

ARIC Manuscript Proposal # 894 (Revised)

PC Reviewed: 08/14/02

Status: A

Priority:

SC Reviewed: 08/15/02

Status: A

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1.a. Full Title: Repeatability of Heart Rate Variability Measures: The ECG Repeatability Study

b. Abbreviated Title (Length 26 characters): HRV Repeatability

2. Writing Group (list individual with lead responsibility first):

Lead: **Emily Schroeder**

Address: 137 E Franklin Street, Suite 306
Chapel Hill, NC 27514

Phone: (919) 966-1967 Fax: (919) 966-9800

E-mail: eschroed@email.unc.edu

Writing group members: Eric Whitsel

Ronald Prineas

Gregory Evans

Lloyd Chambless

Gerardo Heiss

3. Timeline:

Data collection for the ECG Repeatability Study, an ARIC ancillary study, took place from July through October 2001. Data processing at EPICARE and the Ultrasound Reading Center will be finished by June 2002. Data analysis has been ongoing, will be completed during the summer of 2002. A draft of the manuscript should be complete by the end of Summer 2002.

4. Rationale:

The measurement of heart rate variability (HRV), the oscillation in the interval between consecutive heart beats, has been gaining prominence as a noninvasive method to assess cardiac autonomic activity quantitatively. Experiments in animal and humans have characterized many of the physiological phenomena underlying various heart rate variability measures. Epidemiological studies have described some of the population correlates of these HRV measures, and have demonstrated that low heart rate variability predicts post-myocardial infarction mortality, incident coronary heart disease, incident hypertension, and all cause mortality.

Historically, HRV has been measured using 24-hour Holter recordings. It is now recognized that HRV from much shorter records (2- to 5-minutes) can be used to accurately assess cardiac autonomic activity. Furthermore, there has been much recent interest in using ultra-short recordings from the standard 12-lead electrocardiogram (ECG) to capture HRV. These records,

approximately 10-seconds in length, are much easier to collect in routine clinical care and epidemiologic research.

However, the ability to make full use of HRV indices derived from both short and ultra-short term recordings is limited by the sparse available data on the repeatability of HRV measures. This study is designed primarily to estimate and compare the repeatability of these HRV measures.

5. Main Hypothesis/Study Questions:

This study will estimate and compare the repeatability over one to two weeks of common heart rate variability measures (heart rate, RR interval length, SDNN, RMSSD, high frequency power, low frequency power, etc.) from 10-second ECGs, 2-minute heart rate recordings, and 6-minute heart rate recordings. As a natural extension of this, the study will also estimate and compare the repeatability of the mean of measures from one, two, or three 10-second ECGs. This study will also use mixed models to partition the measurement error into various components. Finally, the study will examine the correlations between heart rate variability measures of different lengths, in order to indirectly estimate the validity of the measures derived from shorter length records.

6. Data (variables, time window, source, inclusions/exclusions):

The data for this study comes from the ECG Repeatability Study, an ARIC ancillary study. The study included a simple questionnaire, which collected basic demographic and medication information, and 10-second electrocardiographic recordings and 6-minute heart rate recordings. Data from the standard 10-second ECGs were processed by Ronald Prineas at EPICARE. Data from the 6-minute heart rate recordings were processed by Gregory Evans at the Ultrasound Reading Center in Winston-Salem, NC.

Study population. The study population for the ECG Repeatability Study was a group of 63 healthy volunteers, aged 45 to 64. These volunteers were recruited through flyers from the UNC community and the Chapel Hill area. None of these volunteers were ARIC cohort participants. The ECG Repeatability Study had a gender and race distribution very similar to that of the original ARIC cohort.

Data collection. Volunteers underwent two visits at the General Clinical Research Center at UNC Hospitals. At each visit three resting, supine, standard 12-lead ECG's recordings and two 6-minute beat-to-beat heart rate recordings were obtained, following the ARIC protocols as closely as possible. Four trained and certified technicians obtained the ECG's and the heart rate recordings. In addition, basic demographic information and medication information was recorded on specially prepared forms. Information from the forms were double entered into a spreadsheet program, and then converted to a SAS dataset.

Processing of 10-second records. The processing of the ECG's was coordinated by Ronald Prineas of the Epidemiological Cardiology Research (EPICARE) Center in Winston-Salem, NC. The ECG's were obtained using the MAC PC Personal Cardiograph (Marquette Electronics, Inc., Jupiter, FL). The tracings were sent via phone modem to EPICARE, where they were computer coded and processed using the most recent version of the Marquette GE program version 12SL.

Processing of 6-minute records. The processing and reading of the 6-minute recordings was coordinated by Gregory Evans of the Ultrasound Reading Center in Winston-Salem, NC. The recordings were obtained using a dedicated desktop computer and software (Arrhythmia Research Technology, Inc., Austin, TX), which detects of R waves from the electrocardiogram at a sampling frequency of 1,000 Hz. The R waves were stored in electronic files and mailed to the Ultrasound Reading Center for data processing. Stored R-R intervals were converted into beat-to-beat heart rate. At the reading center, a version of the ART software modified by the Ultrasound Reading Center was used by the readers to access the stored files in the ART system, extract these files, and apply an artifact and imputation system. Two trained readers used a filter program that graphically displays a plot of beat-to-beat heart rate over time to identify and flag any visually apparent artifacts in the heart rate record. Data files were converted to binary format and transferred to a dedicated computer with specialized software (PREDICTOR II HRVECG, Arrhythmia Research Technology, Inc., Austin, TX) for data processing and spectrum analysis. The PREDICTOR II software uses a variance preserving imputation algorithm for estimating power components in the presence of artifacts. The power spectral analysis includes time trend analysis, Fast Fourier transformation, smoothing, and computation of frequency- and time-domain power spectral components. Each records was read as a 6-minute record, and then truncated at 2-minutes and reread as a 2-minute record. Each record was given a different identification number, so that readers could not determine which records came from the same participant.

Data management. The resulting data files were sent to Emily Schroeder at UNC, where the record identification numbers were matched with the master ID's, using a master list. She then merged the data files containing the basic demographic information, the information from the 12-lead ECG's, and the information from the 6-minute heart rate recordings to create the final dataset from the ECG Repeatability Study.

7.a. Will the data be used for non-CVD analysis in this manuscript? ☐ Yes ☒ No

b. If Yes, is the author aware that the file ICTDER02 must be used to exclude persons with a value RES_OTH = "CVD Research" for non-DNA analysis, and for DNA analysis RES_DNA = "CVD Research" would be used? ☐ Yes ☐ No
(This file ICTDER02 has been distributed to ARIC PIs, and contains the responses to consent updates related to stored sample use for research.)

8.a. Will the DNA data be used in this manuscript? ☐ Yes ☒ No

8.b. If yes, is the author aware that either DNA data distributed by the Coordinating Center must be used, or the file ICTDER02 must be used to exclude those with value RES_DNA = "No use/storage DNA"? ☐ Yes ☐ No

9. The lead author of this manuscript proposal has reviewed the list of existing ARIC Study manuscript proposals and has found no overlap between this proposal and previously approved manuscript proposals either published or still in active status. ARIC Investigators have access to the publications lists under the Study Members Area of the web site at: <http://bios.unc.edu/units/csc/ARIC/stdy/studymem.html>

☒ Yes ☐ No