Framingham Heart Study P Wave Indices
August 27, 2012

Background.
Initial ECG tracings were obtained on Hewlett-Packard 1500-B and Sanborn 100 platforms. In 1985, the FHS adopted the Marquette MAC/PC followed by the Marquette (now General Electric) MAC 5000, which allowed for digital storage of the ECG. Regardless of the electrocardiograph used, all paper recordings have uniformly been printed on lined paper at 25 mm/sec and 0.1 mv/mm. In 2011-2012 investigators at the Study purchased the MUSE 8 ECG Management System (General Electric) for development of an ECG repository. With the assistance of GE Healthcare, older digital data has been transformed for contemporary analysis on the MUSE 8. The Framingham Heart Study MUSE system now contains all ECGs recorded since the switch to the digital electrocardiographs in 1986.

Altered P wave indices (PWI) result from impaired atrial electrophysiology. Intracardiac electro-anatomic mapping has demonstrated that prolonged P wave duration is accompanied by electrical silence and significant decreases in interatrial conduction and regional voltage.\(^1\) The clinical correlates of PWI include age, sex, race, obesity (body mass index [BMI], waist circumference), and metabolic syndrome and its components.\(^2,3\) PWI have been examined in subjects with HTN,\(^4\) obesity,\(^5-7\) diabetes,\(^8\) and sleep apnea\(^9\) have prolonged P wave duration compared to healthy controls. PWI have been reported as increased in individuals with AF following cardioversion,\(^10,11\) post-cardiothoracic surgery,\(^12-14\) paroxysmal, and incident AF. Many of these studies are limited by measurement technique, incomplete covariates, small sample size, and limited follow-up duration. The largest prospective, community-based study employed contemporary software algorithms to identify significant associations between PWI and incident AF and stroke. FHS early PWI investigation confirmed the long-term relation with AF using PWI but employed a limited measurement technique.\(^15,16\)

The present database consists in the FHS PWI (P wave duration, amplitude, area and terminal force) constructed using the General Electric MUSE 8 12SL software. The software is an automated algorithm for determination and quantification of the PWI described here. Because the software uses an automated algorithm, reproducibility is 100% with repeated software measurement.

Methodology
PWI were determined using the MUSE 8. A contemporary 12SL was used to quantify measures across exams in order to employ a uniform software algorithm for ECG quantification. Output was obtained from the MUSE 8 and submitted to FHS data management. As all PWI quantification employed the software described above, reproducibility ascertainment was not indicated.

Terminology
P refers to the initial deflection of the P wave, be it positive or negative.

P’ refers to the secondary deflection of the P wave, which will be the opposite polarity to the P. Hence, both positive and negative values are possible for P and P’. Duration, measured in ms, cannot be negative. As a result, we expect positive values only for pduration and p1duration.

Parea, p1area, ppeakamp, and p1peakamp may have positive and negative values depending on the initial or secondary deflection.

Examinations
Original cohort, examination 20
Offspring, examination 6
Gen 3, examination 1

Variables
pduration_*, P wave duration, where * is 1 to 12 as measured for each of the leads, ms
p1duration_*, P1 wave duration, where * is 1 to 12 as measured for each of the leads, ms
parea_*, P wave area, where * is 1 to 12 as measured for each of the leads, \(\mu V\cdot ms\)
p1area_*, P1 wave area, where * is 1 to 12 as measured for each of the leads, \(\mu V\cdot ms\)
**ppeakamp_***, P wave peak amplitude, where * is 1 to 12 as measured for each of the leads, $\mu$V

**p1peakamp_***, P1 peak amplitude, $\mu$V

### Exclusions for submission:

<table>
<thead>
<tr>
<th>Exam</th>
<th>SAS Dataset name</th>
<th>Variable</th>
<th>Exclude</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Cohort exam 20</td>
<td>EX0_20S.SSD01</td>
<td>FM430</td>
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<td>FM442</td>
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<td>Excludes for 2nd degree A-V block</td>
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<td>FM443</td>
<td>1, 2 or .</td>
<td>Excludes for A-V dissociation</td>
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<td>Excludes for Wolff-Parkinson-White (WPW)</td>
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<td>Excludes for atrial fibrillation</td>
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<td>Excludes for atrial flutter</td>
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<td>F584</td>
<td>3, 4, 5, 6, 7, 8, or 9</td>
<td>Excludes 2nd degree or higher heart block, atrial arrhythmias, and paced rhythms</td>
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<td>G3A357</td>
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<td>G3A363</td>
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</table>

### Dataset cleaning and quality control

- **Atrial and ventricular rates**. Examine all ECGs where arate and vrate are not equivalent.
- **Heart rate**. Examine distributions and extremes (<40, ≥100).
  - **pduration_***
    - Expected to be always >0. Examine all ECGs with pduration <0
    - Examine distributions and extremes
  - **p1duration_***
    - Expected to be always ≥0. Examine all ECGs with p1duration<0
    - Examine distributions and extremes
  - **parea_***
    - May be positive or negative
    - Examine distributions and extremes
  - **ppeakamp_***
    - May be positive or negative
    - Examine distributions and extremes
  - **p1peakamp_***
    - May be positive or negative
    - Examine distributions and extremes
Reference List


