

This Week's Citation Classic

Hinkle L E, Jr., Carver S T & Stevens M. The frequency of asymptomatic disturbances of cardiac rhythm and conduction in middle-aged men. *Amer. J. Cardiol.* 24:629-50, 1969.
[Div. Human Ecology, Depts. Medicine and Psychiatry, Cornell Univ. Med. Coll., New York, NY]

The electrocardiograms (ECGs) of a random sample of 301 men aged 55-60 were recorded during six hours of standardized activity. Asymptomatic abnormalities of rate, rhythm, or conduction were found in 92.6 percent. Men with frequent ventricular dysrhythmias or conduction abnormalities had significantly more coronary deaths within five years. [The SC1® indicates that this paper has been cited in over 290 publications since 1969.]

Lawrence E. Hinkle, Jr.
Department of Medicine
Division of Human Ecology
New York Hospital—
Cornell Medical Center
New York, NY 10021

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"In the early-1960s, I was seeking a method for recording the ECGs of active people over long periods to investigate the hypothesis that many out-of-hospital sudden deaths were caused by cardiac arrhythmias. Learning that Norman J. Holter had developed a recorder, I flew to his laboratory in Helena, Montana, and borrowed one. It proved able to do the job, but what was 'normal' and what was 'abnormal' for ECG recordings obtained with these devices was not evident.

"With Jerome Meyer, we first determined the electronic and mechanical characteristics of the recorders that might affect the form of the ECG signal, and we developed a method for obtaining accurate hard copy write-outs of ECGs using a photographic rapid-writer with a wide frequency range.¹ My colleague, Susan T. Carver, developed a standard protocol of recording, designed to demonstrate the effects of position of the body, physical activity, intake of food and fluids, digestion, cigarette smoking, and mild anxiety. She and I together developed a protocol for analyzing the ECG data for abnormalities of rate, rhythm, conduction,

and repolarization. Michael Stevens, working with us, learned how to recognize the waveforms in the recordings. Over the course of four years, he laboriously investigated every area of potential abnormality that appeared in the photographic write-outs, which Carver and I then reviewed independently.

"To obtain a sample of 'normal men' we utilized the nationwide population of 260,000 men in the Bell Telephone System, which had known demographic characteristics and rates of coronary heart disease and sudden deaths similar to those of all American men. We drew a random sample of 356 men aged 55-60 from all those on the payroll in New Jersey and then traveled to cities, towns, and rural areas throughout the state persuading the designated men to come to New York and spend a day having their ECGs recorded. All of the 301 who did so were followed thereafter for ten years.

"I believe that the report of this research has been cited so widely because it was influential in establishing long-term recording of the ECGs of active people as a valuable diagnostic procedure. It demonstrated that a large proportion of ostensibly healthy American men had disorders of their cardiac rate, rhythm, conduction, and repolarization, most of which were asymptomatic; and that the risk of death was greater among the men who had many ventricular dysrhythmias or major disorders of conduction. The report stimulated the widespread use of Holter's recorder. Ultimately, it helped to provide a basis for the present efforts to prevent sudden death by controlling ventricular dysrhythmias and disorders of conduction.

"This research was carried out by the Division of Human Ecology in the department of medicine at the Cornell University Medical College. I was associate professor of medicine, Carver was assistant professor of medicine, and Stevens was research assistant to Carver and me.

"For recent summaries of work in this field, see references 2 and 3."

1. Hinkle L E, Jr., Meyer J, Stevens M & Carver S T. Tape recordings of the ECG of active men: limitations and advantages of the Holter-Avionics instruments. *Circulation* 36:752-65, 1967.
2. Wenger N K, Mock M B & Ringqvist I, eds. *Ambulatory electrocardiographic recording*. Chicago: Yearbook Medical Publishers, 1981. 456 p.
3. Hinkle L E, Jr. The immediate antecedents of sudden death. *Acta Med. Scand.* 210(Suppl. 651):207-17, 1981.