg, where he introduced the prime conductor to pick up the charge from the spinning glass.

[8] It was the privilege of the student body in eighteenth-century Germany to request a topic for discussion at the beginning of the school year. To the practical Prussian mind, the burning question about anything new was "Cui bono?"—"What good is it?" (In ancient Rome this phrase meant "Who benefited?" It was a legal term. The meaning given here is grammatically correct even though not acceptable to classicists.)

[9] Krueger, who was professor of both philosophy and medicine, first gave his "Thoughts About Electricity" as a series of lectures in 1743. These were published in 1744 and reprinted and "enlarged by notes" again the following year. In a way, it is the first book on medical electricity, although the book of his pupil, Kratzenstein, was the first to use medical electricity in a title.

At this very early time, Krueger recognized and recorded thoughts which were to recur almost every decade after him. "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

Johann Gottlob Krügers

Zuschrifft

an

seine Zuhörer

Worinnen er Ihnen seine Gedancken

von

der Electricität mittheilet

und

Ihnen zugleich seine künftige Lectionen bekant macht.

HALLE,

Verlegts, Carl Herrmann Hemmerde.

1744.

Christian Gottlieb Kratzensteins

d. Arzneywiss. Best.

herausgegebene

physicalische

Briefe

Dritte und vermehrte Auflage.

HALLE,

verlegts Carl Hermann Hemmerde

1746.

Fig. 1. At left, facsimile of title page of first work to mention electrotherapy, by Krueger. At right, facsimile of title page of third edition of first work on electrotherapy, by Kratzenstein.

just succeeded the 82-year-old Friedrich Hoffmann, the most distinguished physician in Germany. Hoffman had held the Chair of Medicine at Halle since the founding of the University in 1693 and was one of the first in modern times to espouse physical medicine.

Krueger (456) apologized to his students for not being fully informed on the subject. "My time is not given exclusively to physics, but must also be divided with my teaching of mathematics and medicine, and so I have not had the opportunity to make any experiments". But what is the usefulness of electricity? "For all things must have a usefulness; that is certain. Since electricity must have a usefulness, and we have seen that it cannot be looked for either in theology or in jurisprudence, there is obviously nothing left but medicine". He predicted that "the best effect would be found in paralyzed limbs; just as one uses flagellation with nettles to restore sensation and re-establish the power of motion", so can electricity be used.

Among the students present at these lectures was the 20-year-old Christian Gottlieb Kratzenstein[10], who was so impressed by the possibilities of

have taken the health 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 medical ends. I have said for the first time in this present work that eventually we shall be able to attack diseases by electrification".

Although Krueger was the first to write on electricity in medicine, we would be subject to criticism if we did not point out that the ancients also used this force therapeutically without identifying it as electricity. In addition to Galen and Dioscorides, the author most often cited is Scribonius Largus. The following two quotations are from *Compositiones Medicamentorum* (Strasbourg, 1786).

"Cap. I. 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; numbness is the sign of the cure."

"Cap. XLI. The live black torpedo, when available and placed under the feet carries off the pain of arthritis. The patient must stand in the water just off shore, and the torpedo must numb the whole foot and leg up to the knee. When that happens the pain is relieved and the cure is permanent. Thus was cured Anthero, hereditary freedman of Tiberius."

[10] Christian Gottlieb Kratzenstein was born in Wernigerode in 1723 and studied at Halle, where he became professor of physics in 1747. Two years later, he was appointed professor of mechanics at St. Petersburg. On invitation of the King of Denmark, he arrived in Copenhagen in 1752 and in the following year became professor of physics at the University. Even though his primary interest was in the basic sciences, he acceded to the King's demand that he investigate medical electricity further. He had considerable difficulty finding lodgings for himself and his fearsome electrical apparatus, until the courageous Mrs. Jensen was at last persuaded to rent him rooms (in a house which still stands). He published an advertisement in the Copenhagen press inviting all who wished to call at his rooms between four and