by 3 technicians. The ECGs were also fed into 3 computer algorithms, and the median values of the durations/intervals were derived. The differences were expressed as percentage values (Diff × 100 / Ref), and their mean and SD were calculated. The stability of measurements against noise was evaluated by adding high-frequency, line frequency, and baseline noise (per IEC 60601-2-51).

Result:

Standard deviations of the differences between manual and computer measurement

Global measurement	Single-beat lead II	Average-beat lead II	Online 12 lead
PR	5.13	2.51	2.74
QRS	11.25	8.46	3.61
QT	5.38	2.89	2.26

Standard deviations of the differences between manual measurement of noise-free ECGs and ECGs with added noise

Type of added NOISE	Single-beat lead II	Average-beat lead II	Online 12 lead
High frequency	5.08	3.08	1.46
Line frequency	4.23	4.48	1.49
Baseline	5.81	3.24	1.43

Conclusion: The online 12-lead caliper method has significantly smaller variations than the single-beat approach. Especially for all types of noise, the online 12-lead method is much more stable. Furthermore, online 12-lead ECG measurement with calipers provides the closest measures to the reference values provided by the CSE study.

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Variability of intraindividual QT interval estimates corrected for heart rate in a population-based follow-up study

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Background: A prolonged QT interval corrected for heart rate is an independent predictor for severe cardiac rhythm disturbances and for cardiac mortality. A controversial discussion has been raised about the optimal QT correction formula concerning on one hand the QT-RR relation estimated on a population-based scale, and on the other hand, changes of QT with heart rate in individuals derived from serial electrocardiograms.
Methods: To address both of these aspects, we investigated the QT-RR relation derived from computerized 12-lead resting electrocardiogram (ECG) analyses of 3299 persons (1669 men, 1630 women) aged 25 to 64 years (*a*) in a population-based survey (Monica Project Augsburg) and (*b*) in a 3-year follow-up of the same persons comparing individual QT changes with the individual R-R changes between the survey examination and the follow-up examination. The ECG measurement program used analyzed all ECG cycles of the 20-second records to derive a final QT interval estimate from all normal ECG cycles. QT-RR relation was analyzed using (1) Bazett's formula, (2) Fredericia's cubic root, (3) linear regression according to the Framingham Heart Study, and (4) the nomogram method, which applies piecewise linear regressions for the ranges RR <600 milliseconds, RR = 600-1000 milliseconds, and RR >1000 milliseconds. The proportion of explained variation R^2 attributed to the fit derived from the application of the 4 different QT correction formulas was used as a measure of the goodness of fit.
Results: The best fit for both the cross-sectional approach of QT-RR relation based on the survey data (R^2_{sd}) and the intraindividual QT-RR changes between the survey and the follow-up examination (R^2_{ic}) was achieved using the nomogram method (R^2_{sd} = 0.54; R^2_{ic} = 0.58). Use of the linear regression derived from the Framingham Heart Study (R^2_{sd} = 0.53; R^2_{ic} = 0.56) and use of Fridericia's cubic root (R^2_{sd} = 0.49; R^2_{ic} = 0.57) resulted in a slightly less accurate fit. Bazett's formula was least effective (R^2_{sd} = 0.35; R^2_{ic} = 0.36).
Conclusion: Obviously, an optimized approach of QT correction for heart rate based on population characteristics is also an appropriate approach for intraindividual QT correction in resting ECG analyses of short-term records. However, even after applying the best correction for heart rate, the distribution of intraindividual QT interval differences showed a considerable standard deviation of 14 milliseconds over the whole range of heart rate changes at rest.

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Analysis of the scope of unipolar and bipolar electrograms in implantable cardioverter defibrillators

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Background: Detection of life-threatening arrhythmias by implantable cardioverter defibrillators involves methods that analyze sensed intracardiac electrograms (EGMs). Nowadays, EGM can be stored and retrieved for further analysis, and therefore, they constitute a valuable source of information in the investigation of arrhythmias. The definition of cardiac indices for EGM analysis often entails some assumption on the scope of the recorded electrical activity. Nevertheless, although the scope of an EGM is usually classified as near or far field, it would be desirable to obtain a quantitative measurement for it, and this could be done by estimating the contribution of different regions within the myocardium to EGM power. Resting on these considerations and from a lead field theory approach, we studied the scope of a bipolar configuration consisting of 2 electrodes located in the left ventricle and a unipolar configuration consisting of an electrode in the left ventricle, and the implantable cardioverter defibrillator can in subpectoral position.
Methods: For each lead configuration, we calculated the measurement sensitivity field based on finite difference methods featuring the visible human man model. Five regions of the ventricle myocardium were defined as the volumes enclosed by 5 isosensitivity surfaces at which sensitivity dropped from 2 to 6 orders of magnitude from the maximum sensitivity, and their radii were estimated. The power contribution of each region was studied by incorporating a model of the electrical activity of the cardiac tissue and by simulating the pacing of the ventricles. Then, we calculated the mean square error (MSE) between simulated EGM when the whole ventricular activity was considered and simulated EGM when only the activity within each region was included, and we normalized it by the mean power of the whole-ventricles simulated EGM.
Results: Calculations showed that a logarithmic decrease in the magnitude of the sensitivity involves a linear increase in the radii of isosensitivity-enclosed volumes. This increase was found to be in the unipolar case twice as large as in the bipolar case. When plotting MSE against the radii of isosensitivity-enclosed volumes, we found that within a region of 8-mm radius for bipolar and unipolar configurations, normalized MSE was 11.3% and 67.6%, respectively, whereas within a region of 30-mm radius, normalized MSE was 0.4% and 8.2%, respectively.
Conclusion: Lead field theory in conjunction with simulation techniques provide us with a quantitative measurement of the scope of a given lead configuration based on EGM power.

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Cardiac repolarization abnormalities and potential evidence for loss of cardiac sodium currents on electrocardiograms of patients with Chagas heart disease

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