A century of electrocardiographic progress: A tribute to Willem Einthoven on the 100th anniversary of his Nobel Prize on Medicine and Physiology

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Willem Einthoven was born on 21 May, 1860 in Semarang, a port city on the northern coast of the Indonesian island of Java. Indonesia was known at that time as the Dutch East Indies. Willem Einthoven followed in the footsteps of his grandfather (a surgeon) and father (an army medical officer), and began studying medicine at the University of Utrecht in the Netherlands.

In 1885, Einthoven defended his doctoral thesis on stereoscopy (a series of tests involving 32 volunteers whose pupils were partially covered). His dissertation was only 32 pages long, but he was awarded a highly prestigious "cum laude". He was offered the position of head of the Department of Physiology in the University of Leiden, even though he was still a student [1].

In 1887, Dr. Augustus Waller, an English physiologist, demonstrated in London an electrocardiogram (ECG) performed by a laboratory technician using a capillary electrometer. In 1889, scientists from all over Europe came to Switzerland for the 1st International Congress of Physiologists. It was there that Willem Einthoven saw Waller's technique of recording ECG using a capillary electrometer, which made a great impression on him [2–4].

In 1893, Willem Einthoven coined the term ECG. He soon found that ECG recording by using a capillary electrometer was tedious, time-consuming and inconvenient. The galvanometer, which Einthoven improved using a silver-plated quartz string, was logistically far superior. In 1902, he published the first graphical recording of the heart's electrical activity by using a string galvanometer. In 1905, he transmitted an ECG signal by telephone cable from the clinic to his laboratory 1.5 km away. A year later, he presented correct and incorrect recordings made by a string galvanometer in patients with various cardiac problems (*Le télécardiogramme*). Einthoven's characteristic physiological and pathological ECG patterns included left and right ventricular hypertrophy, left and right atrial hypertrophy, P, Q, R, S, T and U waves, the characteristics of QRS complex, premature ventricular beats, ventricular bigeminy, atrial flutter, complete heart block, and the word "electrocardiogram". In 1912, Einthoven introduced the concept of an isosceles triangle formed by standard leads I, II, and III. Thanks to this arrangement, it was possible to observe the mutual relations between the leads and determine the axis of the heart and the leads' misplacement. This geometric figure immortalized his name in the form of an eponym: Einthoven's triangle. Modern medicine owes to him the standardization of ECG recording and unification of the registration process [1–4].

In 1924, while visiting America and giving lectures, Einthoven was awarded the Nobel Prize for Physiology or Medicine for his "discovery of the mechanism of the electrocardiogram" (Figure 1). On 11 December, 1925 he said during his Nobel Lecture: "*A new chapter has been opened in the study of heart diseases, not by the work of a single investigator, but by that of many talented men, who have not been influenced in their work by political boundaries and, distributed over the whole surface of the earth, have devoted their powers to an ideal purpose, the advance of knowledge by which, finally, suffering mankind is helped. (…) An advantage of electrocardiography over other*

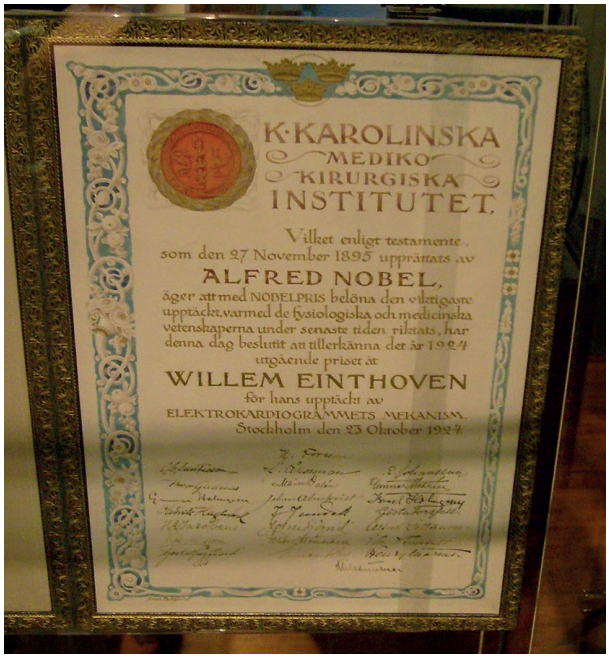

Figure 1. Willem Einthoven's Nobel Prize diploma (courtesy: public domain)

graphic methods for the study of the heart and pulse is that the ECG can record in absolute units, and the shape of the curve no longer depends on the properties of the instrument used. (…) Provided a string galvanometer (…) each curve, whenever and wherever in the world it may be recorded, is directly comparable to any other curve [2]".

Willem Einthoven worked at the University of Leiden for over 40 years until his death from cancer at the age of 67. Einthoven has a street named after him in Leiden, as well as a crater on the moon.

ECG use in the future will evolve by digitization, wireless transmission, minituarization, the use of artificial intelligence, and telemedicine on demand, allowing the prediction of not only a stage of disease but also its progress and future events. ECG remains a critical screening tool for the assessment of acute and chronic syndromes as well as genetic cardiovascular disorders. Several arrhythmic and genetically-based syndromes (e.g., LQTS, SQTS, BS, WPW syndrome, ARVC, CPVT, and ERS) are diagnosed *via* a combination of ECG parameters, clinical history, and symptoms [5].

In the same year as Willem Einthoven, the Polish author Władysław Reymont received the Nobel Prize in Literature. One of the best known of his books is his novel "The Promised Land".

ECG remains "the promised land" for cardiologists and their patients. It is the foundation upon which future developments, inventions, research, and more personalized, preventive and predictive patient care will continue to be built, as they have been over the last century (Figure 2).

Article information

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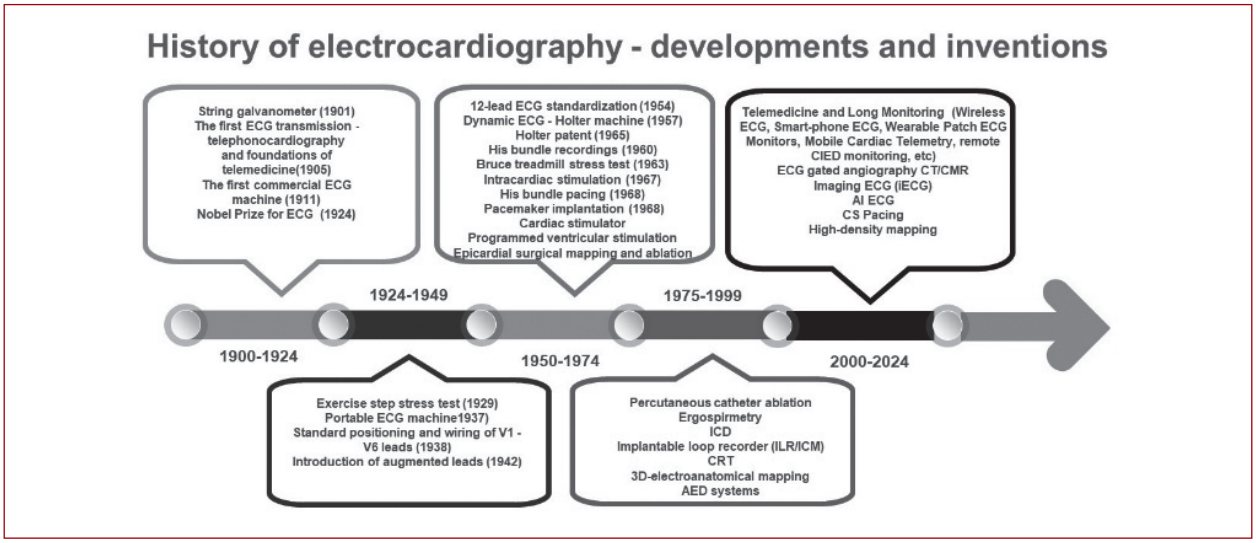

Figure 2. A century of electrocardiographic developments and inventions

REFERENCES

1. Mazurak M. 100. rocznica Nagrody Nobla za zapis EKG. Medium. 2024; 3(402): 19–20.
2. Einthoven W. The string galvanometer and the measurement of the action currents of the heart (Nobel Lecture, December 11, 1925). https://www.nobelprize.org/prizes/medicine/1924/einthoven/lecture/ (accessed: July 22, 2024).
3. Gomes JA. Rhythms of Broken Hearts: History, Manifestations, and Treatment of Heart Rhythm Disorders and Heart Disease. 1st ed. Springer, Cham 2021.
4. Kligfield P. Derivation of the correct waveform of the human electrocardiogram by Willem Einthoven, 1890–1895. Cardiol J. 2010; 17(1): 109–113, indexed in Pubmed: 20104469.
5. Biernacka EK, Osadnik T, Bilińska ZT, et al. Genetic testing for inherited cardiovascular diseases. A position statement of the Polish Cardiac Society endorsed by Polish Society of Human Genetics and Cardiovascular Patient Communities. Pol Heart J. 2024; 82(5): 569–593, doi: 10.33963/v.phj.100490, indexed in Pubmed: 38712785.