

History of Stress Testing

- ❖ Key persons and events in stress testing
- ❖ Key concepts
- ❖ Late-breaking methods



Historical Note

- ❖ The “cornerstone” of modern stress testing was the recognition of the importance of ST segment changes to predict the presence of coronary artery disease (CAD)

Historical Highlights

- ❖ 1918 ST depression first noted during angina (*Bousfield*)
- ❖ 1928 ST changes during exercise (sit ups) are associated with chest pain & decreased cardiac blood flow (*Feil & Siegel*)
- ❖ 1929 Master’s Step test, first “standard” exercise protocol—submaximal w/o EKG (*Master*)
- ❖ 1932 ST depression is present in only 75% of patients with angina during exercise (similar to percentages today). (*Goldhammer & Scherf*)
- ❖ 1938 First to use maximal exercise testing to test for CAD—climbing stairs (*Missal*)

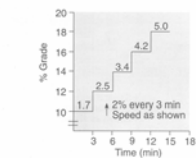
Historical cont.

- ❖ 1940 Continuous EKG monitoring, depression > 1.0 mm is clinically significant (*Riseman et al.*)
- ❖ 1941 EKG changes after exercise can be useful to detect CAD (*Master & Jaffe*)
- ❖ 1942 The **Harvard Step Test** used to assess fitness from HR during recovery (*Johnson et al.*)
- ❖ 1950 Maximal exercise (stair climbing) was more sensitive (88%) to detect CAD than submaximal exercise (39%) (Master’s test) (*Wood et al.*)

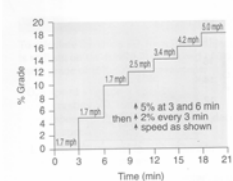
Historical cont.

- ❖ 1952 Treadmill testing used with set criteria to screen for CAD (*Yu et al.*)
 - ❖ ST depression > 1.0 mm
 - ❖ Change in T wave (upright - inverted)
 - ❖ Increase T wave amplitude & Q-T duration
- ❖ 1954 Cycle tests used to predict fitness (*Astrand*)
- ❖ 1956 Bruce established the guidelines used today: treadmill, with EKG, during exercise
- ❖ 1969 Refined interpretation of ST changes (V5 or CM5 most sensitive leads) (*Blackburn et al.*)

Bruce Treadmill Protocols



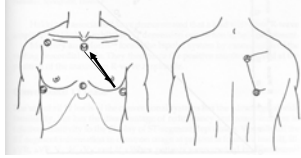
Bruce et al. (1973)
For: normal and high risk
Initial workload: 1.7 mph, 10%, 3 min = normal
1.7 mph, 0-5%, 3 min = high risk



Modified Bruce (Lerman et al. 1976)
For: normal and high risk
Initial workload: 1.7 mph, 0%, 3 min

V₅ and CM₅ leads

- ❖ **Bi-polar Limb Leads**
 - ❖ I, II, and III
- ❖ **Uni-polar Limb Leads**
 - ❖ AVR, AVL, AVF
- ❖ **Uni-polar precordial leads (V₁ to V₆)**
- ❖ **Modified bi-polar leads (CC₅, CM₅, CS₅, CA, CB) (+ electrode in V₅)**



CM₅ lead
see pg 105 in text

General Concepts Today

- ❖ Computer-based analysis of 12-lead EKG changes
- ❖ Combination of ST changes with other exercise data (HR, BP)
- ❖ Imaging methods (echocardiography, nuclear methods)
- ❖ Bayesian Analysis approach, ST interpretation must be consistent with risks of the patient population

Bayes Theorem (1970s and 1980s)

- ❖ The probability of a “true” positive stress test depends on the pre-test risk of the patient

70-yr old man vs 30-yr old woman, both with suspicious chest pain and ST depression



10 %



90 %

Current breaking advances

- ❖ Appreciate there are various types of ischemia
 - ❖ occlusive, vasospastic, blood flow redistribution
 - ❖ ST doesn't need to correlate to angiography occlusion
- ❖ Newer EKG leads and imaging techniques to localize diseased vessels
- ❖ predictive value of traditional (cholesterol, LDL) and non-traditional (ApoB, C reactive protein) biochemical markers