Quality of Electrocardiographic Records in Population Studies: What Can We Achieve?

Siegfried Perz*, Roswitha Küfner, Karl-Hans Englmeier, Moritz F Sinner, Stefan Kääb, Christine Meisinger and H-Erich Wichmann

Institute for Biological and Medical Imaging, Helmholtz Zentrum München, Neuherberg, Germany

Measurement precision and validity of the diagnostic interpretation are to a major extent associated with the noise interference in routinely recorded electrocardiograms (ECGs), even if computerized methods for signal enhancement and noise rejection are applied. In order to provide appropriate quality in the population-based KORA-F4 study, we applied a multi-stage monitoring of the resting ECG recording. Before the beginning of the study, we conducted a comprehensive training of five technicians to enhance their skills for appropriate electrode application, artefact recognition and prevention. During the data collection period a continuous quality monitoring of the digitized ECG records was performed consisting of (1) computerized online measurement of the noise exposure, and (2) the evaluation of the technical quality of the records by physicians. Utilizable ECGs were derived from 98.3% (3027/3080) of the study participants. 0.5% of the ECG records were rated as being of limited technical quality by the physicians. Using the computerized noise level measurement (characterizing each ECG record by the maximum noise level in any of the twelve leads), overall, the distribution (m$\pm$s) of noise level measurements was 13.2$\pm$6.8 V, the median was 12 V. In 80% of the records the noise exposure was 18 V. On average, noise caused by muscle tremor was consistently increasing with age (0.14 V per year). Repeated ECG recording - applied to 6.7% of the study participants with increased noise in the first record - resulted in a 7.5 V reduction of noise. The maximum difference of the mean noise levels attributed to the five technicians was 3.0 V. The comprehensive training of the technicians and the continuous monitoring of the ECG recording provided records of predominantly good quality, which is a precondition for reliable estimates of population-based ECG characteristics, especially when valid phenotyping for serial ECG analyses and genetic association studies is required.