Penicillin proved effective in achieving a final cure. During an observation period of three years no relapse has occurred.

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THE RELATION OF HEART SIZE TO THE TIME INTERVALS OF THE HEART BEAT, WITH PARTICULAR REFERENCE TO THE ELEPHANT AND THE WHALE

PAUL D. WHITE, M.D.,* ROBERT L. KING, M.D.,† AND JAMES JENKS, JR.‡

BOSTON AND SEATTLE

ONE of the moot questions in human electrocardiography is that of the normal upper limit of the atrioventricular conduction time (PR interval) and of the duration of the spread of the excitation wave through the ventricles (QRS complex). It is the general consensus that the former may measure from 0.10 second or even a little less in the healthy newborn infant to 0.20 second or even a little more in the healthy full-grown adult, and that the latter may measure from about 0.05 second in the infant to about 0.10 second in the adult. The change from the shorter measurements to the longer takes place gradually with the growth of the heart. It is not, however, adequately appreciated by all concerned that larger adults with larger normal hearts or that persons of any age with enlarged hearts due to strain from hypertension, systemic or pulmonary, or from valvular disease may have electrocardiographic time intervals a little above the generally recognized upper limits of 0.20 second for PR interval and 0.10 second for QRS duration without having myocardial disease per se to produce either atrioventricular or bundle-branch block. Thus, on occasion, persons with apparently normal or with simply enlarged hearts may have PR intervals measuring up to 0.21 or even 0.22 second or QRS complexes measuring up to 0.11 or even 0.12 second.

In 1916 White and Kerr[1] dissected the heart of a young sperm whale and found a clearly differentiated and extensive atrioventricular conduction tract with large Purkinje cells; this heart was 56 cm. broad and 33 cm. long. The atrioventricular bundle was 1 cm. wide. Soon after that, Burwell and White (1920) dissected the heart of a forty-year-old elephant (Mollie) and again found an extensive conduction system, which was confirmed later by King in the case of the elephant Tusko, which was forty-three years old. King, Burwell and White[2] reported on the anatomy of these 2 elephant hearts in 1938.

A companion article in the same number of the *American Heart Journal* in 1938, written by White,

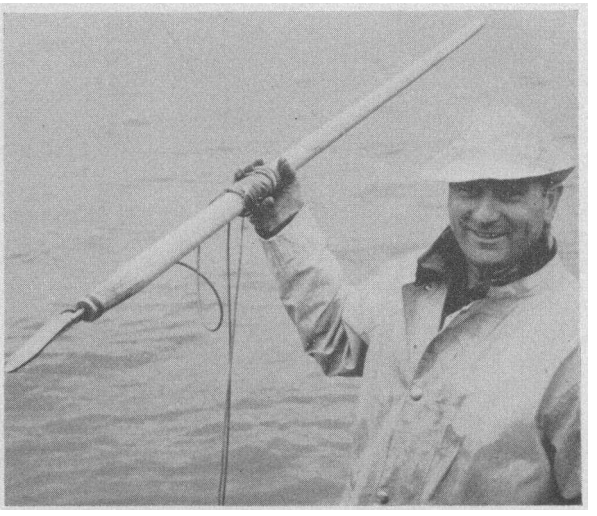

FIGURE 1. *Jeff Davis, Expert Whale Hunter, with Harpoon, Showing Electrode Head with Insulated Cable and Nylon Cord.*

Jenks and Benedict,[3] concerned the electrocardiograms of 9 healthy circus elephants (Juno, Modoc, Tillie, Myrtle, Lizzie, Clara, Queen, Pigmy and one whose name is not remembered). These observers found that the heart rate of the elephants averaged about 35 per minute (range from 24 to 53) and that the PR interval and QRS duration were about twice those of the normal human adult — that is, 0.28 to 0.41 second and 0.12 to 0.18 second respectively. Since the newborn human infant has about twice the heart rate and half the PR interval and QRS duration of the normal human adult, and since a small mammal such as the mouse§ has corresponding differences in heart rate and time intervals as compared to the human infant, it was suggested in 1939 that there might be similarly considerable differences between the heart rates

*Consultant in medicine, Massachusetts General Hospital; executive director, National Advisory Heart Council.

†President, American Heart Association.

‡President, Heart Council in Cambridge.

§The electrocardiograms of 4 mice showed heart rates varying from 620 to 780 per minute, PR intervals varying from 0.03 to 0.04 second and QRS durations ranging from 0.008 to 0.011 second (information obtained from M. Rappaport, of the Sanborn Company, Cambridge, Massachusetts).

and time intervals of the elephant and those of a large whale, which, of course, has a much larger heart.

In 1940 we proposed to obtain an electrocardiogram of a whale with the help of Governor Gruening

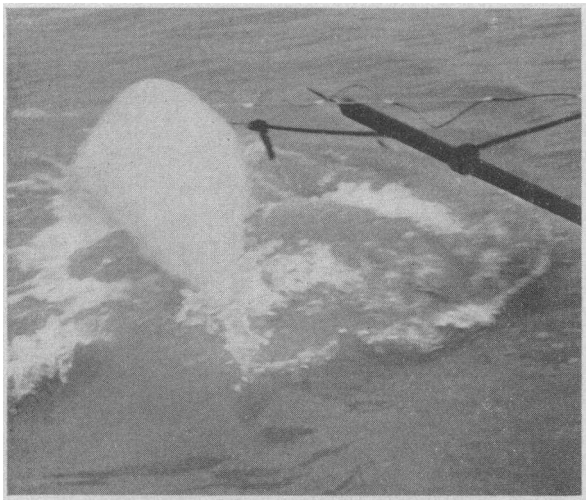

FIGURE 2. *"Moby Dick, Jr.," Towing the Skiff Used As a Whale Boat, Showing Two Connections Already Established. The large holding rope had been inserted by the first harpoon shaft, which is still visible, tipped by a point that fitted into the harpoon head. The nylon cord and insulated cable (looped and attached to the cord) are inserted into the second harpoon shaft, which is not visible.*

of Alaska and the United States Bureau of Fisheries, but World War II intervened and we all became greatly preoccupied.

During the past year, however, plans went forward again, and with the generous help of the Alaska Packers and in particular Mr. Delebecque, of King Salmon, Mr. Don Cooper at Clark's Point and several of his staff, in particular Jeff Davis (Fig. 1), skillful hand harpooner and Joe Clark, able skipper, we succeeded, after several vicissitudes, in early August in obtaining by the use of bipolar harpoon electrodes a dorsal electrocardiogram of a Beluga whale (Fig. 2). This small species was selected because it was readily available, could easily be reached and was small enough to permit us to develop our technic, which we hope to be able to apply to a large whale at some later date.

Details of this experience and our findings will be published elsewhere, but the present note seemed advisable to establish the scientific background for this exploit. Suffice it to say herewith that the record made while the whale was pulling us along in our 20-foot skiff showed a heart rate varying from 12 to 23, with an average of 15 to 16, indistinct inverted P waves with PR intervals of about 0.3 second, diphasic QRS waves of low amplitude and inverted T waves. The heart of the Beluga whale, the record of which we obtained, was actually not so large as that of Mollie, the elephant, or as the heart of the young sperm whale that was dissected in 1917. It seems quite clear that an important factor in reducing the heart rate to this low figure was that of the vagal effect of diving and immersion, as Irving, Scholander, and Grinnell[4] have already pointed out in a study on the seal.

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11. My Debbie

Exhibited at American Medical Association, San Francisco, 1950

Award of Merit Sculpture in Carrara Marble

by

NATHAN L. FINEBERG, M.D.

Associate Professor of Otolaryngology
Boston University School of Medicine