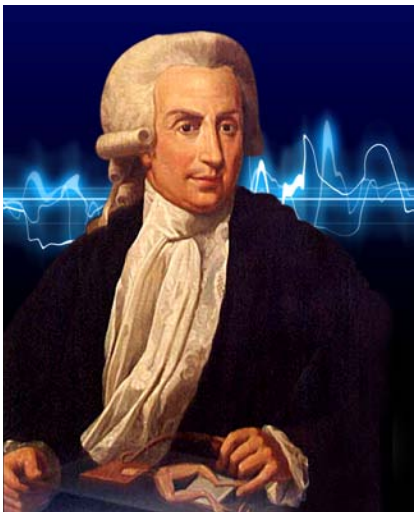

Lessons From The Father of Electromedicine — *Dr. Luigi Galvani*

Most everyone has heard of a galvanometer, and most even know that it has something to do with the measurement of electrical current. Few, however, know that the galvanometer is named after Luigi Galvani, an Italian physician who lived from September 9, 1737, to December 4, 1798. Even less common is the person, much less the physician, who recognizes that Luigi Galvani ranks among the great physician-scientists of all time.

To that point, Dr. Galvani is clearly the father of electromedicine. His discoveries about bioelectricity were profound. However, the distance in time between when he made his discoveries and the present have made all parties except medical historians unaware of his contributions. This is unfortunate, because Dr. Galvani's discoveries have great application in today's pain practice. For example, he discovered that electric currents are emitted at wound sites and that opium suppresses the body's electricity.

Who was Dr. Galvani, and what did he do? To start, in the 1700s Dr. Galvani was a practicing physician in Bologna, Italy. He had a curious mind and began studying and writing on anatomy and physiology. In his later years, he was convinced that body movement was controlled by some force or electricity. He conducted numerous experiments with frogs, and he is credited with discovering that electricity flows in currents. Prior to his discovery, electricity was known only to have a "static" or "spark" nature. His best-known experiment occurred in 1790, when he caused a dead frog's legs to move by means of electrical stimulation from a completed circuit that connected dissimilar metals such as copper and iron.

Animal Electricity

Dr. Galvani believed the vital force that caused muscles to move was "animal electricity." He contrasted this with the "natural" form of electricity that produced lightning and the "artificial" form that is produced by friction (ie, static electricity). He also believed that the brain secreted an "electric fluid" and that the flow of this fluid through the nerves provided a stimulus for the muscle fibers. His discovery that nervous action could be induced by artificial electrical phenomena marked the beginning of the study of electrophysiology. His experiments laid the foundation for electromagnetic treatments used today.

In the 1790s, a controversy broke out between Dr. Galvani and Alessandro Volta, an Italian physicist after whom the volt—a unit measure of electromotive force necessary to move one ampere of current through one ohm of resistance—is named. Volta did not believe that animal tissue contained electricity. He felt that the contractions of frog legs and animal muscle only occurred because of external electricity generated by contact of different metals such as brass, copper, and iron in a moist environment. Dr. Galvani later conducted an experiment with frogs that showed that muscular contraction of one leg in one frog would occur when touched by the exposed nerve and muscle of another frog.

In summary, Dr. Galvani and Volta were both correct. Before 1800, their collective pioneering investigations set forth the fundamental bioelectric understanding that is used in pain practice today—muscle and nerve contain innate electricity and external electricity can be administered to cause physiologic actions.

Dr. Galvani summarized the majority of his work in a 1791 treatise titled De Viribus Electricitatis in Moto Musculari Commentarius, which translates to "Effect of Electricity on Muscular Motion." Dr. Galvani's treatise was translated from Latin to English in 1953 by Robert Montravelle Green, MD, a Harvard anatomy professor.1 It is a difficult but fascinating read that I've done a half dozen times, and I highly recommend it to practitioners who wish to become electromagnetic experts.

Two of Dr. Galvani's many studies with frogs and electricity are of particular interest to pain practitioners today. In one of his studies, Dr. Galvani experimented with Leyden jars, which were the first batteries. Invented by the Dutch scientist Pieter

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Gets a **New Look** and a New Website

We hope you were pleasantly surprised when you picked up this month's issue of *Practical Pain Management*. From the cover to the new logo, PPM has undergone a major redesign to coincide with the launch of our new website: PracticalPainManagement.com.

The journal still contains the feature articles and departments that have made PPM a must-read for pain practitioners. But now PPM also includes some new items, such as:

- ☐ **Ask the Expert**
- ☐ **Case Challenges**
- ☐ **News You Can Use**

In this month's **Ask the Expert** (see page 103), Dr. Jennifer Schneider answers the confounding issue of opioid tolerance.

Dr. Laurence Robbins continues his discussion of "Heather"—a patient with complex refractory headache—in this month's **Case Challenge** (see page 82).

And **News You Can Use** brings you the latest news from the pain field (see page 104).

Also highlighted in this issue, is a special section devoted to **Electromagnetic Treatments** (starts page 55).

So sit back and enjoy the publication!

Also, please visit *Practical Pain Management's* redesigned website. We added a patient education side (an outstanding resource for your patients), and a Find a Specialist service. You can register your practice for free, and patients looking for a pain specialist in your area will then be able to find you with ease. The goal of *Practical Pain Management* continues to be to provide practical information that you can use in your daily practice to help improve patient care. We hope that these latest steps will help you do just that.

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Van Musshenbroek at the University of Leiden (Leyden), the jars' inner and outer surfaces were coated with metal foil, usually tin or silver, and an iron rod was in the core. When filled with an acetic fluid, an electric current was generated. The current produced by a Leyden jar would normally shock and kill a frog. Dr. Galvani found, however, that if the frogs were pretreated with opium, they would survive the electric shock. The opium could be administered into the stomach, abdominal cavity, or cerebrum. This experiment shows that opioids have a potent controlling affect on body electricity and helps to explain the remarkable effectiveness of opioids in pain treatment.

Another investigation that has direct relevance to pain treatment today is Dr. Galvani's work showing that damaged nerves emit an electric current. One of Dr. Galvani's students, Dr. Carlo Matteucci, carried on extensive studies of the emission of electricity from damaged nerves after Dr. Galvani's death in 1798. The importance of these early findings is that an injury to nerves, as found in the typical pain patient, emits an electric current that leaks into and pools in the tissue around the damaged nerves. It is this "free" or "pooled" electricity that may produce pain and inflammation.

Dr. Galvani laid the foundation for and provided the basic scientific understanding of the numerous electromagnetic measures that are employed today in the practice of pain medicine. It is only fitting that *Practical Pain Management* salute Dr. Galvani and dedicate this issue to this great physician-scientist.

—Forest Tennant, MD, DrPH
Editor in Chief

Reference

1. Green RM. *A Translation of Luigi Galvani's De Viribus Electricitatis in Moto Musculari Commentarius*. Baltimore, MD: Waverly Press; 1953.