A Simplified Clinical ECG score for the prediction of Cardiovascular Mortality

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Background & Objective

More than a century has passed since Einthoven demonstrated the ability of the ECG to discern between a healthy heart and one that is diseased. During this time, the venerable 12 lead ECG is has become a readily available, affordable and indispensable tool clinically. Aside from its well-established role in the diagnosis of acute coronary ischemia and arrhythmias, the ECG has tremendous potential in prognostication for cardiovascular disease.

Risk stratification using the 12 lead ECG has been extensively studied. Various ECG scores and criteria have demonstrated associations with cardiovascular (CV) mortality. These include the Minnesota code, Cardiac Injury Index damage (CIIS) scores, the Simplified Selvester Score (SSS) and various indices of left ventricular hypertrophy (LVH). Specific ECG abnormalities, such as T wave changes, bundle branch blocks and QRST spatial angle have been associated with CV mortality. Unfortunately, these scores are relatively complicated, thus limiting their practical utility in the clinical setting. Simplification of ECG interpretation would be a great benefit for the primary care physician.

Our aim was to devise a simple yet functional ECG score that could be used by the clinician for day to day clinical use. This score should be at least comparable if not better than existing ECG scores that have been developed.

Methods

Study Design

Since 1987, the Palo Alto Veterans Affairs Health Care System has used a computerized ECG system (GE Marquette) to coordinate collection, storage and analysis of ECGs. This system has been validated by both the United States Food and Drug Administration and the European Community and is widely used across the world. The current study involved a retrospective analysis of 45,855 ECGs obtained between March 1987 and July 2000. In cases where more than one ECG was available for a patient, only the first ECG was considered.

ECG analysis

The recorded data on each ECG included the intervals and voltages at each of the points of the PQRST complex of the basic eight leads with derivation of the remaining four leads. The system also flagged rhythm abnormalities and performed waveform analysis to provide the basic electrocardiographic interpretations Standardized ECG criteria as described by the GE 12-lead electrographic analysis program were used for the diagnosis of Q waves, ST changes, and bundle branch blocks. From these, the Cardiac Infarction Injury Scores (CIIS) and Selvester scores, Minnesotta code as well as the Romhilt-Estes criteria for LVH were calculated.

The Simple ECG Score

The ECG score comprises 12 variables, each of which were selected by their prevalence in the population and their association with CV mortality. The prevalence and the hazard ratios for the ECG abnormalities are in the table below.

ECG abnormality	Hazard Ratio	Pvalue	Prevalence in %
RBBB	1.3	<0.003	3.7
LBBB	2.5	<0.001	1.3
IVCD	1.8	<0.001	3.1
Afib	1.4	<0.001	2.7
Qwaves	2.0	<0.001	11.7
RVH	2.8	<0.001	0.3
LVHRomhilt	2.4	<0.001	5.2
RAD	1.8	<0.001	2.3
LAD	1.3	<0.001	9.5
QTC>450	1.9	<0.001	11.6
STdepression V5	1.9	<0.001	9.2
LAE	2.0	<0.001	3.3

The number of ECG abnormalities were then summed to provide a score out of 12.

Results

Cox Proportional Hazard Analysis

Adjusting for age and heart rate in the proportional hazards models, the ECG score was univariately associated with CV mortality. When the established ECG abnormalities were entered together in a multivariate analysis with the new ECG score, the new score superseded them for predicting CV death (see below).

Variable	Chi Square Increment	Z value	P values
ECG score	633	27	<0.0001
T wave amplitude in aVR	358	18	<0.0001
CIIS score	162	11	<0.0001
Minnesotta code	24	3.61	<0.0001
QRST spatial angle	NS	NS	NS
LVHRomhilt	NS	NS	NS
Selvester Score	NS	NS	NS
T wave amplitude in lead I	NS	NS	NS

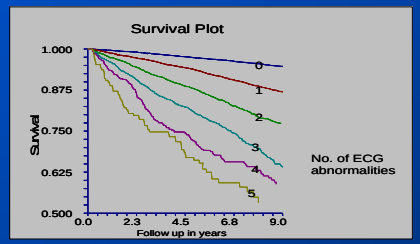
Relative Risks

The relative risks for the ECG score were calculated, with the group having no ECG abnormalities as the reference group. The relative risk increased as the number of ECG abnormalities increased. With one ECG abnormality the relative risk was only 1.8; however, this rose to 6.0 when there were 5 or more ECG abnormalities. (see table below)

No. of ECG abnormalities	Relative Risks	P value
1	1.8 CI (1.6 – 2.0)	<0.001
2	2.4 CI (2.2 – 2.7)	<0.001
3	3.6 CI (3.2 – 4.1)	<0.001
4	4.5 CI (3.8 – 5.4)	<0.001
5 or more	6.0 CI (4.7 – 7.8)	<0.001

Survival Curves

Kaplan-Meier survival plot showing that as the number of ECG abnormalities increase, the higher the mortality



Clinical Implications

Many attempts have been made to study the utility of the ECG for screening and risk stratification purposes. Some utilize single disparate ECG abnormalities, while others use a combination of ECG criteria to define a score/ index that predicts mortality.

The current simple score is a composition of 12 classic abnormalities chosen by their prevalence in our population and their association with CV mortality. We found it to be the most powerful ECG predictor of cardiovascular mortality, stronger than all other established scoring systems or criteria.

This scoring algorithm could be easily incorporated into ECG systems, potentially assisting the clinician in stratifying CV risk and helping to guide clinical management.

Conclusions

The simplified ECG score could be incorporated in ECG machines such as to avail general practitioners another tool for risk stratification. An elevated ECG score should heighten a physician's index of suspicion for cardiovascular disease in a patient., This can help him decide if further specific cardiac testing or a cardiology consult is needed.