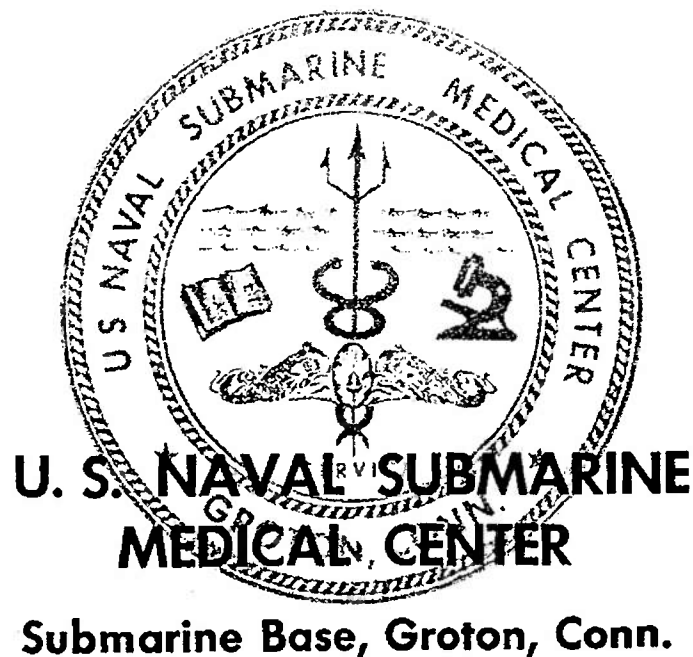




REPORT NUMBER 621

ELECTROCARDIOGRAPHY AND CARDIAC MONITORING
ABOARD A NUCLEAR POWERED SUBMARINE ON PATROL

A Case Report

by

LT Michael A. Prosin, MC, USN

Approved and Released by:

J. E. Stark, CAPT MC USN
COMMANDING OFFICER
Naval Submarine Medical Center

19 March 1970



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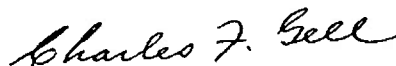
SUBMARINE MEDICAL RESEARCH LABORATORY
U. S. NAVAL SUBMARINE MEDICAL CENTER REPORT NO. 621

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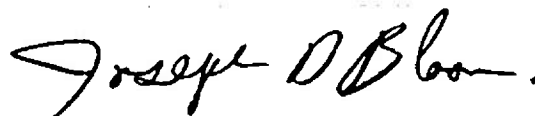
John H. Baker, CDR MC USN
Director, School of Submarine Medicine

Reviewed and Approved by:



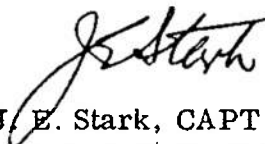
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SUMMARY PAGE

THE PROBLEM

To describe the equipment used to improvise electrocardiography and monitoring for a severe attack of what appeared to be myocardial ischemia and possibly actual myocardial infarction, which occurred during a patrol.

FINDINGS

Directions are given for modifying a Tektronic 545A Oscilloscope, with improvised electrodes and electrode paste. Further modification supplied augmented leads, giving two pick-ups to the oscilloscope. Splicing in additional cable supplied chest leads. This equipment, together with a Polaroid camera, made it possible to take complete electrocardiograms.

APPLICATION

Knowledge gained from this report should enable a medical officer on submarine patrol to improvise electrocardiograph equipment, should such an emergency present itself.

ADMINISTRATIVE INFORMATION

The manuscript for this report was prepared by the author during his tour of duty on an SSBN submarine and submitted to the Board in partial fulfillment of the requirements for qualification as a Submarine Medical Officer. It has been selected by the Qualification Board for publication, in order to make it available in the Technical Library at the Submarine Medical Center and as reference material in the School of Submarine Medicine.

It was approved for publication on 19 March 1970 and designated as Submarine Medical Research Laboratory Report No. 621.

PUBLISHED BY THE NAVAL SUBMARINE MEDICAL CENTER

ABSTRACT

This report concerns an incident of sudden serious illness which developed in a crew member of an SSBN while on patrol. Symptoms indicated a possible heart attack. The medical officer was able to devise a simple piece of improvised equipment from materials normally at hand which substituted for electrocardiography and permitted thorough medical care of this patient.

This case history should be of interest and assistance to all submarine medical personnel.

ELECTROCARDIOGRAPHY AND CARDIAC MONITORING ABOARD SSBN-602 ON PATROL

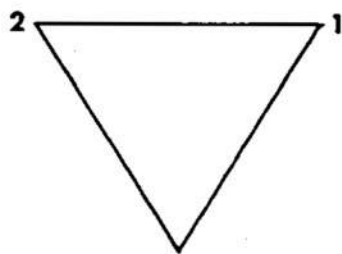
While on routine patrol, a crew member of the USS ABRAHAM LINCOLN (SSBN-602) suffered what appeared to be a severe attack of myocardial ischemia and possibly actual myocardial infarction. At this time, we did not have the capability for performing routine electrocardiography or continuous cardiac monitoring.

Due to this sudden illness and in an effort to confirm the suspected diagnosis, we attempted to obtain a look at his cardiac electrical complex using a Tektronic 545A oscilloscope and two hastily prepared electrodes consisting of quarters soldered to RG-58 cable. Our first attempt was unsuccessful in delineating a recognizable complex on the oscilloscope, but we were able to pick out the patient's heartbeat. Since the patient had finally become comfortable and was resting under sedation, it was thought advisable to discontinue our efforts with the patient as our subject.

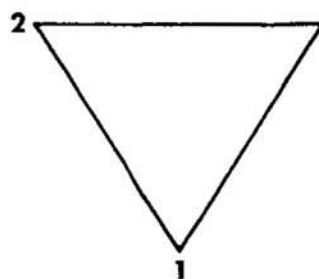
Continuing with our experimentation using other crew members as the subject, after about an hour we were able to adjust the oscilloscope to obtain a satisfactory representation of the cardiac complex. These results were obtained utilizing the following criteria:

- (a) Time of sweep to be such that one centimeter represents .2 second, and
- (b) Voltage representation was set such that one centimeter deflection represented one millivolt.

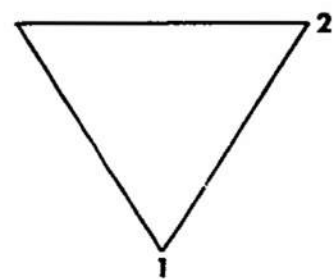
Utilizing two probes we were able to obtain Leads I, II and III. Probe #1 being the positive electrode and probe #2 the negative electrode, the following schemata were followed with the probes placed on the chest surrounding the heart:



LEAD I



LEAD II



LEAD III

For electrode paste, we used surgical lubricant to which had been added NaCl (table salt). The oscilloscope presented a clear picture without the paste, but an even sharper picture was obtained utilizing the paste.

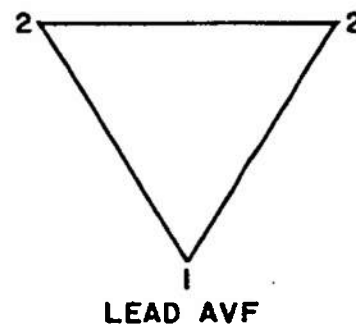
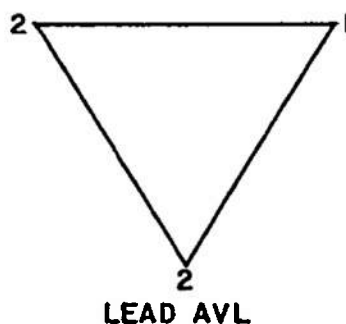
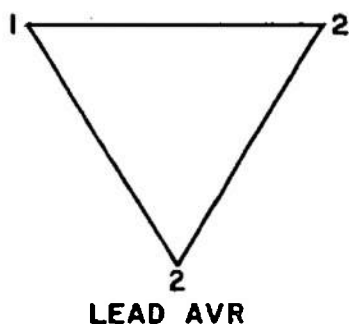
With the above setup, the standard leads were taken on our patient and photographic reproduction of the same was done with the ship's Polaroid camera mounted on a tripod in front of the oscilloscope. The results of this procedure were more than satisfying.

In order to obtain a more complete picture however, we needed additional information obtainable only by more leads.

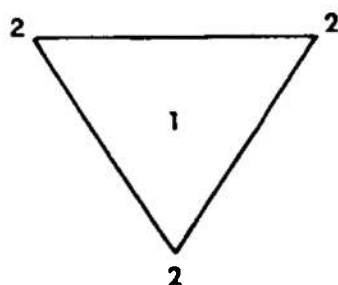
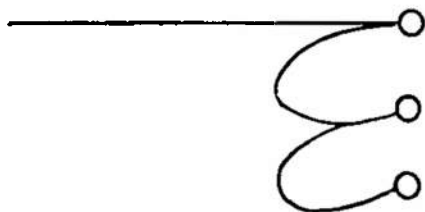
To obtain the so-called augmented leads, we modified probe #2, splicing in another piece of cable to which had been soldered another quarter, thus giving us two pick-ups to the same input of the oscilloscope.



Thus, we recorded the augmented leads of the standard electrocardiogram utilizing the following schemata to obtain AVR, AVL and AVF:



To obtain chest leads V_1-V_6 we further modified probe #2 by splicing in another piece of cable to which had been soldered another quarter, thus giving us three pick-ups to the same input of the oscilloscope. Probe #1 was then used as the wandering chest electrode.



Chest leads V_1-V_6 were placed on the chest as follows: V_1 - right sternal border, 4th interspace; V_2 - left sternal border, 4th interspace; moving progressively laterally, V_3 - between the 4th and 5th interspaces; V_4 - 5th interspace at the nipple; V_5 and then V_6 at the anterior axillary line.

With the above setup and utilizing the Polaroid camera as described previously, it was possible to take a complete electrocardiogram. The described probe combinations give one ready access to any lead that he might want to monitor for extended periods of time.

Invaluable data was thus obtained on a patient who suffered myocardial infarction while on a routine Polaris submarine patrol. A permanent record of the patient's electrocardiogram was thus obtained and additional information on arrhythmic cardiac beats was noted during periods of monitoring.

TECHNICAL DATA ON THE USE OF THE TEKTRONIC 545A OSCILLOSCOPE FOR ELECTROCARDIOGRAPHY AND CARDIAC MONITORING

1. Use type "D" plug in unit
2. Millivolts per centimeter on 1
3. Vertical position, as desired
4. Preamp balance, as necessary
5. Input, AC (A-B)
6. MV/cm mult set at 1
7. Horizontal display on A
8. Time base "A" set at:

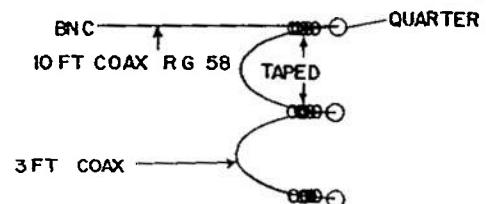
Trigger stop - internal (allows to
strobe with incom-
ing pulse, heart-
beat)

Trigger level (sync) - as neces-
sary

Time/cm = .2 sec/cm

9. Focus, Intensity, Astigmatism
and Scale Illumination as desired
10. Ground scope to a very good
ground. Failure to accomplish
this step will cause scope to pick
up any amount of interference
11. Make up probes and number them
as No. 1 for input A into the "0"
plug in unit, No. 2 for input B
12. The probes shall be constructed
in the following manner:

- (a) Use silver quarters or a good
electrical substitute. Four
are required.
- (b) RG-58 cable about 26 feet
- (c) BNC connectors
- (d) Cut two ten-foot sections of
the cable and install the BNC
connectors on one end of each
- (e) On the other end of each
cable, strip back the cable
insulation and shielding and
solder the center conductor
to the quarters
- (f) The No. 2 lead is modified in
the following manner:

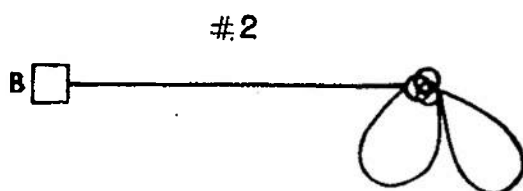
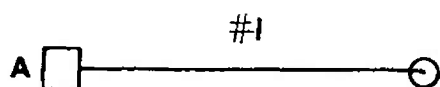


- (g) The shielding between each
additional lead must be sol-
dered together. Then tape
them together for strength.
13. It is important that a good con-
ducting medium be used when
attaching the probes to the chest.
The better the conductor, the
better the presentation. Failure
to provide this medium will de-
grade the display.

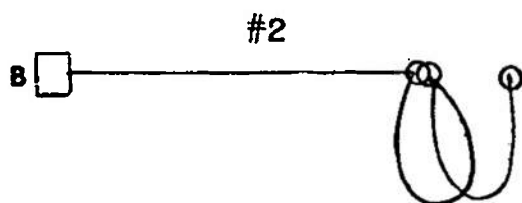
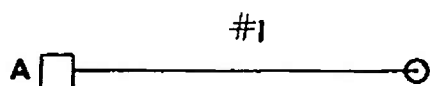
14. When using the two- or three-probe setup it is important that the unused probes be attached to the primary probe or otherwise it will pick up stray transients.

15. When actually using the probes for single, double or triple pick-up, the following may be helpful:

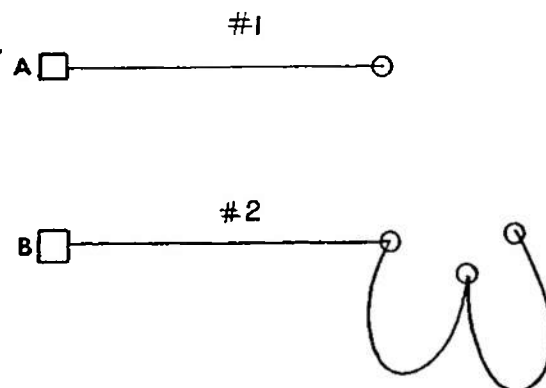
(a) Two probes, standard leads:



(b) Three probe, augmented leads:



(c) Four probes, chest leads:



CASE SUMMARY AND FOLLOW-UP

A 36 year old SKC (SS) experienced the sudden onset of severe, sharp, crushing substernal chest pain with radiation to the left arm and down to the finger tips. He was seen by the Medical Officer approximately one minute after the onset of symptoms. He was slumped down in a chair, markedly dyspneic, sweating profusely, pale, and very weak. He was alert as to time and place and able to relate his symptoms clearly. Pulse was 120. Initially he had several short bursts of intense sharp pain (3 of these in the first 10 minutes). He was moved to the Commanding Officer's stateroom and oxygen was administered with some relief of pain, dyspnea, and his apprehension. Pulse was 100-120 and blood pressure 165/100. His pain remained severe for 30 minutes and then continued as dull

and aching with associated severe numbness of the entire left arm. Narcotics were not readily accessible and 25 mg of Phenergan was given IV approximately 15 minutes after the initial episode. He remained anxious and perspired heavily for approximately one hour.

Past history reveals pneumonia one year previously and a 16 year history of duodenal ulcer, well controlled. He denied diabetes, high blood pressure, tuberculosis, venereal disease, lung, liver, or kidney disease. He had smoked approximately 1 pack of cigarettes per day for many years up until 3 years ago. He notes over the past 2-3 years several episodes of what can be described as anginal-like pain. He states that a few of these episodes were 4-5 minutes of severe substernal pain with some radiation to his left shoulder. He recalls that after these episodes he was extremely fatigued and usually required sleep for several hours to recover. He had an EKG two years ago and told that it was normal. (EKG was not available).

Family history reveals that his father died at age 42 years of a myocardial infarction complicated by pneumonia. A brother died at age 28 from a teratoma of the lung. His mother, two other siblings, his wife, and four children are all in good health.

He was placed at strict bed rest, sedated with Phenobarbital, legs wrapped, given IV fluids and blood was drawn every 12 hours, spun down, and the serum separated and frozen for future analysis for enzymes. (These specimens were subsequently lost by

the support tender.) He remained seriously ill for 4-5 days experiencing 15-20 episodes of short, sharp chest pain without radiation. He developed VPC's on day 3 which continued for several days, approximately 3-4 every 5 minutes. They appeared to be multifocal in origin (as noted during periods of monitoring using the oscilloscope). On day 4 a grade II/IV systolic murmur was noted at the mitral area. The murmur was heard intermittently over the next 5 weeks. Slowly progressive ambulation was begun on day 8 and tolerated well up to ambulation of 4-5 times per day for 15-30 minutes at the end of 5 weeks. He was changed to Librium 10 mg four times a day on day 12.

Upon return from patrol, an EKG on the tender and another in New London were read as essentially within normal limits. He returned to New London with the crew and his care was assumed by the Medical Clinic at the Naval Submarine Medical Center Hospital.

In April 1969 a Medical Board was held. Diagnosis was Acute Anteroseptal Myocardial Infarction, #4201-541. He was sent to "6 months limited duty not to include athletics, extremes of emotion and strenuous exercises". He continued to do well for the next several months noting several episodes of severe angina relieved by nitroglycerin. He was also medicated with Librium.

In August 1969 consultation with a Cardiologist at the Naval Hospital, St. Albans, revealed a baseline EKG read as abnormal and compatible with an old anteroseptal myocardial infarction. A triple Masters test produced some ST

segment depression. He was placed on Propanolol 40 mg QID and Isordil 10 mg QID with some decrease in the frequency of his angina.

In September 1969 he was admitted to the Naval Submarine Medical Center Hospital because of chest pain with subsequent fainting. Upon regaining consciousness, he took a sublingual nitroglycerin which aided in decreasing the chest pain. EKG was normal except for occasional VPC's. Serum enzymes on 3 successive days were all within normal limits. He was discharged to duty 6 days after admission on Phenobarbital 64 mg QID and Propanolol 40 mg QID. Following this admission he did well with 1-2 episodes of chest pain per week.

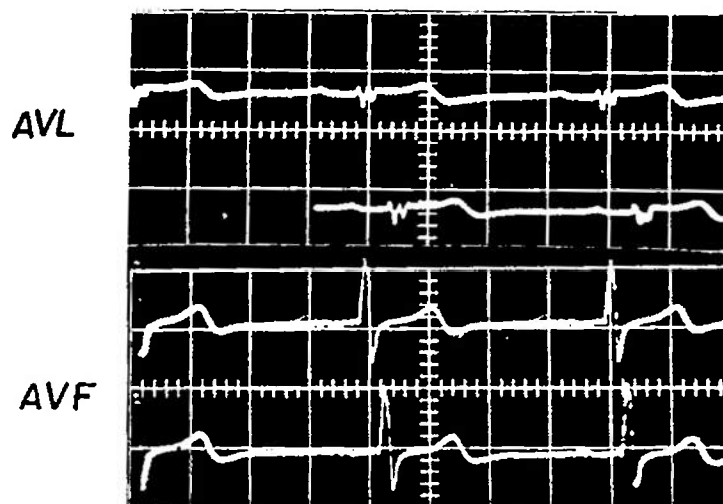
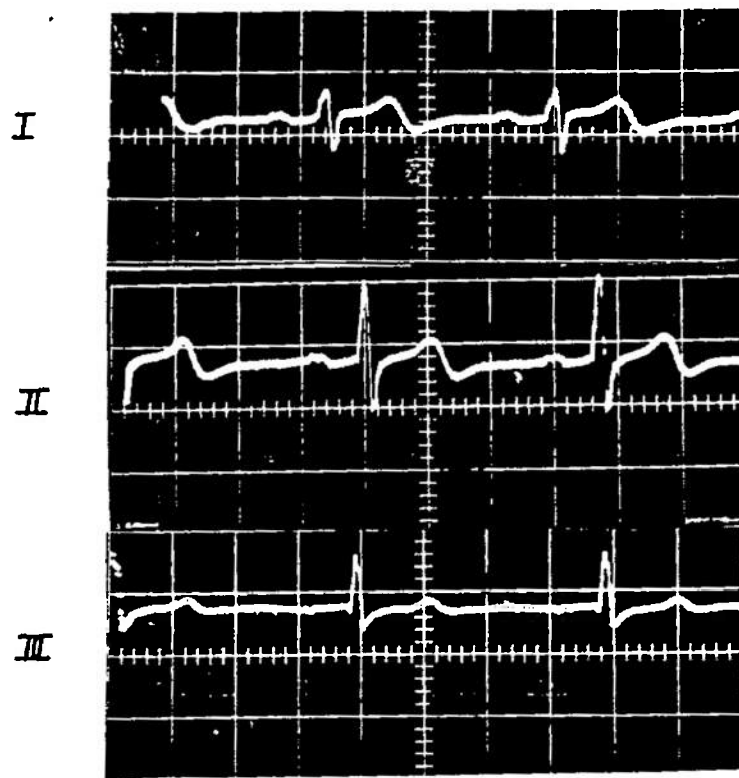
In November 1969 he was sent to the Cardiology Service, Naval Hospital Bethesda, Maryland for cardiac catheterization with coronary angiography.

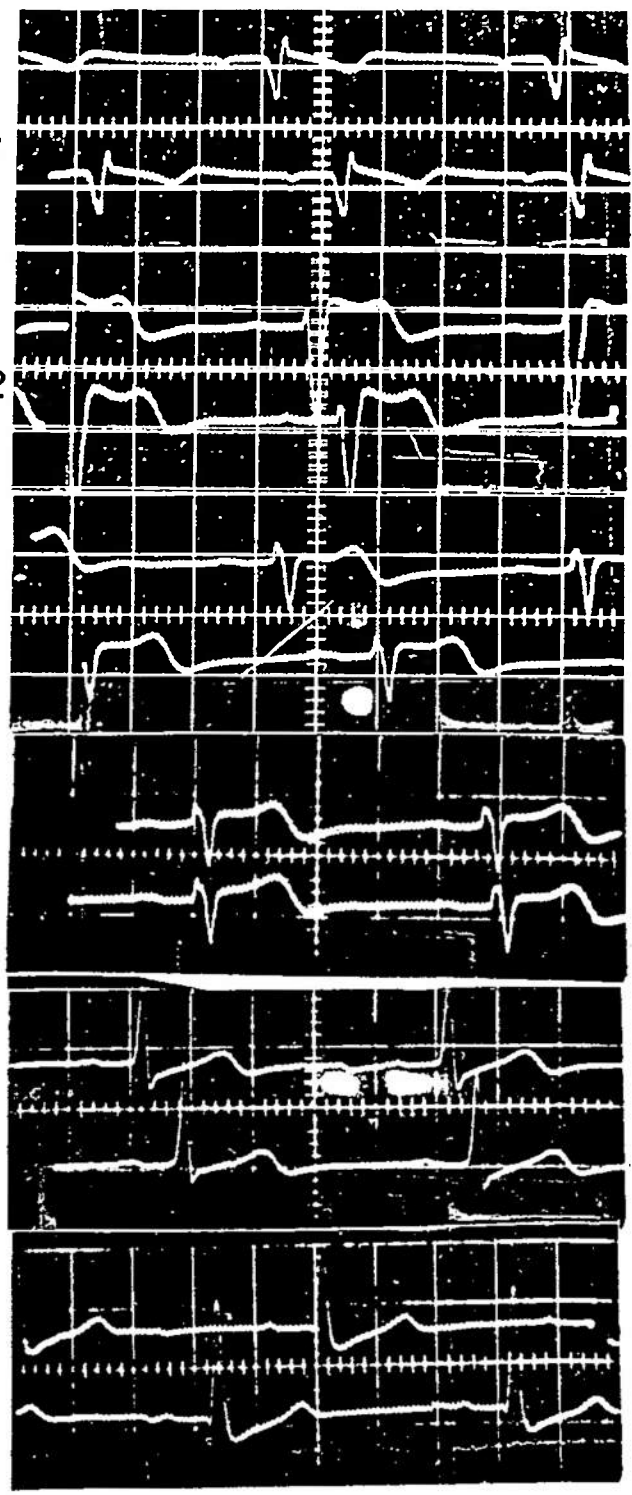
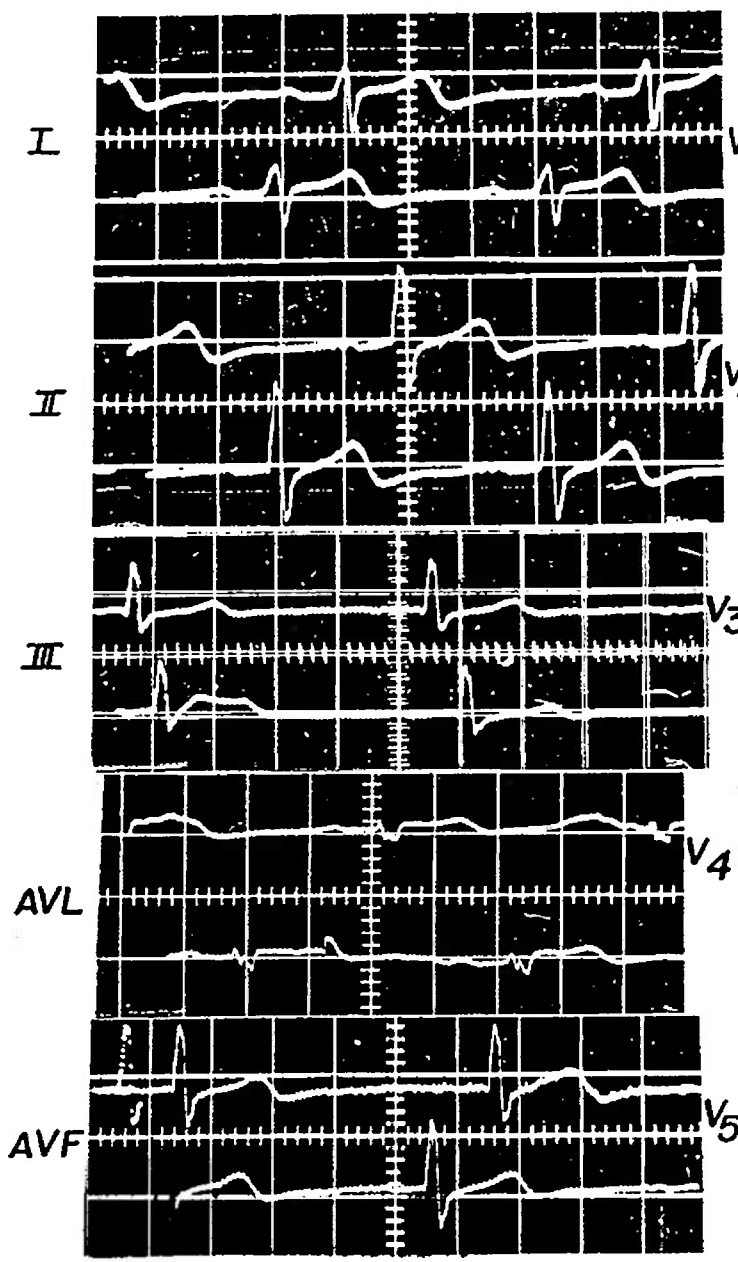
A treadmill EKG was obtained. A heart rate of 150 per minute was accomplished without evidence of pain, arrhythmia or hypotension. Right and left heart catheterizations and coronary angiography and left ventriculogram were performed. Mild diffuse changes of coronary atherosclerosis and no evidence of a previous infarction were reported. The studies were felt to be within normal limits for the patient's age. It was recommended that he be returned to full duty.

In November 1969 a Medical Board was held. Diagnosis was Coronary Atherosclerosis, mild, #4201-000 and he was returned to full duty. At the present time he is on no medication except for a mild tranquilizer when needed. He has mild attacks of chest pain which subside spontaneously.

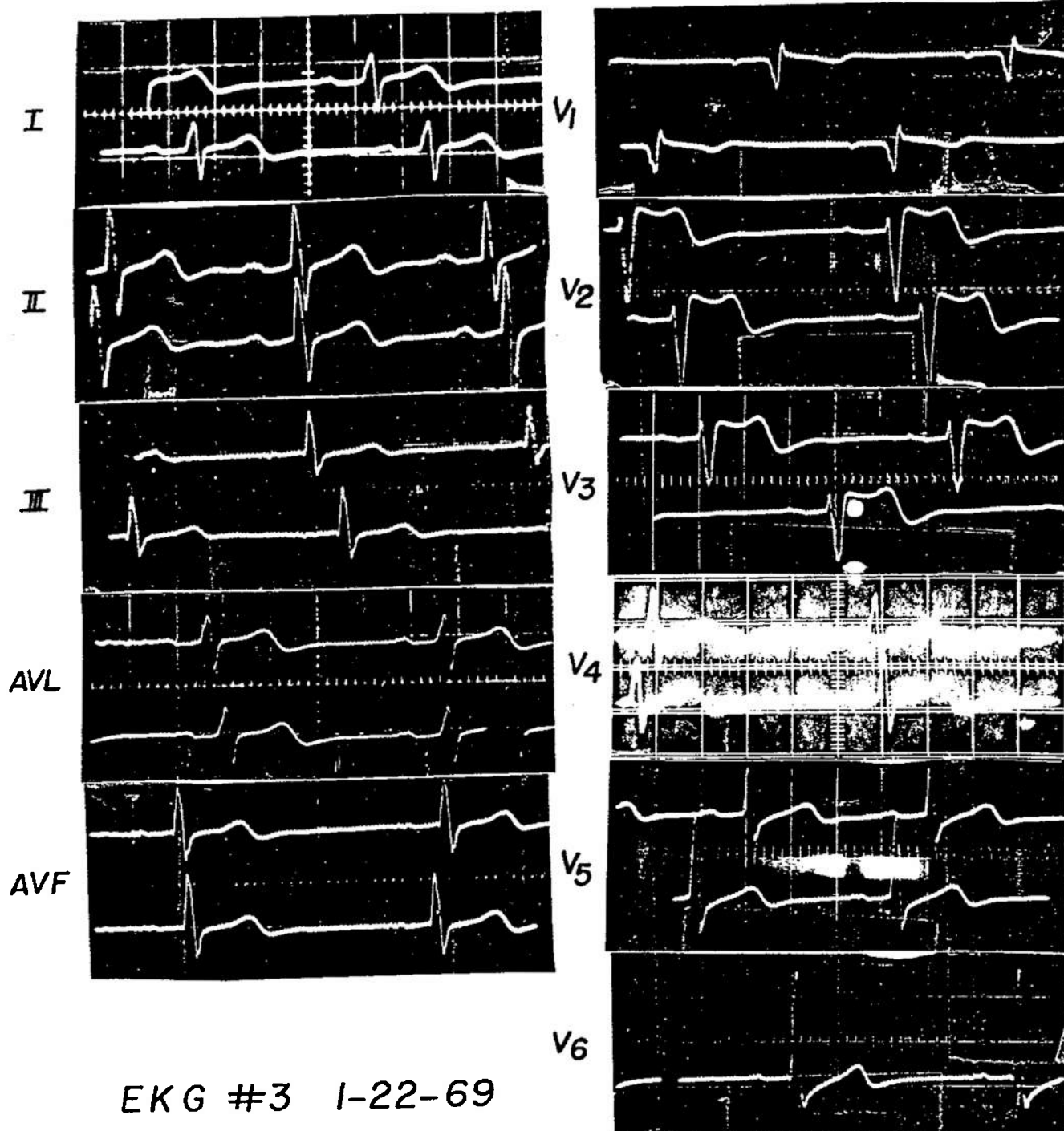
EKG's taken on patrol utilizing the oscilloscope and Polaroid camera are presented on the following pages:

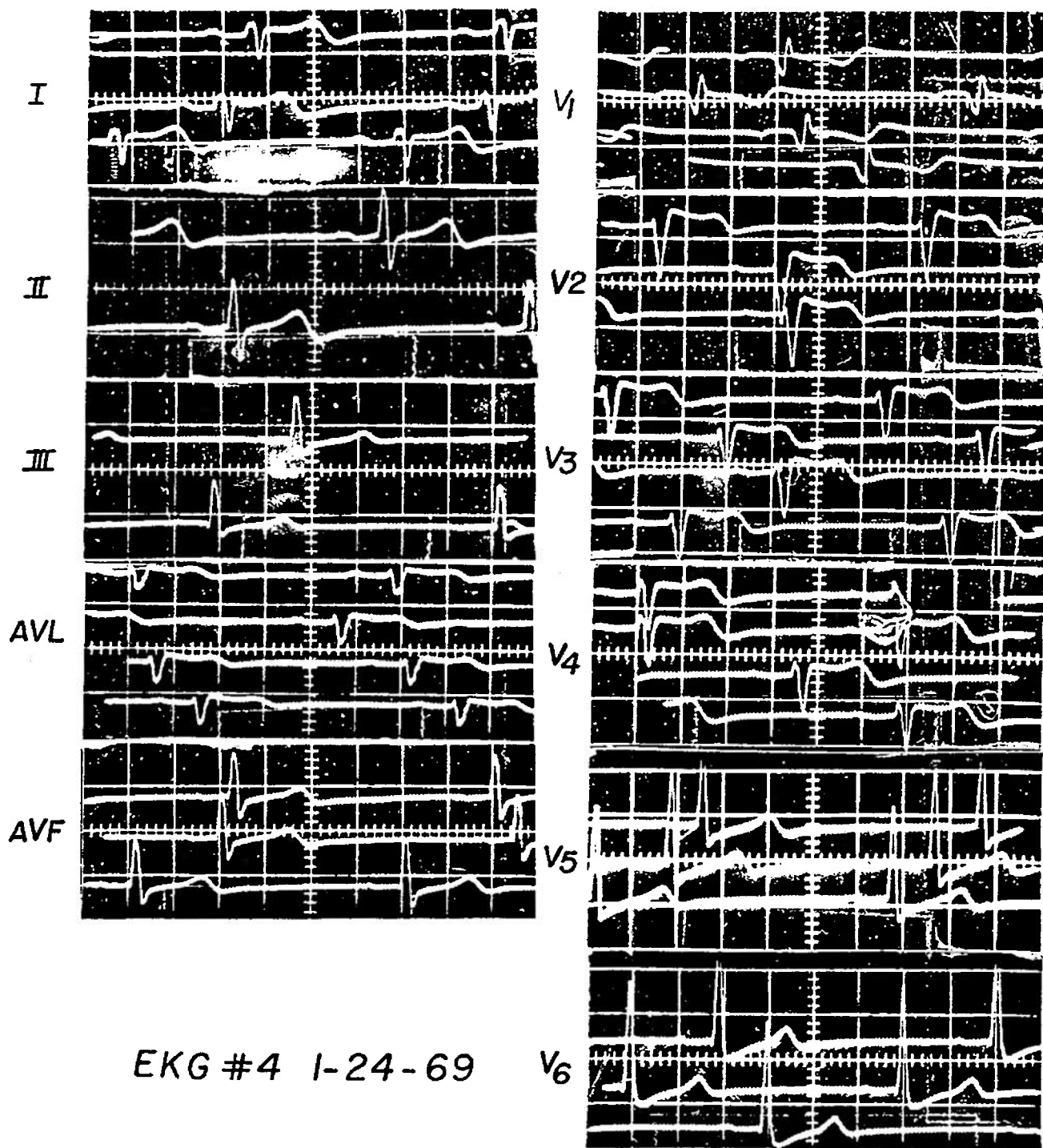
EKG #1 1-20-68





EKG #2 1-21-69





I

II

III

AVL

AVF

V₁

V₂

V₃

V₄

V₅

V₆

EKG #5 1-29-69

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13. ABSTRACT Directions are given for modifying an oscilloscope for use in taking electrocardiograms in an emergency situation, such as one described in this report where a crew member suffered an acute attack of what appeared myocardial ischemia, possibly actual myocardial infarction, while the submarine was on patrol.		

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