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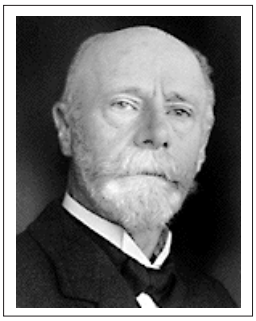
Willem Einthoven (1860–1927): Father of electrocardiography



In an age of great technical advances with many tools to evaluate and treat the heart we are referred to Einthoven's remarks "An instrument takes its true value not so much from the work it might possibly do but from the work it really does" (to Lewis 1922) and "Truth is all that matters, what you or I may think is inconsequential" (to Wiggers 1926).

Willem Einthoven was born on May 21th, 1860 in Samarang, Java, Dutch East Indies (now Indonesia). He was the son of a military physician and a descendant of Spanish Jews who had fled to Holland at the time of Spanish Inquisition.

Einthoven lost his father when he was ten years old, then his mother settled in Utrecht (Netherlands) with her children. There Willem Einthoven graduated from the Hogere Burger School and registered as a medical student at the University of Utrecht in 1878. In January 1886 he qualified as a general practitioner.

As a student he was particularly influenced by Franz Cornelis Donders, a physiologist studying the *action currents* of the heart. Donders supported him a professor of physiology position at Leiden University where he remained for the rest of his life.

The French physicist Gabriel Lippmann invented the *capillary electrometer* in 1873 which allowed Étienne-Jules Marey to record the first electrocardiogram in 1876. A physiologist at St. Mary's Medical School in London, Augustus Desiré Waller, was the first to succeed in registering the current of the heart from the body surface (First from his bulldog, Jimmy, then from himself). Waller, however, was unable to register the true shape of the recording.

Einthoven saw Waller demonstrate his technique at the First International Congress of Physiologists in 1889. Then he repeated the experiment and developed the necessary photographic equipment to register a graphic reproduction of electricity and sound produced by the hearts of humans and animals. Einthoven defined the physical constants of the capillary electrometer and calculated the *true curve*, which he called the *electrocardiogram*. He used only arm leads.

Based on Deprez and d'Arsonva's *wire coil galvanometer* and Johann Salomo Christoph Schweigger's *capillary galvanometer* Einthoven invented a new galvanometer for producing electrocardiograms using a fine quartz string coated in silver and was able to publish the first electrocardiogram using it in 1902.

On March 22nd 1905 Einthoven recoded the first tele-cardiogram. He utilized a telephone cable to transmit the signal from the hospital to his laboratory 1.5 km. During the next seven years Einthoven developed his *equilateral triangle of limb leads* considering the extremities as mere extensions of the electrodes. The size and direction of the electrical potentials of the heart were calculated from a simultaneous registration of the three contacts.

"Clinical" electrocardiograms were then transmitted by a cable from patients with heart disease in the hospital to Einthoven's laboratory. This *clinical* application was suggested by Einthoven's good friend Lewis. The correspondence between them is available thanks to H.A. Snellen's continued interest in publishing Einthoven's writings [1].

Einthoven's last work was his treatise on the action current of the heart, which appeared posthumously in Albrecht Bethe's 1872-Handbuch der normalen und pathologischen Anatomie, Berlin 1925.

Einthoven is remembered by most of his colleagues as a very modest man who was hospitable and courteous with a good sense of humor.

"Einthoven as a man had an unusual and compelling personality. In a crowd, he was indistinguishable, but when one saw him in the face, one recognized at once that there was a strong and vital personality — a personality of determination and drive" [2].

Einthoven used to ride his bike to the laboratory to work and would stay until he was reminded to go home by his assistants (upon request from Mrs. Einthoven). His ability to devote himself entirely to a particular intellectual inquiry with such determination, hard work and multidisciplinary knowledge were key factors behind his remarkable achievements.

His "Human imperfection" according to Fahr was being clumsy with hands during difficult nerve dissections. However, when there was trouble with the string galvanometer which nobody else could solve, his assistants would ask for his advice, even if he was working at home. He could almost always tell how to get the instrument going again without touching or even seeing it; a proof of his practical mind which Smojloff admired together with his theoretical knowledge.

His "perseverance, modesty, honesty and idealism" [2] were evident when he gave credit in his Nobel speech to Lewis and his co-workers as well as in his effort to share the award money with his assistant; He eventually shared it with his assistant's sister after knowing the former has died.

He could speak three languages fluently in addition to his native Dutch and this no doubt helped his influence in international scientific circles.

Both Einthoven and Lewis had to deal with the impact of World War I on the conduct of medical research and then with the issue of how to treat scientists who were former enemies [2].

Einthoven was a great believer in physical education. As a student he urged his fellows "not to let the body perish" [3]. He was President of the Gymnastics and Fencing Union, and was one of the founders of the Utrecht Student Rowing Club. After suffering from a sports-related elbow fracture he wrote his paper on the functions of the shoulder and elbow joints.

In 1924, while visiting America to give the Dungham lectures, Einthoven was awarded the Nobel Prize for Physiology or Medicine for his discovery of the mechanism of the electrocardiogram. He was elected foreign member of Royal Society in 1925.

Willem Einthoven died from cancer at the age of sixty seven.

Einthoven was a pioneer electrophysiologist. "He worked almost exclusively in the field of electrophysiology. This branch of physiology stood for a long time completely isolated from life, medicine and even from the general path of development of physiological knowledge" [4] Nonetheless, he was a brilliant physicist and a insightful physician.

"We should first endeavor to better understand the working of the heart in all its details, and the cause of a large variety of abnormalities. This will enable us, in a possibly still-distant future and based upon a clear insight and improved knowledge, to give relief to the suffering of our patients." (From "Het tele-cardiogram"; The tele-cardiogram, 1906) [5].

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Talal Moukabary, MD
Department of Internal Medicine
William Beaumont Hospital
3601 W. 13 Mile Rd.
Royal Oak, MI 48073, USA
Tel: 248 259 6025, fax: 248 551 8880
e-mail: talal@moukabary.com