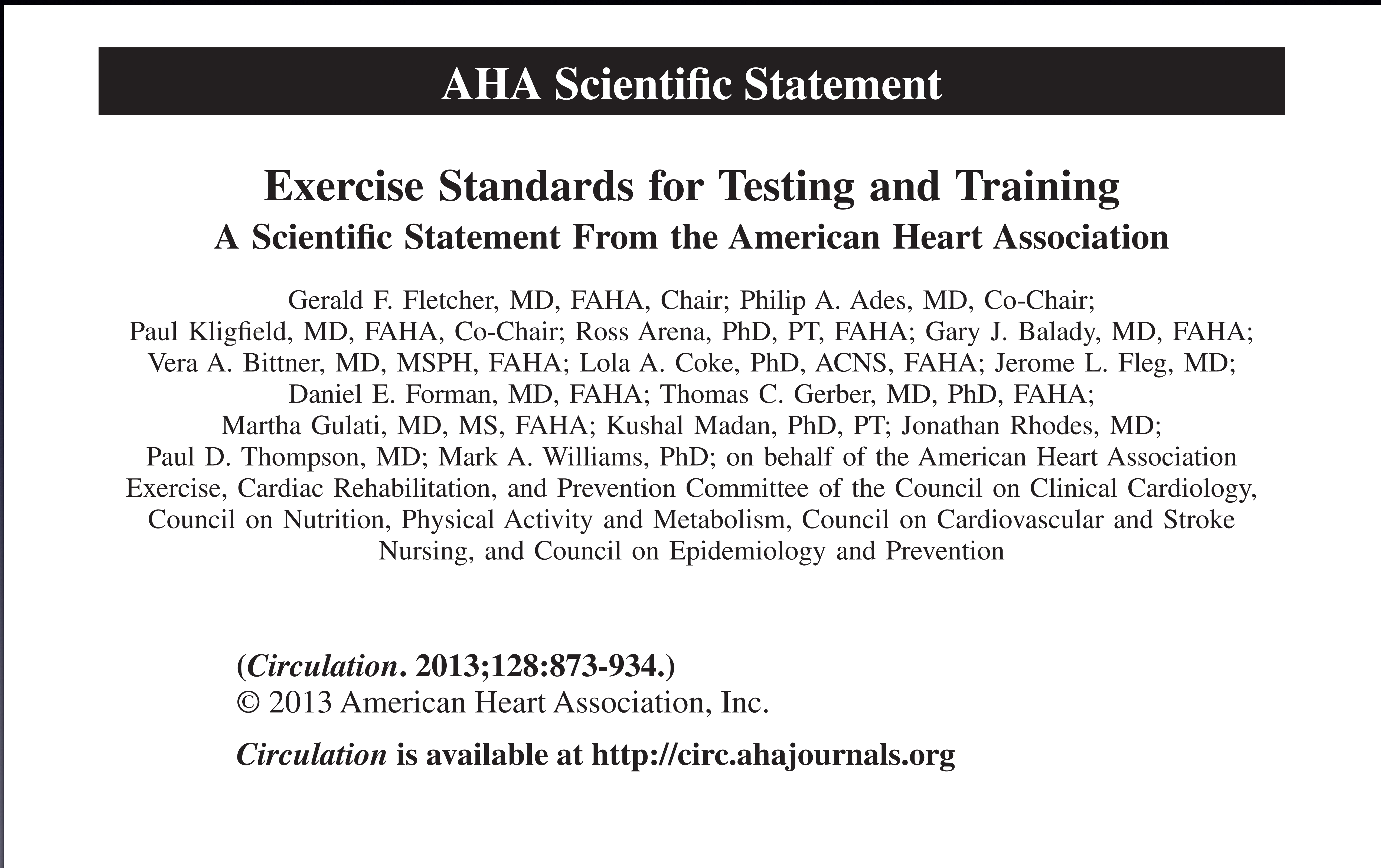
Intro to Exercise Stress Testing*

Dr. Sarah Ramer
2021

Resources

- 2013 ACC/AHA guideline
- Dr. Sarah Ramer - sarah.ramer@nshealth.ca

63 pages to combat insomnia…..


AHA Scientific Statement

Exercise Standards for Testing and Training

A Scientific Statement From the American Heart Association

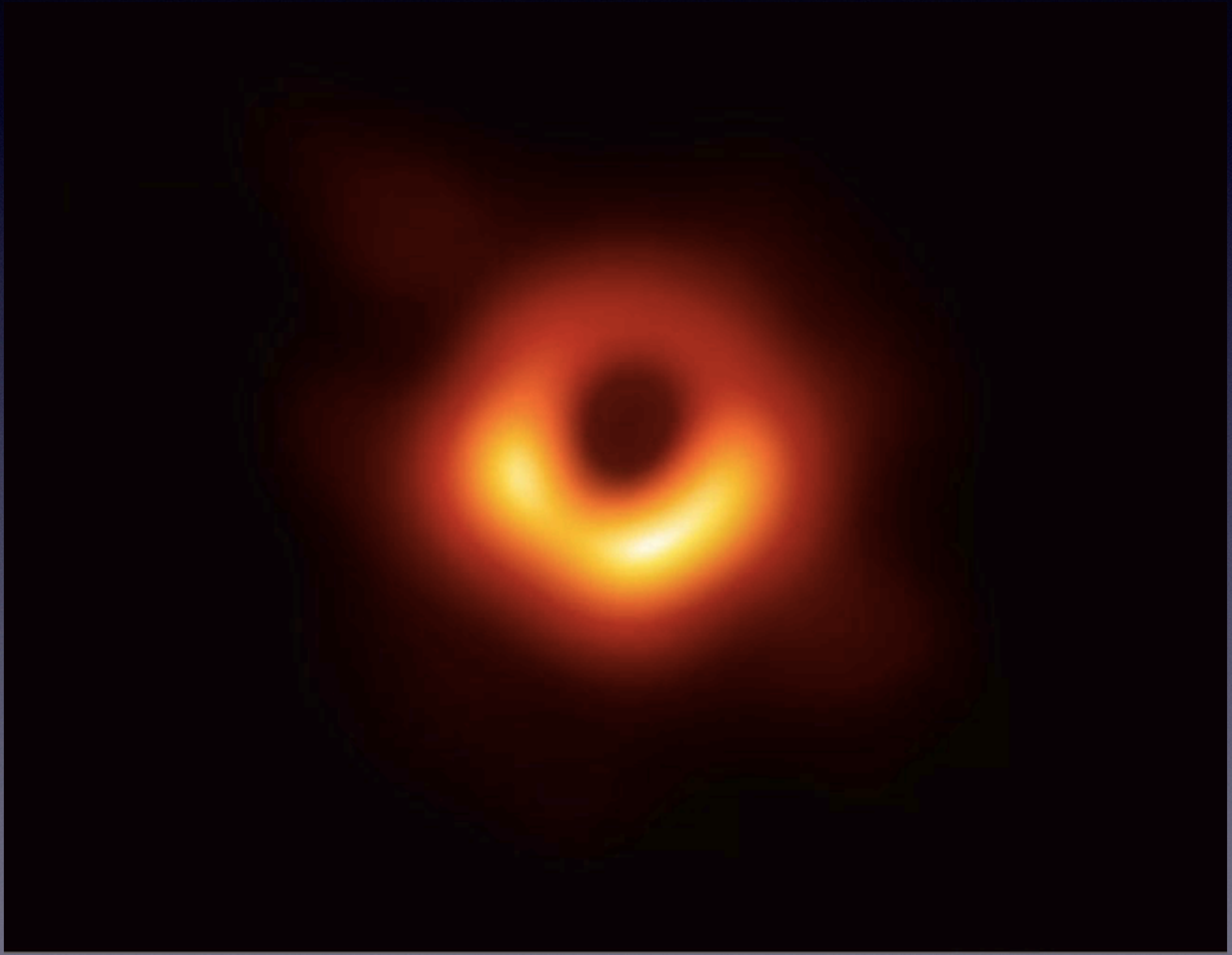
Gerald F. Fletcher, MD, FAHA, Chair; Philip A. Ades, MD, Co-Chair; Paul Kligfield, MD, FAHA, Co-Chair; Ross Arena, PhD, PT, FAHA; Gary J. Balady, MD, FAHA; Vera A. Bittner, MD, MSPH, FAHA; Lola A. Coke, PhD, ACNS, FAHA; Jerome L. Fleg, MD; Daniel E. Forman, MD, FAHA; Thomas C. Gerber, MD, PhD, FAHA; Martha Gulati, MD, MS, FAHA; Kushal Madan, PhD, PT; Jonathan Rhodes, MD; Paul D. Thompson, MD; Mark A. Williams, PhD; on behalf of the American Heart Association Exercise, Cardiac Rehabilitation, and Prevention Committee of the Council on Clinical Cardiology, Council on Nutrition, Physical Activity and Metabolism, Council on Cardiovascular and Stroke Nursing, and Council on Epidemiology and Prevention

(*Circulation*. 2013;128:873-934.)

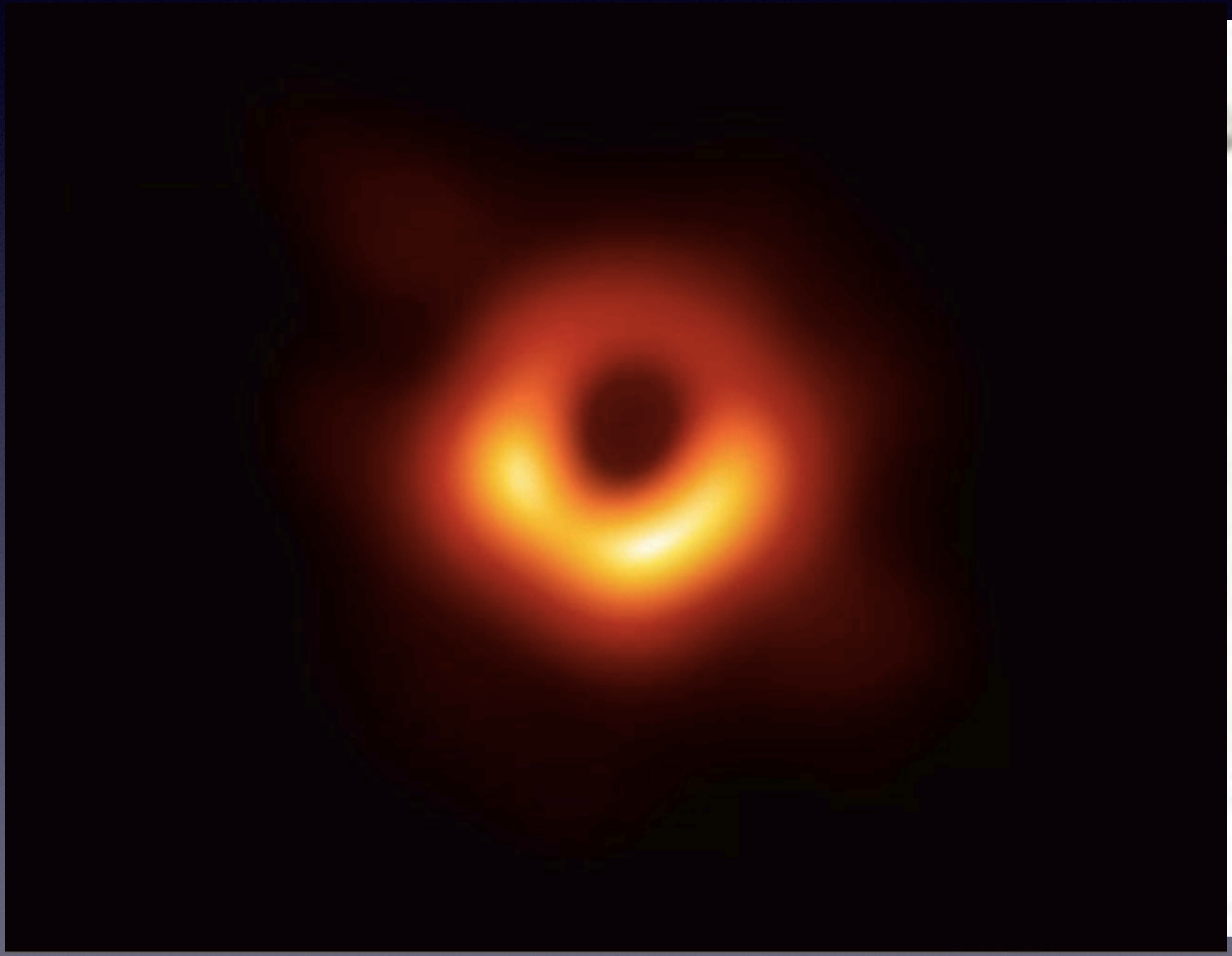
© 2013 American Heart Association, Inc.

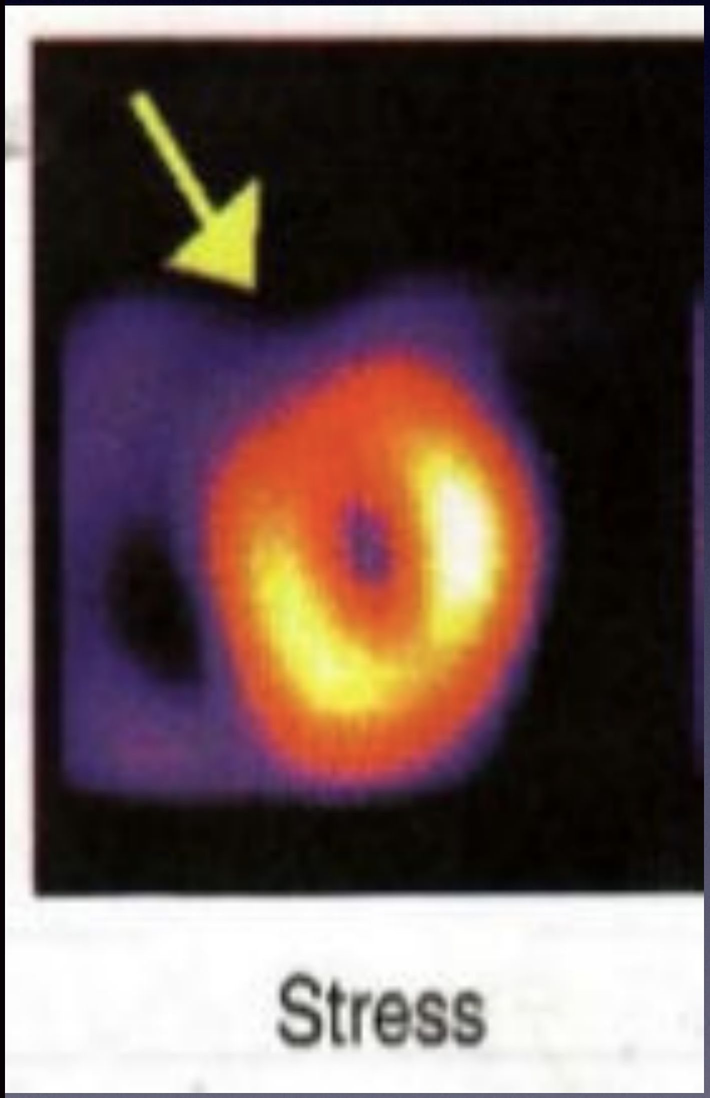
Circulation is available at http://circ.ahajournals.org

What is this?



Look familiar?





On the exam - Paper 1

- List absolute and relative contraindications to stress testing
- Complications of Exercise Testing
- Absolute and Relative Indications for Terminating EST
- Definition of positive, negative or equivocal ECG changes during exercise
- Definitions of abnormal BP response
- Prognostic value of exercise stress testing - DUKE Score
- Exercise prescription
- Sens/Specificity, pre-test and post-test probabilities

On the exam - Paper 2

- Report a stress test (graphics provided)
    - Could be normal or abnormal
- Clinical stem, stress test given - how to manage?
- Calculate a Duke score and estimate risk

On the Exam - Oral

- Clinical scenario where a stress test is ordered. Interpret the stress test in front of the examiner and develop an appropriate management strategy.
    - Evaluation of chest pain
    - Assessment of prognosis
    - Indication for valve surgery based on symptom assessment
    - Assessment of arrhythmia, long QT, WPW etc.

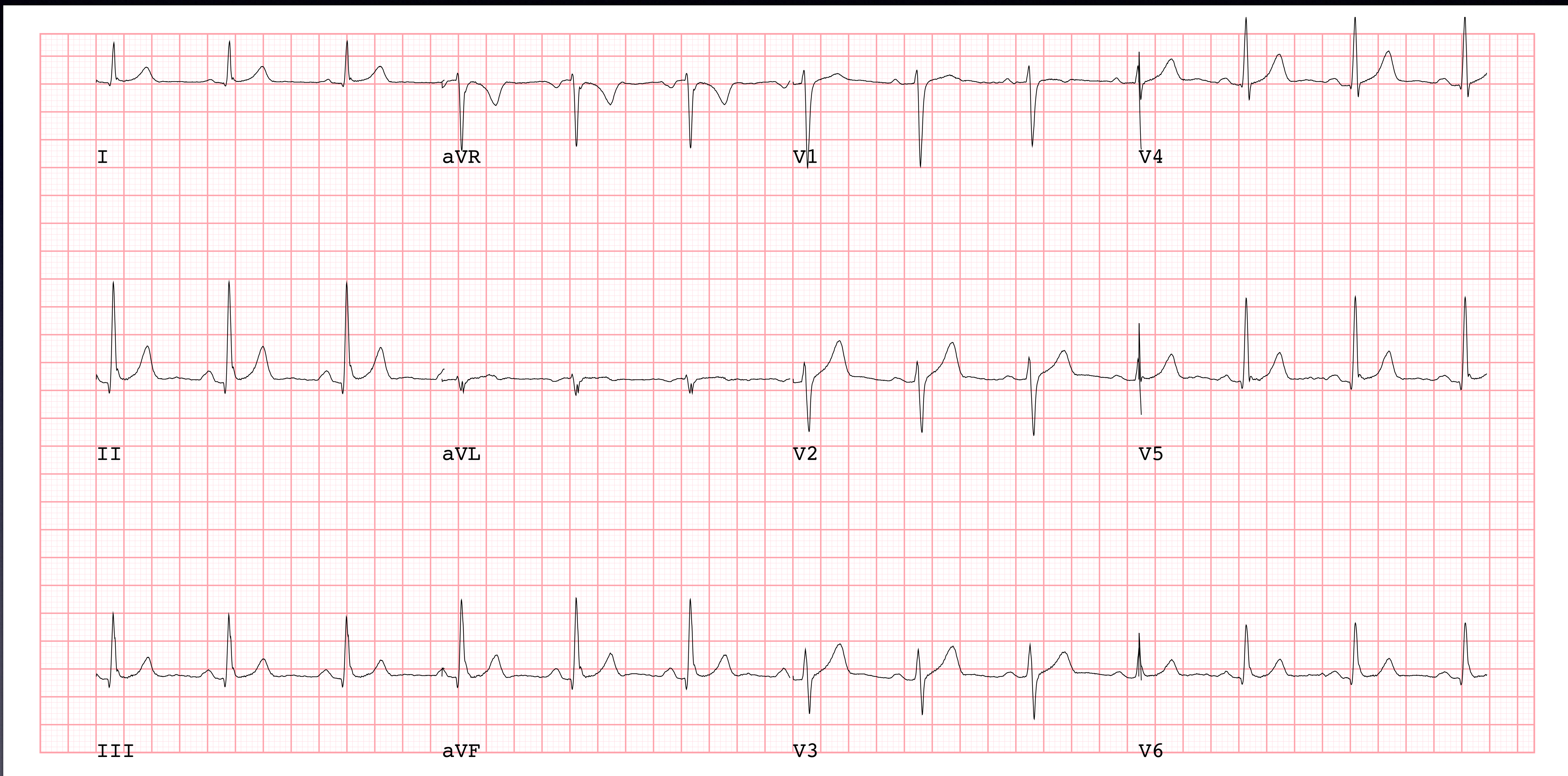
Case

- A 44 year old woman is referred for exercise stress testing. She reports chest pain, sharp stabbing retrosternal lasting a few seconds several times per day. No relationship to physical activity. She is concerned because of a positive family history. She has no other cardiac risk factors.

Stress test

The patient exercised according to the BRUCE for 10:11 min:s, achieving a work level of Max. METS: 12.0. The resting heart rate of 73 bpm rose to a maximal heart rate of 171 bpm. This value represents 103 % of the maximal, age-predicted heart rate. The resting blood pressure of 120/80 mmHg , rose to a maximum blood pressure of 150/76 mmHg. The exercise test was stopped due to Target Heart Rate, Dyspnea.

Rest

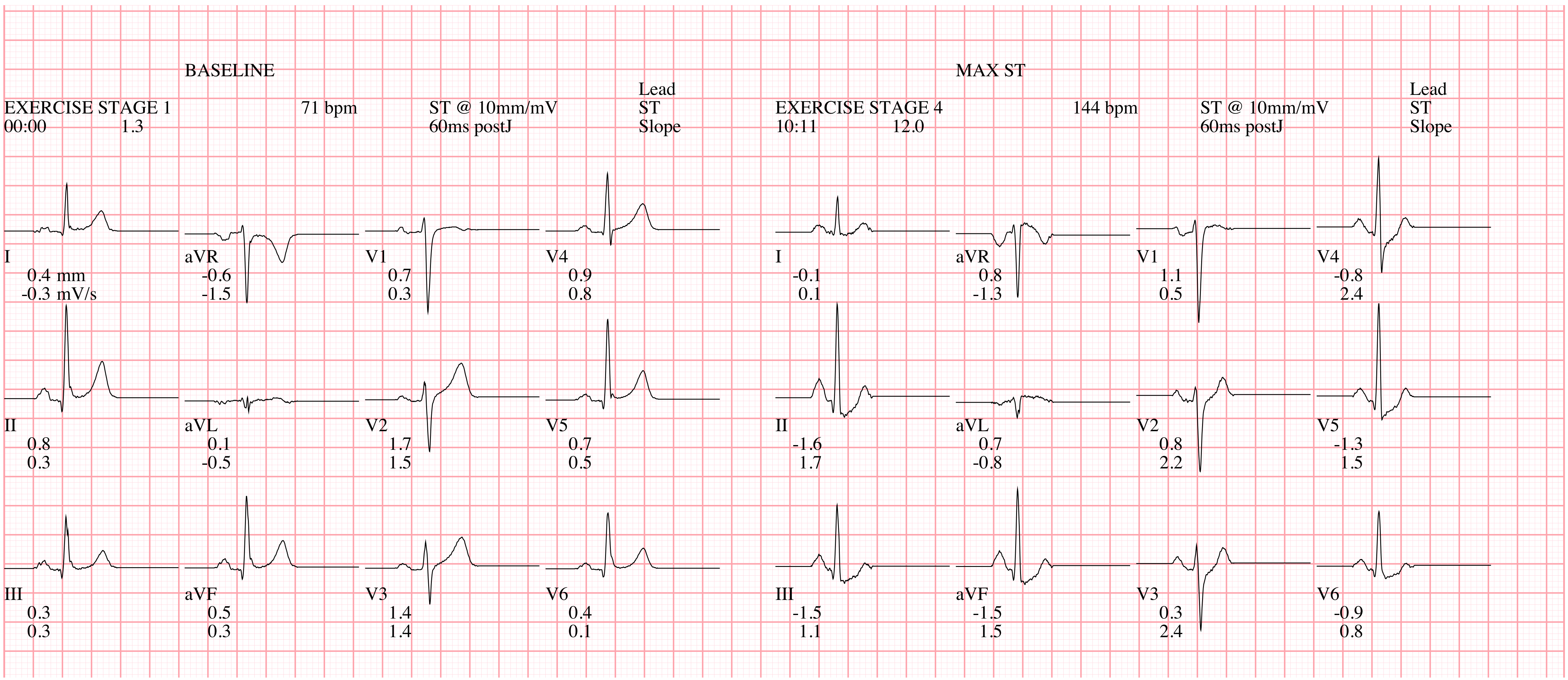


Peak

Recovery 00:15

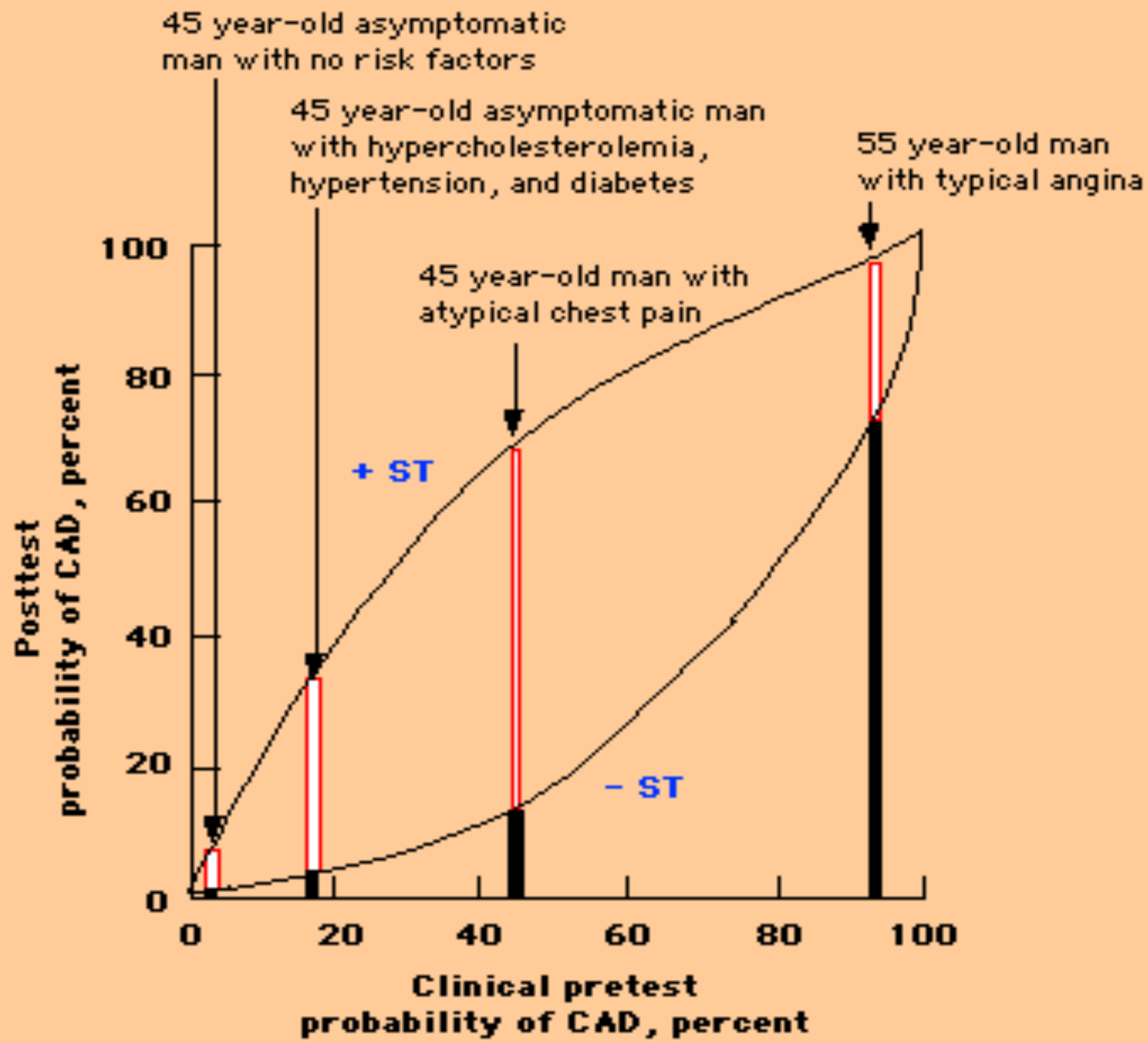
Recovery 2:00

Medians Summary



With respect to this stress test:

- A) It’s normal - Negative
- B) It’s abnormal - Positive
- C) It’s equivocal - Non-diagnostic
- D) Holy crap why did I order this stress test?



Calculation of probability of coronary artery disease The probability of coronary artery disease (CAD) based upon a positive exercise test depends upon the pre-test probability of CAD, ie, the prevalence of CAD in the population studied. The solid black bar indicates the results for a negative test (-ST) while the red bars indicate the results for a positive test (+ST). The results of a postive exercise test are less predictive in an asymptomatic population with a low pre-test probability of CAD while they are very predictive in patients with typical angina who have a high pretest probability of CAD. The posttest probability of CAD is optimal in patients with an intermediate prevalence of CAD, eg, the 45 year old with atypical chest pain. (Data from Patterson, RE, Horowitz, SF. J Am Coll Cardiol 1989; 13:1653.)

ECG changes with exercise

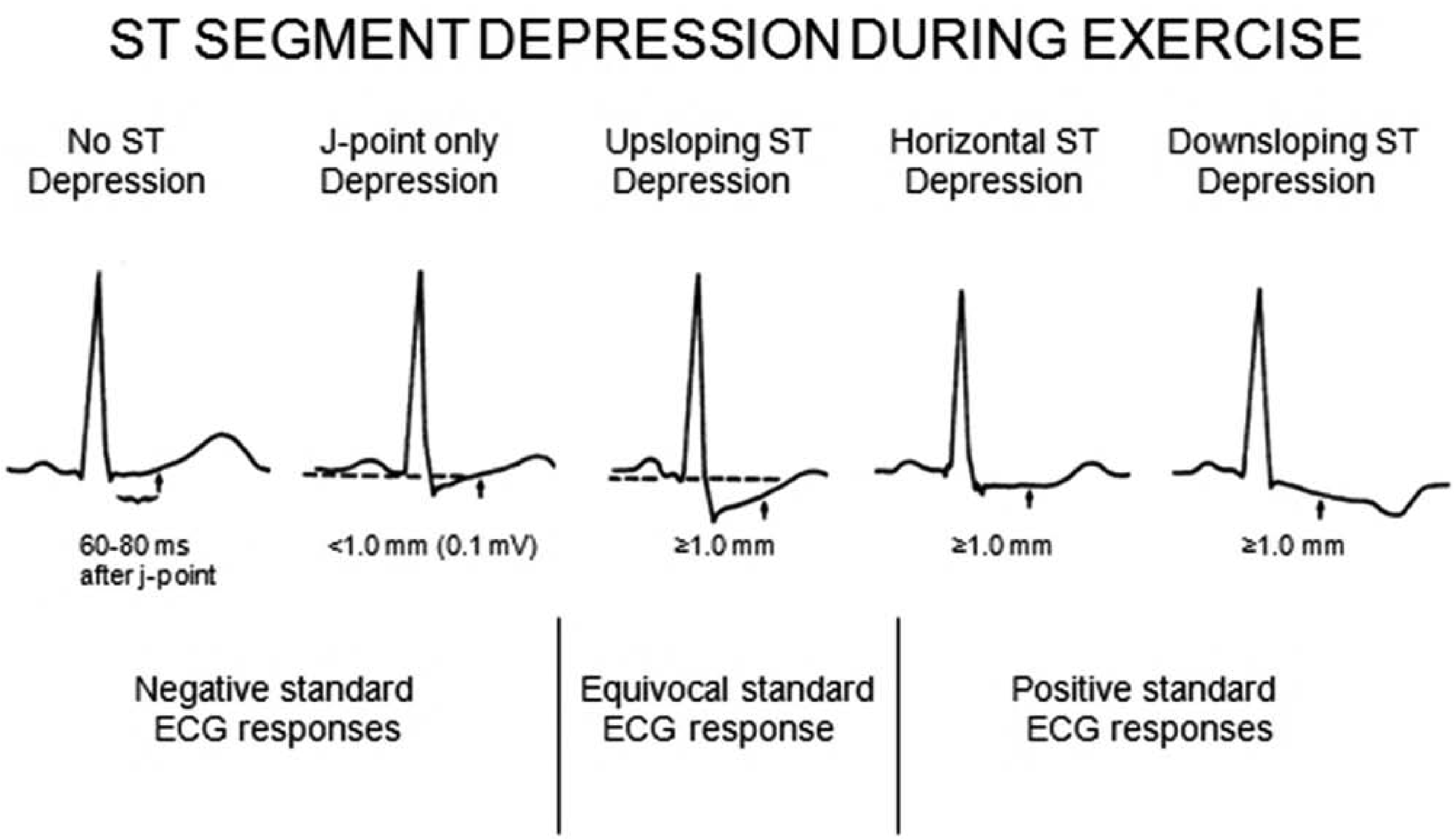


Figure 4. Definition of ST-segment depression changes during exercise. Positive standard test responses include horizontal or downsloping depression ≥1.0 mm (0.1 mV), whereas upsloping ST depression ≥1.0 mm is considered equivocal (a change that does not usefully separate normal from abnormal). All ST depression <1.0 mm additional from baseline is defined as negative. The waveforms depicted are modified from Tavel[610] with permission of the publisher, copyright © 2001, American College of Chest Physicians, but the classification and definitions represent the consensus of the writing group.

Pearl of wisdom

- With resting ST depression, further ST depression is measured
- With resting ST elevation due to early repolarization, only ST depression related to baseline is measured
- Baseline is P-Q segment as T-P is often too short during exercise.

Indications for Exercise Stress testing

-Symptoms suggesting myocardial ischemia
-Acute chest pain in whom acute coronary syndrome (ACS) and myocardial infarction have been excluded
-Recent ACS treated without coronary angiography
-Known coronary heart disease and change in clinical status
-Prior coronary revascularization
-Valvular heart disease (asymptomatic)
-Newly diagnosed heart failure or cardiomyopathy (compensated)
-Certain cardiac arrhythmias
~~-An indication for cardiac assessment prior to non-cardiac surgery~~

- 2012 ACCF/AHA/ACP/AATS/PCNA/SCAI/STS Guideline for the diagnosis and management of patients with stable ischemic heart disease: Miller TD, Askew JW, Anavekar NS.
- Noninvasive Stress Testing for Coronary Artery Disease. Heart Fail Clin. 2016 Jan;12(1):65-82.

Contraindications to Stress Testing

Absolute Contraindications

- Acute myocardial infarction (MI), within 2 days
- Ongoing unstable angina
- Uncontrolled cardiac arrhythmia with hemodynamic compromise
- Active endocarditis
- Symptomatic severe aortic stenosis
- Decompensated heart failure
- Acute pulmonary embolism, pulmonary infarction, or deep vein thrombosis
- Acute myocarditis or pericarditis
- Acute aortic dissection
- Physical disability that precludes safe and adequate testing

Contraindications to Stress Testing

Relative Contraindications

- Known obstructive left main coronary artery stenosis
- Moderate to severe aortic stenosis with uncertain relation to symptoms
- Tachyarrhythmias with uncontrolled ventricular rates
- Acquired advanced or complete heart block
- Hypertrophic obstructive cardiomyopathy with severe resting gradient
- Recent stroke or transient ischemic attack
- Mental impairment with limited ability to cooperate
- Resting hypertension with systolic or diastolic blood pressures >200/110 mm Hg
- Uncorrected medical conditions, such as significant anemia, important electrolyte imbalance, and hyperthyroidism

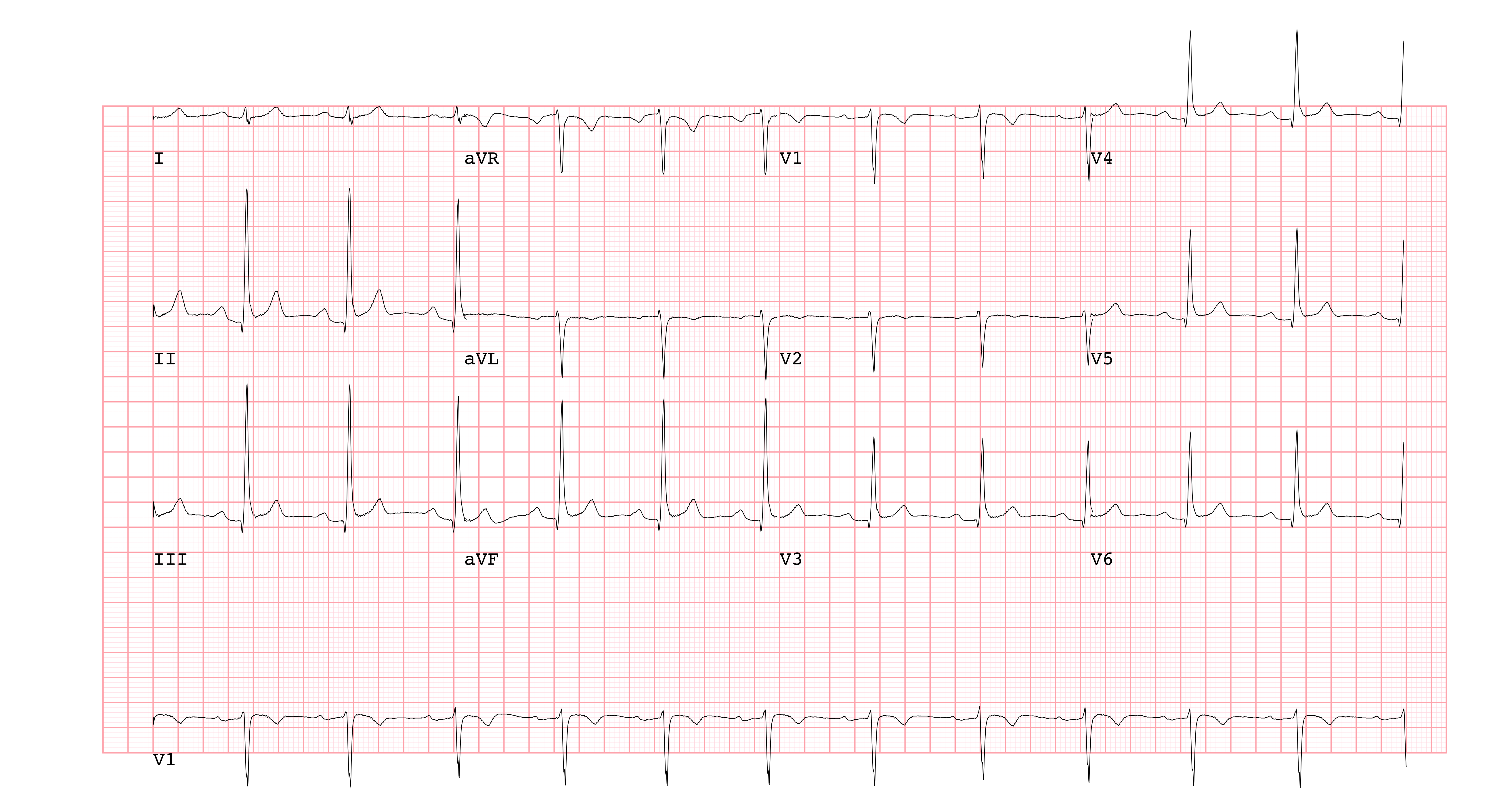
Another case

- 47 year old man complaining of decreased exercise tolerance and palpitations with exertion.
- No cardiac risk factors.

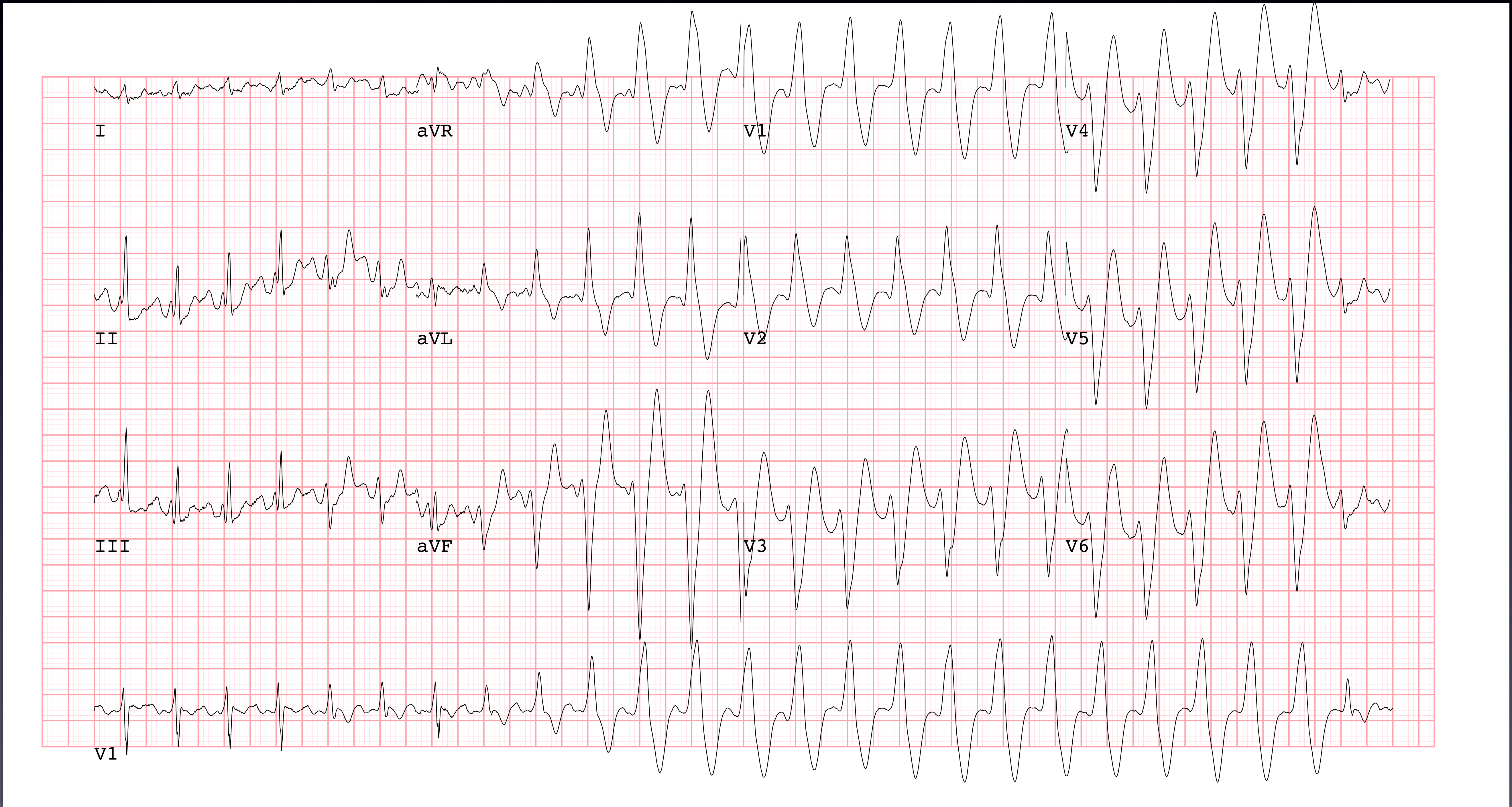
EST

The patient exercised according to the BRUCE for 14:15 min:s, achieving a work level of Max. METS: 17.2. The resting heart rate of 72 bpm rose to a maximal heart rate of 187 bpm. This value represents 106 % of the maximal, age-predicted heart rate. The resting blood pressure of 134/74 mmHg , rose to a maximum blood pressure of 172/60 mmHg. The exercise test was stopped due to Dyspnea.

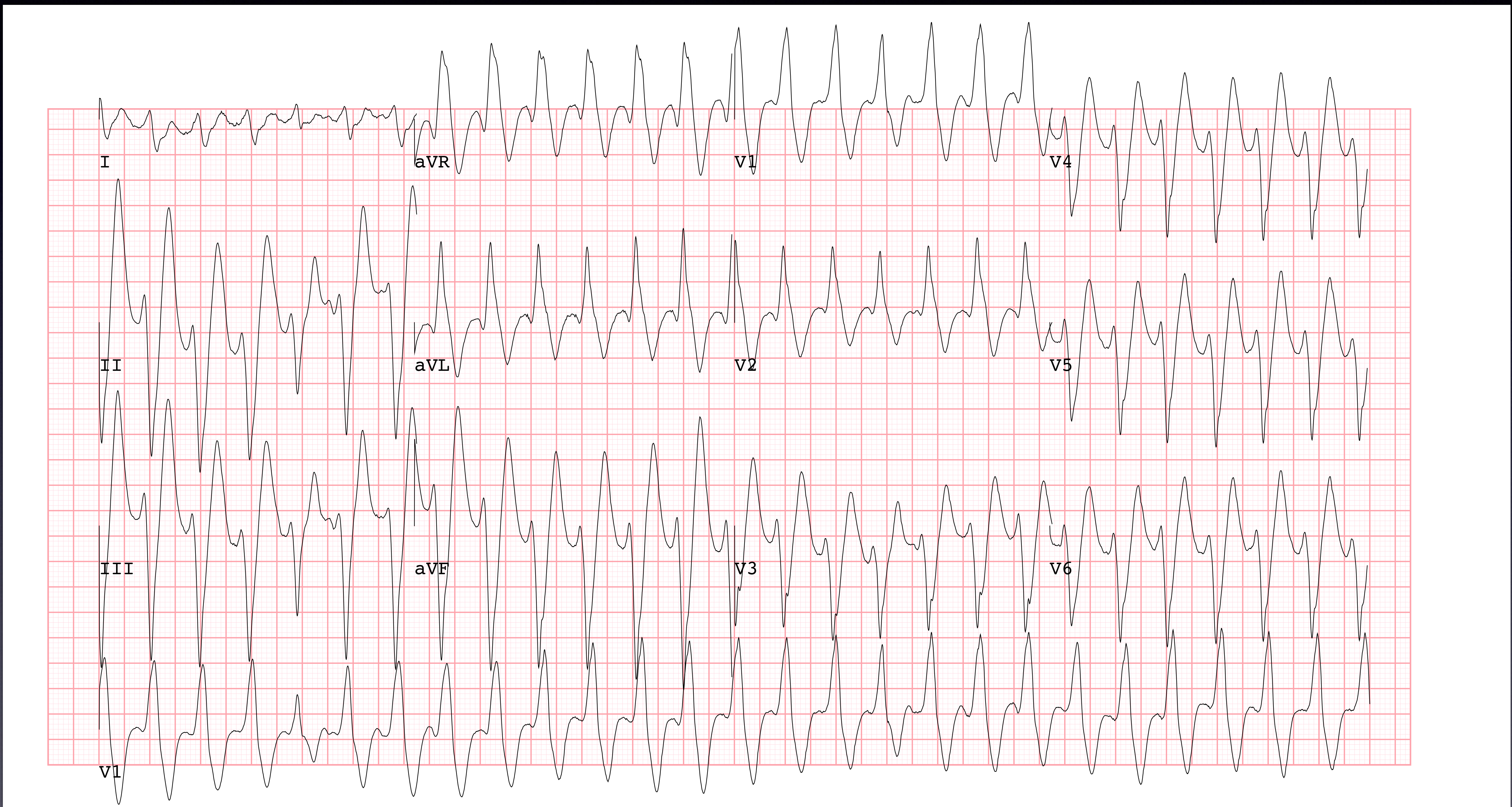
Rest



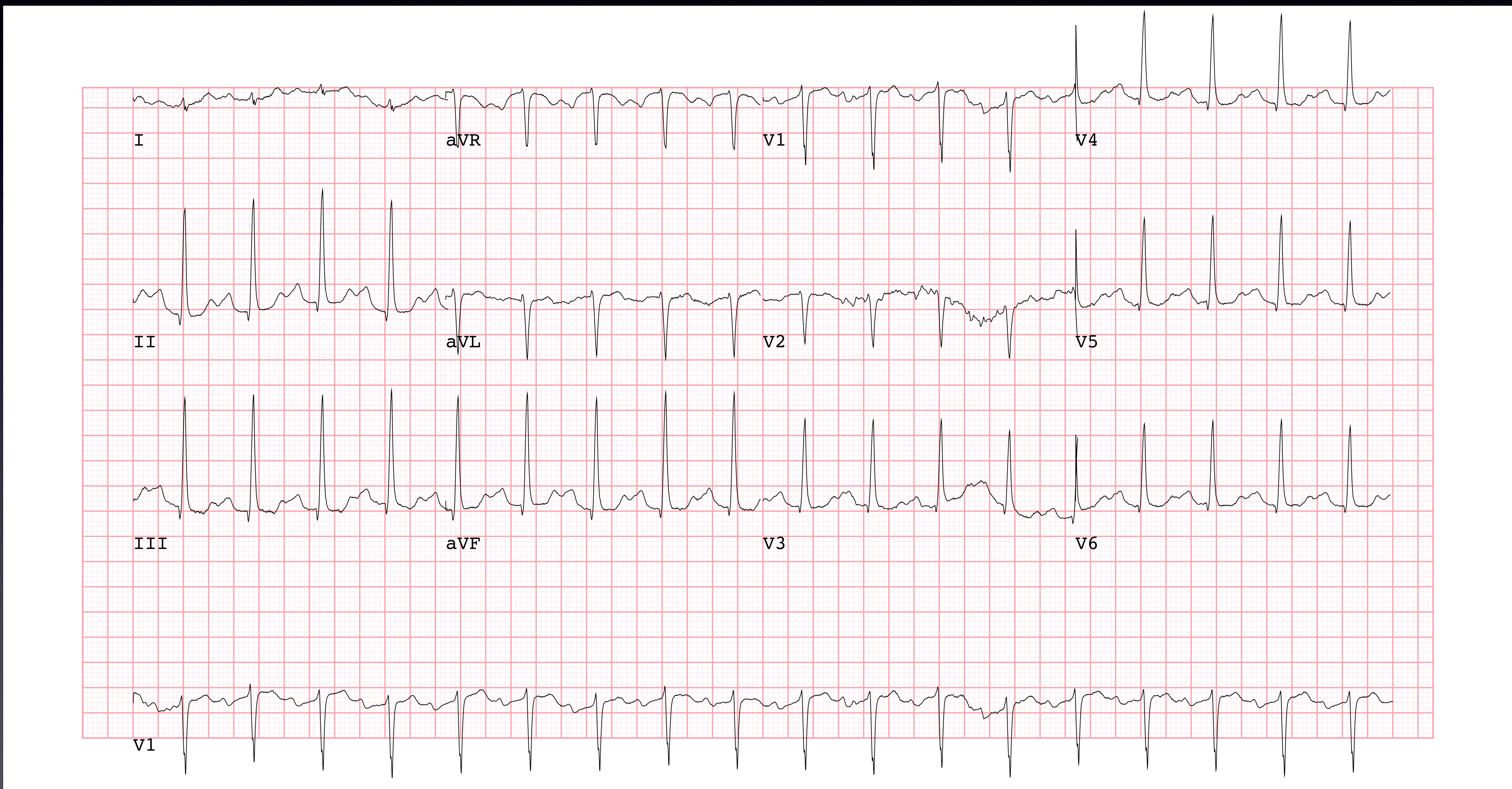
Peak



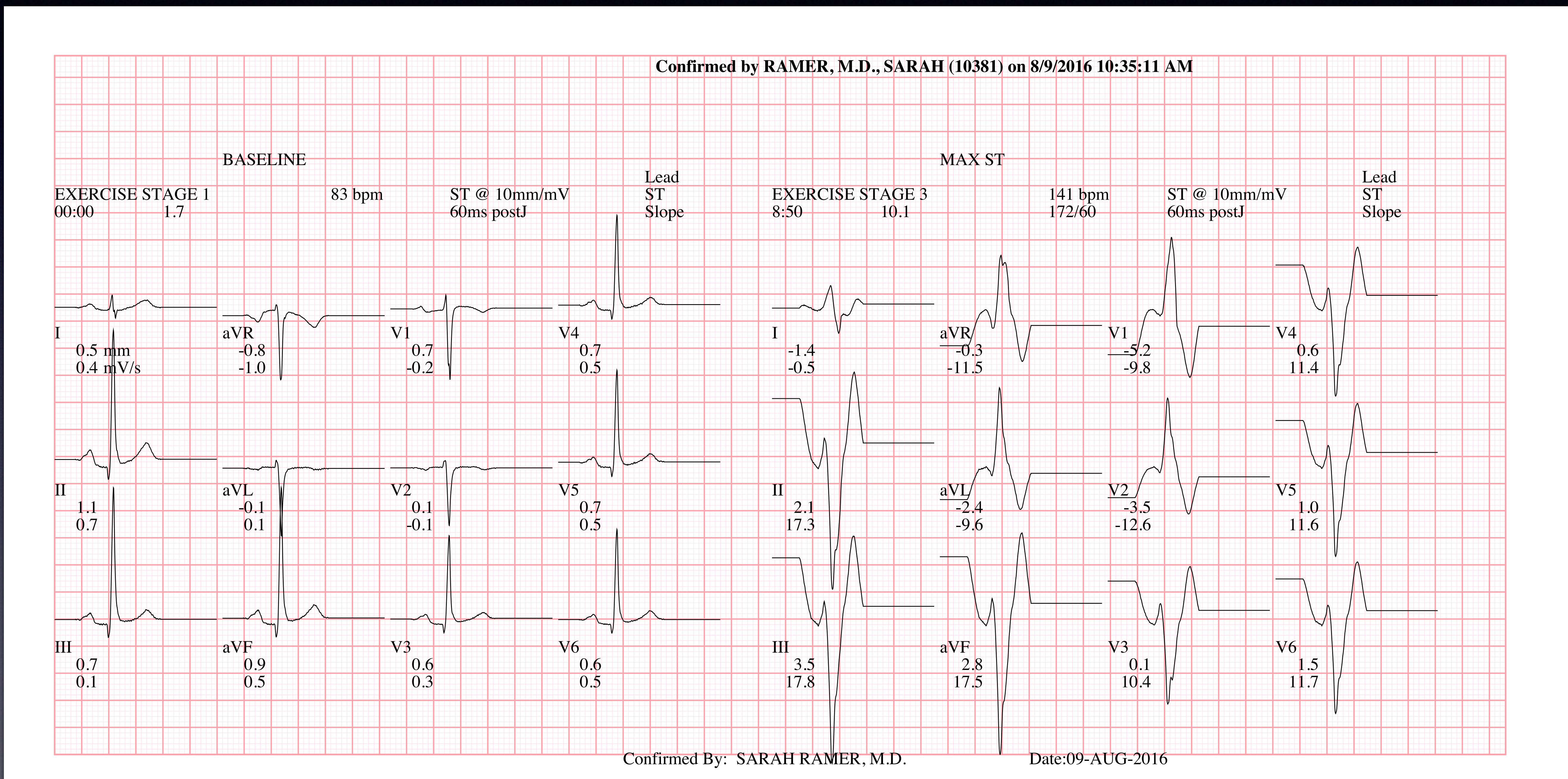
Peak (continued - cardiologist becoming anxious)



Recovery



Medians


Confirmed by RAMER, M.D., SARAH (10381) on 8/9/2016 10:35:11 AM
BASELINE
EXERCISE STAGE 1
00:00 1.7
83 bpm
ST @ 10mm/mV
60ms postJ
Lead
ST
Slope
I
0.5 mm
0.4 mV/s
aVR
-0.8
-1.0
V1
0.7
-0.2
V4
0.7
0.5
II
1.1
0.7
aVL
-0.1
0.1
V2
0.1
-0.1
V5
0.7
0.5
III
0.7
0.1
aVF
0.9
0.5
V3
0.6
0.3
V6
0.6
0.5
MAX ST
EXERCISE STAGE 3
8:50 10.1
141 bpm
172/60
ST @ 10mm/mV
60ms postJ
Lead
ST
Slope
I
-1.4
-0.5
aVR
-0.3
-11.5
V1
-5.2
-9.8
V4
0.6
11.4
II
2.1
17.3
aVL
-2.4
-9.6
V2
-3.5
-12.6
V5
1.0
11.6
III
3.5
17.8
aVF
2.8
17.5
V3
0.1
10.4
V6
1.5
11.7
Confirmed By: SARAH RAMER, M.D.
Date:09-AUG-2016

What happened here and how are you going to report it?

Complications of Stress Testing

Table 1. Complications Secondary to Exercise Testing

Cardiac	Bradyarrhythmias
	Tachyarrhythmias
	Acute coronary syndromes
	Heart failure
	Hypotension, syncope, and shock
	Death (rare; frequency estimated at 1 per 10 000 tests, perhaps less)
Noncardiac	Musculoskeletal trauma
	Soft-tissue injury
Miscellaneous	Severe fatigue (malaise), sometimes persisting for days; dizziness; body aches; delayed feelings of illness

Indications to Stop a Stress Test

Absolute Indications

- ST-segment elevation (>1.0 mm) in leads without preexisting Q waves because of prior MI (other than aVR, aVL, and V1)
- Drop in systolic blood pressure >10 mm Hg, despite an increase in workload, when accompanied by any other evidence of ischemia
- Moderate-to-severe angina
- Central nervous system symptoms (eg, ataxia, dizziness, near syncope)
- Signs of poor perfusion (cyanosis or pallor)
- Sustained ventricular tachycardia (VT) or other arrhythmia, including second- or third-degree atrioventricular (AV) block, that interferes with normal maintenance of cardiac output during exercise
- Technical difficulties in monitoring the ECG or systolic blood pressure
- The subject's request to stop

Indications to Stop a Stress Test

Relative Indications

- Marked ST displacement (horizontal or downsloping of >2 mm, measured 60 to 80 ms after the J point [the end of the QRS complex]) in a patient with suspected ischemia
- Drop in systolic blood pressure >10 mm Hg (persistently below baseline) despite an increase in workload, in the absence of other evidence of ischemia
- Increasing chest pain
- Fatigue, shortness of breath, wheezing, leg cramps, or claudication
- Arrhythmias other than sustained VT, including multifocal ectopy, ventricular triplets, supraventricular tachycardia, and bradyarrhythmias that have the potential to become more complex or to interfere with hemodynamic stability
- Exaggerated hypertensive response (systolic blood pressure >250 mm Hg or diastolic blood pressure >115 mm Hg)
- Development of bundle-branch block that cannot immediately be distinguished from VT

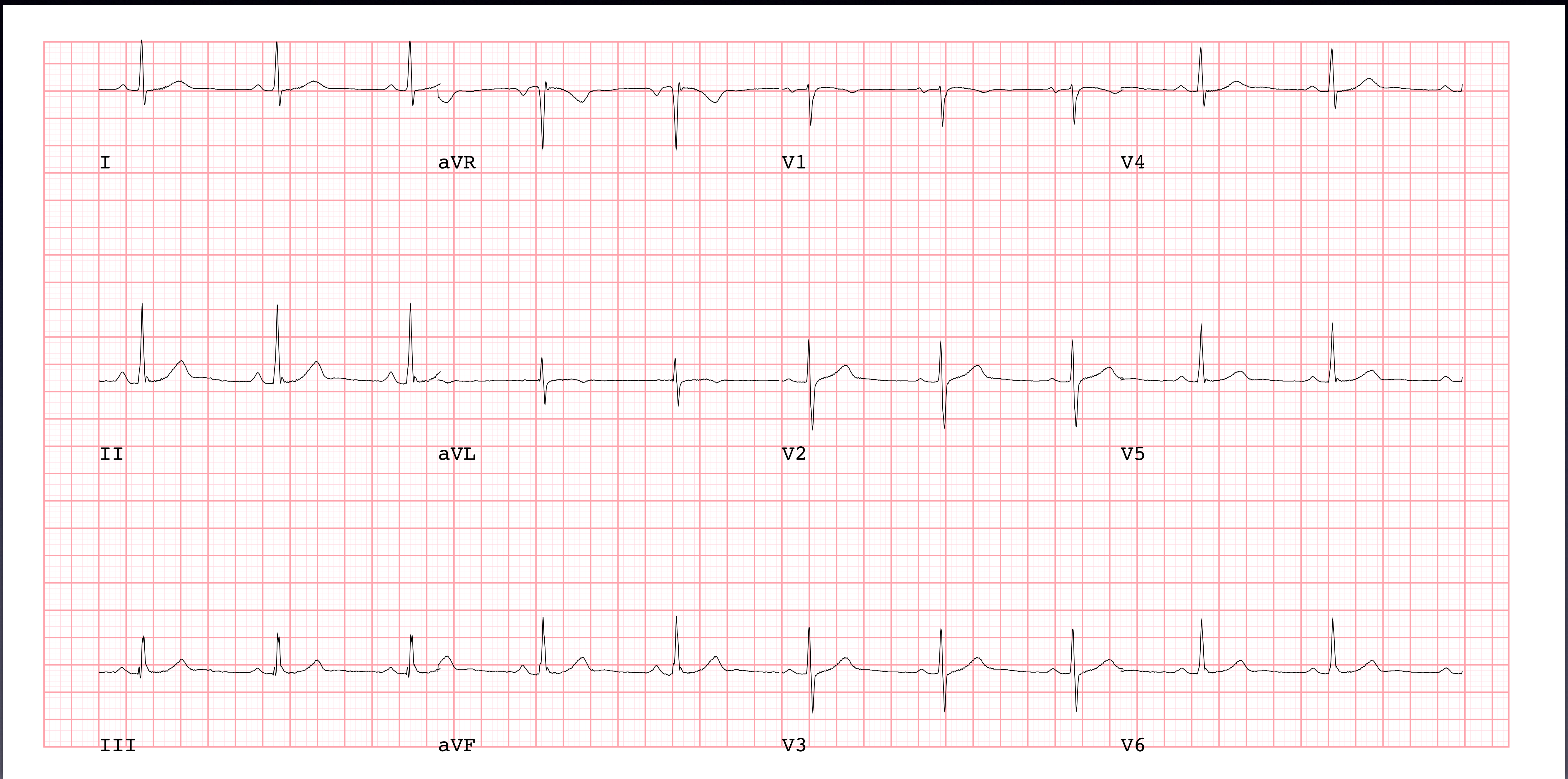
Another case

- 54 year old man with exertional chest pain.
- Restrosternal pressure ‘like somebody sitting on chest’
- Relieved with Rest
- CRF = high cholesterol and pos family history

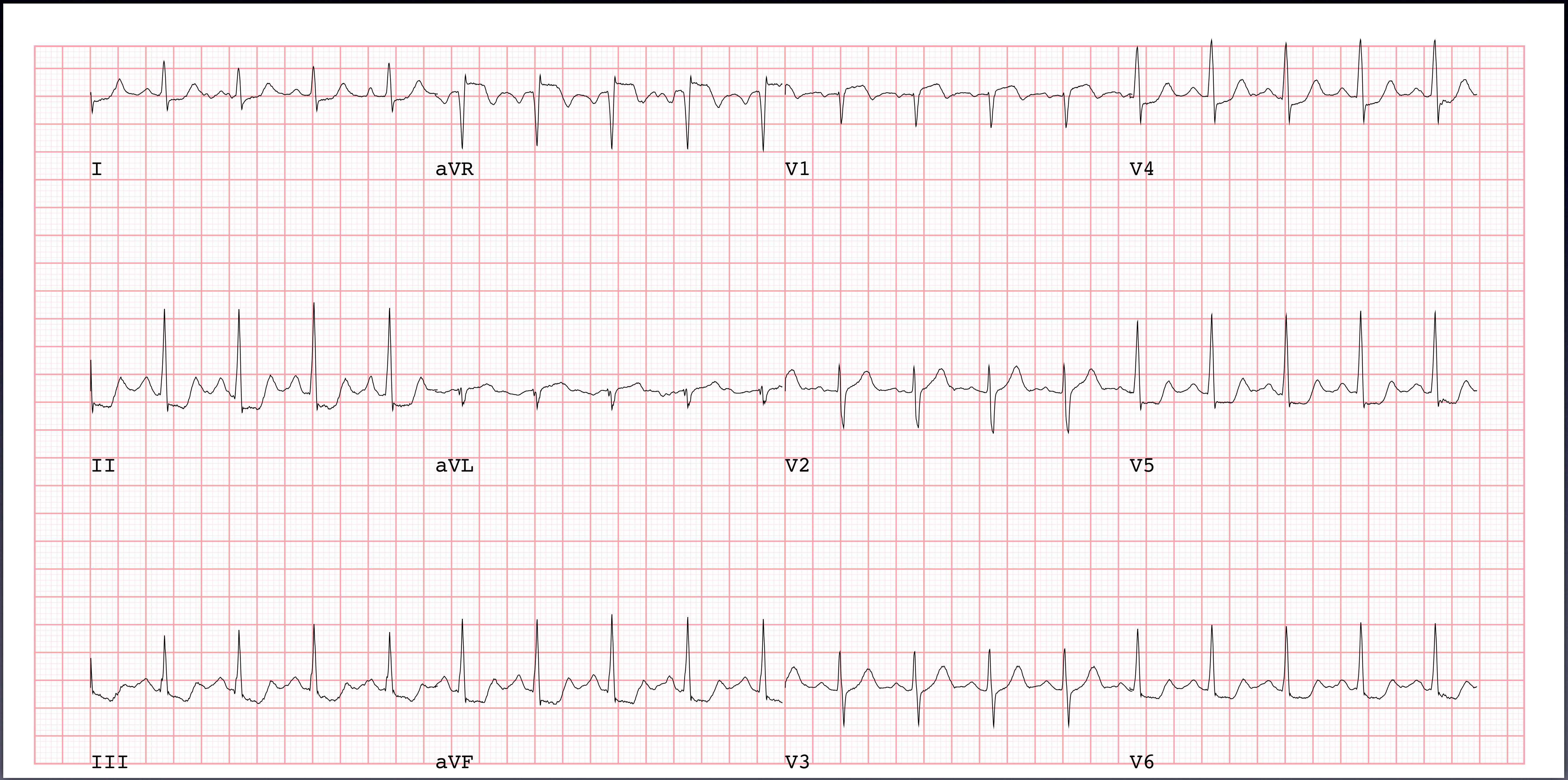
EST

The patient exercised according to the BRUCE for 04:39 min:s, achieving a work level of Max. METS: 6.5. The resting heart rate of 60 bpm rose to a maximal heart rate of 112 bpm. This value represents 66 % of the maximal, age-predicted heart rate. The resting blood pressure of 130/80 mmHg , rose to a maximum blood pressure of 164/82 mmHg. The exercise test was stopped due to usual chest, right shoulder discomfort increasing.

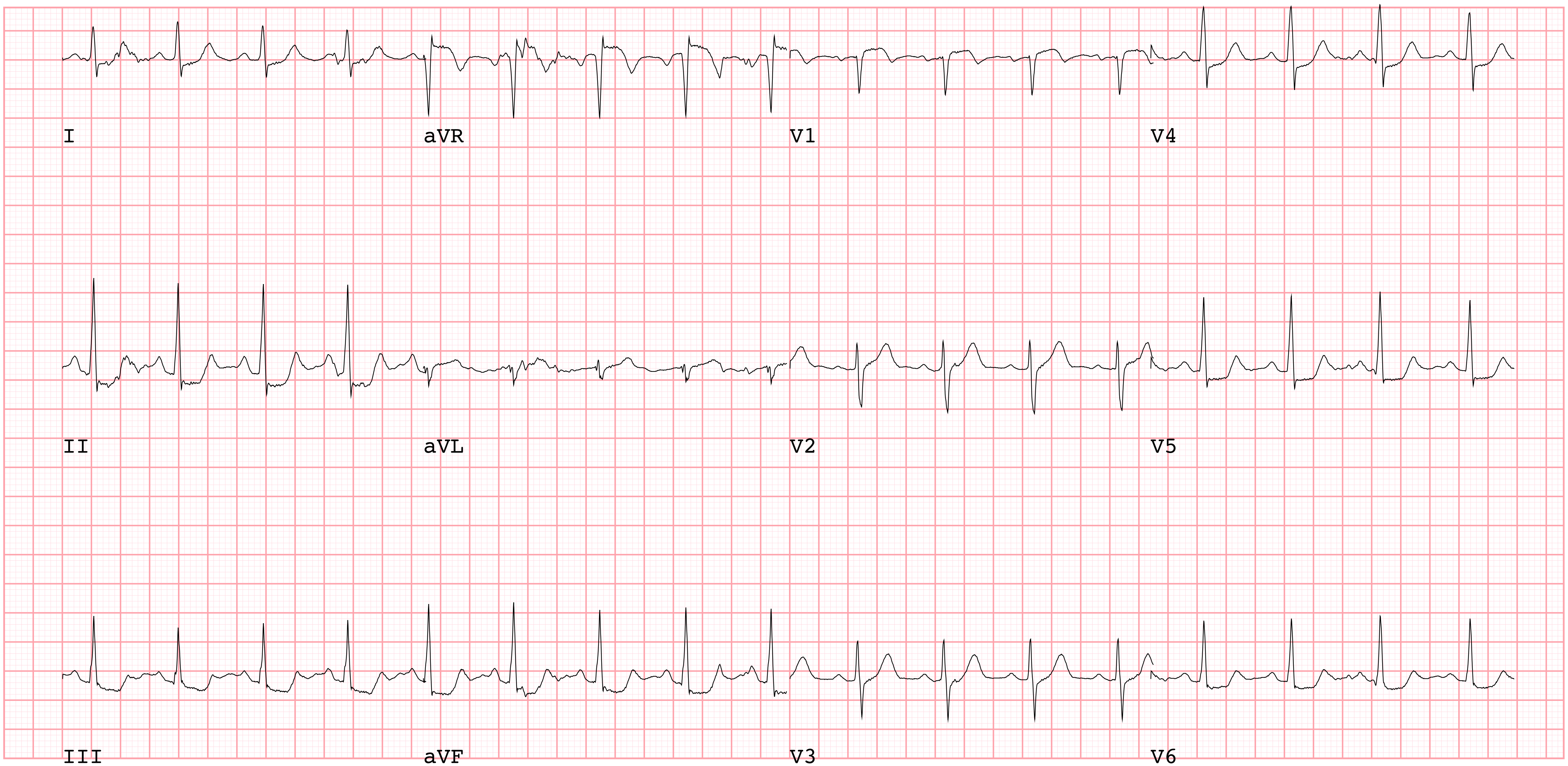
Rest



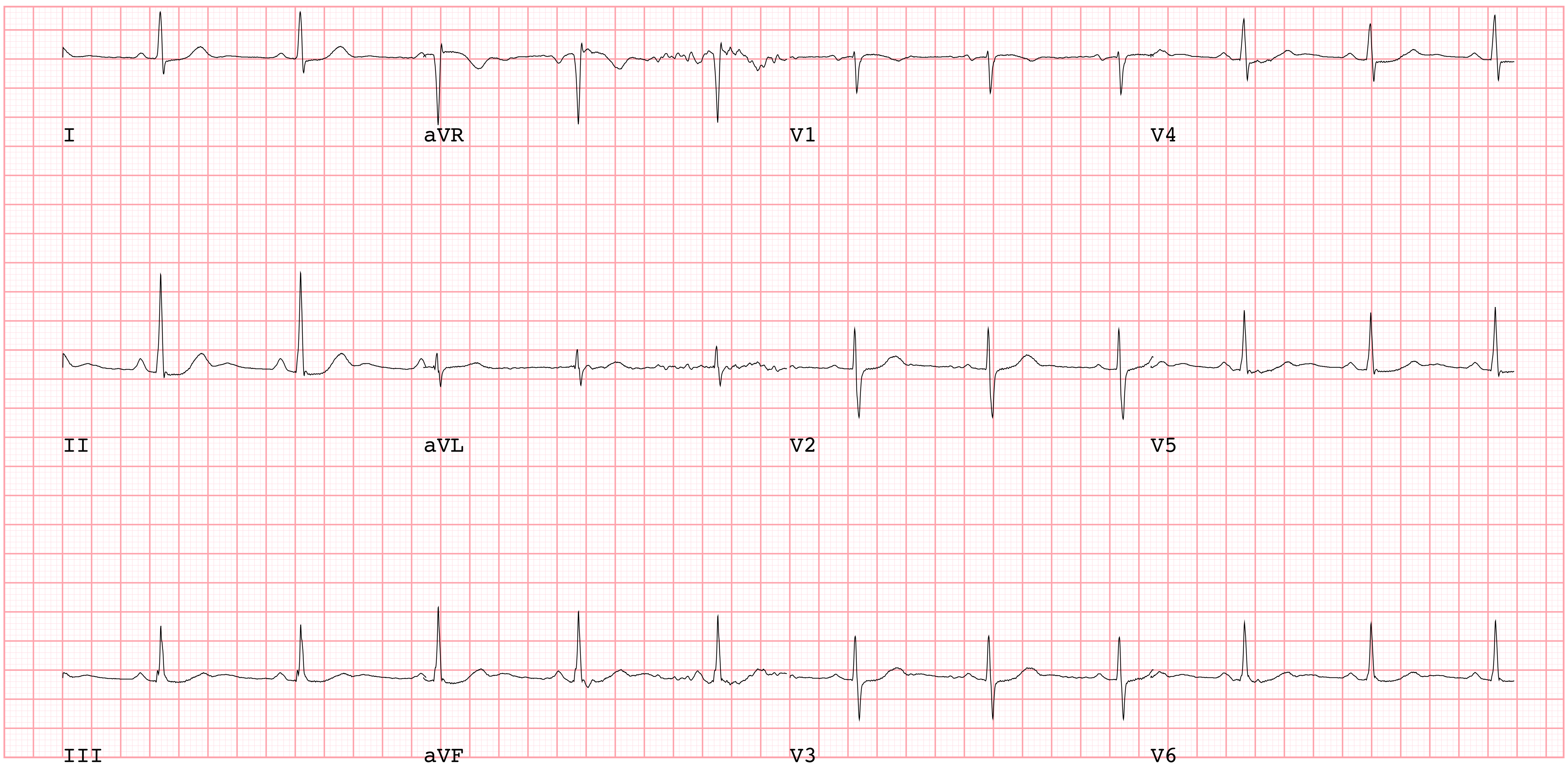
Peak



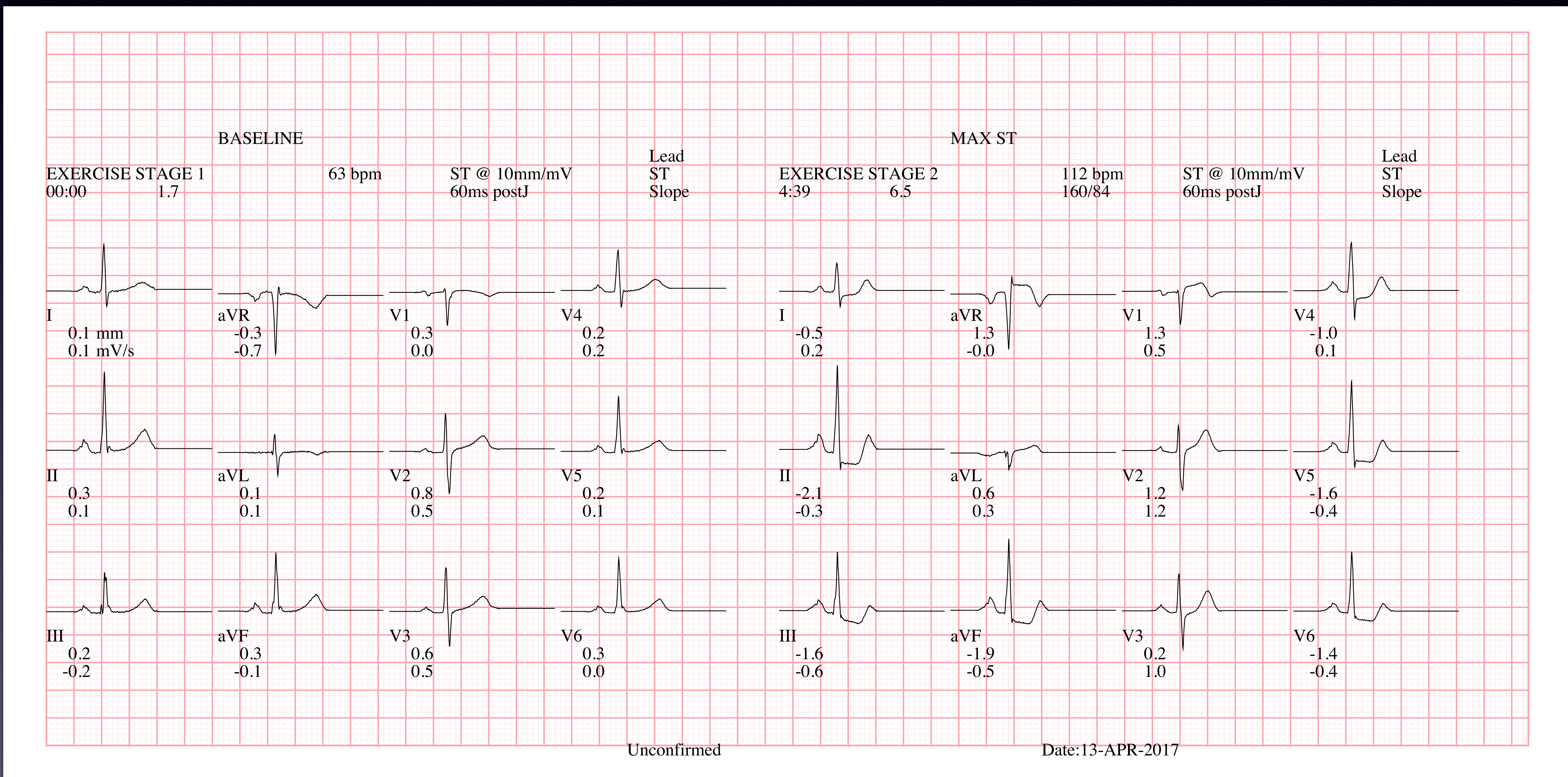
Recovery 00:15



Recovery 2:00



Medians Summary



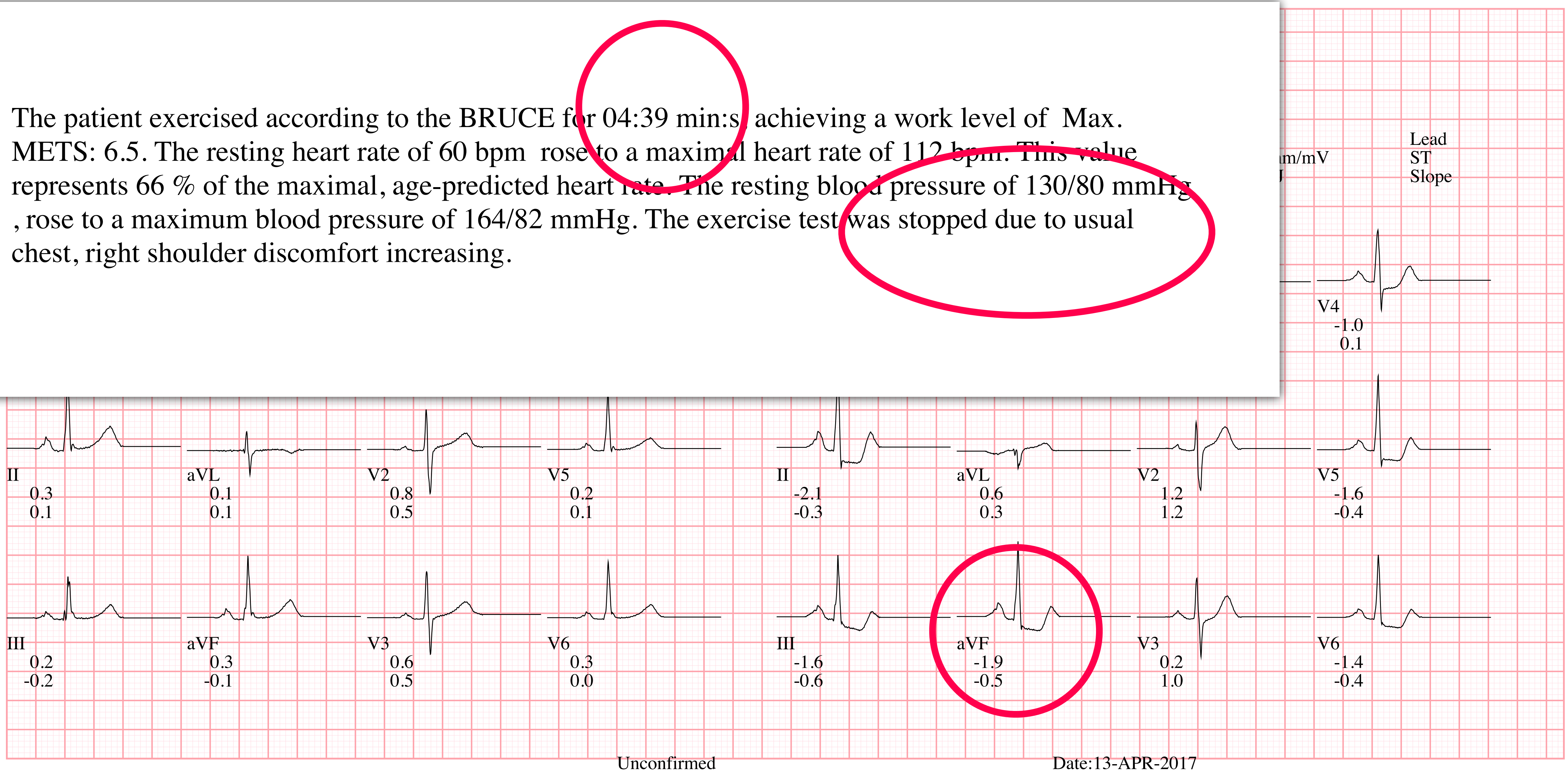
Stress test interpretation

What is his Duke Score and what is the risk?

- Exercise time (minutes on Bruce) - 5 x (max ST depression in mm) - 4 x (angina index)
- 0 = no angina
- 1 = non-limiting
- 2 = limiting

Duke Score

The patient exercised according to the BRUCE for 04:39 min:s achieving a work level of Max. METS: 6.5. The resting heart rate of 60 bpm rose to a maximal heart rate of 112 bpm. This value represents 66 % of the maximal, age-predicted heart rate. The resting blood pressure of 130/80 mmHg , rose to a maximum blood pressure of 164/82 mmHg. The exercise test was stopped due to usual chest, right shoulder discomfort increasing.



Duke Score

- 4 - 5 (2) - 4 (2) = -14
- High Risk

Duke treadmill score

Exercise time in minutes	*n*
mm ST-depression × 5	- *n*
Angina (not limiting × 4)	- *n*
Angina (limiting × 8)	- *n*

Risk		*1 year mortality*
Low risk	≥5	0.25%
Intermediate	4 to –10	1.25%
High	≤ –11	5.25%

Elements of a report

- Patient name
- Referring provider
- Indication for test
- Date performed
- Protocol performed
- Duration of exercise

Elements of a report

- Baseline and Max HR, BP Workload.
- Description of abnormal HR or BP response
- Symptoms - when and what. Specifically mention presence or absence of chest pain.
- Reason for Stopping
- ECG changes - baseline, peak, and when significant
- Arrhythmias - rest and stress
- Comparison to age matched controls

Summary

- “Positive”, “Negative” or “Equivocal”
- “Normal”, “Abnormal” or “Non-diagnostic”
- For detection of ischemia a reasonable RPP must be achieved. (10th percentile 25,000, 90th 40,000)
- THR = 85% max age predicted (220-age)

Report

- Mr. Bob Smith
- Referred by: Dr. S. Ramer
- Indication: Exertional chest pain, ? ischemia
- Date: April 24, 2020

The patient exercised according to the BRUCE for 04:39 min:s, achieving a work level of Max. METS: 6.5. The resting heart rate of 60 bpm rose to a maximal heart rate of 112 bpm. This value represents 66 % of the maximal, age-predicted heart rate. The resting blood pressure of 130/80 mmHg , rose to a maximum blood pressure of 164/82 mmHg. The exercise test was stopped due to usual chest, right shoulder discomfort increasing.

Report

- Decreased exercise capacity (FC II) with endpoint of chest discomfort. Usual CP developed at 4:30 at a HR of 100 beats per minute.

- Blunted HR response to exercise - target HR not achieved

- BP response to exercise - normal resting BP, normal BP response to exercise

- Arrhythmias - none

- ECG changes - Normal resting ECG. Diagnostic ST depression at 4 minutes in the protocol. At peak exercise there is 2 mm ST segment depression, downsloping.

Summary

- Positive Stress test, typical of ischemia at a FCII workload.
- High risk based on a Duke score of -14.

Important definitions

Normal HR response to exercise

- Increase of 10 beats per min per MET
- Expect less if beta blocked
- Chronotropic incompetence can cause symptoms and correlates with poorer prognosis.

Abnormal BP response to exercise

- Hypertensive increase in SBP >60 for men, >50 for women or increase to above the 90th percentile (>210 in men and >190 in women). DBP increase >10 mmHg or absolute value >90mmHg.

- Blunted = an increase of less than 20-25 mmHg.

- Hypotensive = drops below resting value or rises initially and then drops by >/= 10 mmHg.

Oral Scenario

- A 62 year old man presents for outpatient exercise stress testing for evaluation of chest pain. His resting ECG is normal. After 4 minutes on a Bruce Protocol he develops 2 mm of ST elevation in the anterior leads associated with his usual chest pain (retrosternal heaviness).

How to Manage this Patient?

Summary

- Exercise stress testing is ‘bread and butter’ cardiology.
- There will be stress testing on your exam - could be in any section of the exam.
- Know your Duke Score!

Thank you!