Glasgow ECG interpretation program to which automated methods for Minnesota Coding were added. The data were first stratified by matching for sex and then age (in 10-year groupings), and then individuals were randomly allocated to either a training or evaluation set.

Results: In the group as a whole, 4 codes (3-1, 3-3, 9-2 anterior, and 9-5) were found to have specificity levels below 95% in men, although these codes were highly specific in women. A sex analysis of the 4 codes showed a significantly larger proportion of men having the codes than women ($P < .001$). With respect to age, the specificity level in men younger than 40 years (n = 466) was significantly lower than that in the group of men older than 40 age (n = 389) for each code under examination ($P < .001$). The criteria in the 4 groups were altered to increase specificity toward the 95% level (see table). After the optimization process, specificity for men increased across all 4 codes in the test set, with improvement levels ranging from 2.8% for code 3-1 to 12.9% for code 9-2 anterior.

Conclusions: The study showed that specificity levels for some voltage-related Minnesota codes are age- and sex-dependent. Although specificity of the revised criteria applied to the test set was disappointing, compared to those obtained using the training set, there was always an improved specificity up to 12.9% using the revised age-based criteria for men. Users of the Minnesota code should be aware of its lack of specificity in younger men in particular.

Code	Male Specificity (%) Training Set (n = 428)			Male Specificity (%) Evaluation Set (n = 427)		
	Before change	After change	% gain	Before change	After change	% gain
3-1	92.8	94.6	1.8	87.8	90.6	2.8
3-3	86.4	95.1	8.7	89	94.8	5.8
9-2 anterior	79.7	91.6	11.9	79.6	92.5	12.9
9-5	90	94.6	4.6	87.4	91.8	4.4

doi:10.1016/j.jelectrocard.2007.03.362

ECG-5

Diagnostic value of exercise electrocardiogram in elderly patients with suspected coronary artery disease

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Introduction: The aim of this study was to define the diagnostic value of 12-lead exercise electrocardiography (ECG) in elderly patients for whom coronary angiography was planned for diagnosis of coronary artery disease (CAD).

Methods: A selected series of 196 patients older than 64 years (124 men, mean age 75.6 years; 72 women, mean age 67.6 years) hospitalized because of suspected CAD underwent exercise ECG and coronary angiography, respectively. The sensitivity, specificity, and positive and negative predictive values of exercise ECG were calculated. Patients unable to develop an adequate exercise workload were not taken into account.

Results: Between the total of 196 patients, 128 (65.3%) could reach the adequate exercise workload (66.1% of men and 63.9% of women). Exercise ECG results were positive in 102, and coronary angiography confirmed the presence of CAD in 90 of them; results were negative in 26 patients, but only 15 were free from obstructive coronary lesions. The sensitivity and specificity of the ECG was 89.1% and 55.6%, respectively. The sensitivity and specificity of ECG was superior in men than in women and seemed to correlate with the extent of CAD. The predictive values of a positive ECG was 88.2% and negative ECG was 42.3%.

Conclusions: In about one third of elderly patients, it could not possible to reach the target workload. Specificity and negative predictive value of 12-lead exercise ECG is low. In elderly patients with suspected CAD, diagnostic value of exercise ECG is limited.

doi:10.1016/j.jelectrocard.2007.03.363

Oral Presentations

ECG-6

Understanding ST depression in the stress-test electrocardiogram

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Introduction: The electrocardiogram (ECG) obtained during exercise testing often shows a typical pattern of left anterolateral ST depression. A similar pattern can occur spontaneously in patients with UA/non–ST-elevation myocardial infarction and appears to be independent of the occlusion site(s). The current textbook explanation of ST depression involves subendocardial ischemia. However, experimental models could not reproduce such phenomena at a resting heart rate. Recent theoretical work has shown that the classical relation between subendocardial ischemia and epicardial ST depression relies on an incorrect mathematical model of the myocardium. In a realistic model of the human heart, ST depression could only be obtained with subendocardial ischemic zones that covered more than half of the left ventricle. We therefore hypothesized that ECG ST depression can be explained with ischemia affecting the entire left ventricular (LV) subendocardium.

Methods: The ECG was simulated with a reaction-diffusion model of the human heart, incorporating anisotropic myocardium with transmurally rotating fiber orientation at 0.25-mm resolution and an inhomogeneous boundary-element torso model. Details of the models have been published previously.

Results: Limited subendocardial ischemic zones caused ST elevation on the ECG. An ischemic zone of 50% transmural extent covering the entire LV subendocardium caused an ST-depression pattern similar to that observed during stress test.

Conclusions: Our results show that "global" subendocardial ischemia may explain ST depression. ST depression is typically related to partial occlusion, sometimes affecting only a single artery. The mechanism whereby a local perfusion deficit would cause global subendocardial ischemia is unknown but may involve underperfusion of the endocardium due to increased LV pressure, cardiac insufficiency, or an autonomic reaction. Accurate analysis of patient data is required to determine the applicability of our theoretical findings in real cases.

doi:10.1016/j.jelectrocard.2007.03.364

ECG-7

Reliability-based rearrangement of electrocardiographic automated interpretation chain

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Introduction: Sequences of electrocardiographic (ECG) interpretation procedures from various manufacturers of ECG-dedicated software were studied in aspect of data flow and reliability of intermediate results. The results motivated us to design a new system architecture considering error propagation issues on subsequent stages of ECG processing and reducing the data stream on initial stages.

Methods: The proposed architecture has network topology and consists of the procedures interconnected by databases (see Fig. 1). Each node and isolated subnetworks were tested against the MIT-BIH and CSE standard databases and described by the incorrect result probability and data reduction efficiency. The optimized solution considers also the probability of the procedure use and probability of useless outcome. Best-performing network was selected and compared to the original sequential interpretation chain.

Results: The optimized architecture moves reduction-effective functions to the front of the processing chain, reduces the cumulative error propagation by parallel use of multiple short processing chains, and reduces the interpretation processing time and the required computational power. Depending on interpretation domain, the reduction of outcome relative