**Exam 6 Zio Patch Data Set Variable Guide,** version 1.0, 3/18/2021

**MESA Ancillary study #253, Atrial Fibrillation Study**

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See ancillary study publications1, 2 for information on ancillary study methods and for examples of how to analyze the Zio Patch data. Please acknowledge the Atrial Fibrillation Ancillary Study funding in all publications that use the Zio Patch data: R01 HL127659.

This data set contains one record per ancillary study participant who contributed Zio Patch data (n=1557). A subset of participants (n=577) wore 2 patches with a median interval of 23 days between the 2 monitoring periods. For those with 2 patches, most of the variables in this data set are taken from the single patch with the longest monitoring time. However, in addition, calculated variables with names beginning with “tot\_” (indicating “total”), summarize the data across two patches for those who wore two patches, and contain data from the single patch for those who wore only one patch. These “tot\_” variables were created to take advantage of all the rhythm information available for each participant.

Variables without the “\_c” suffix are exactly as they came from the device manufacturer (iRhythm). Calculated variables have the “\_c” suffix.

Please note that in this Variable Guide, “AF” denotes atrial fibrillation OR atrial flutter; “atrial fibrillation” denotes atrial fibrillation specifically, and “atrial flutter” denotes atrial flutter specifically.

In the readings of cardiac rhythm done by iRhythm:

Atrial fibrillation was defined as an irregularly irregular rhythm with absent P waves lasting at least 30 seconds.

A run of supraventricular tachycardia (SVT) was defined as 4 or more consecutive premature atrial contractions (PACs).

A run of ventricular tachycardia (VT) was defined as 4 or more consecutive premature ventricular contractions (PVCs).

A “pause” is defined as a pause of 3 seconds or longer.

No participant had ventricular fibrillation (VF), so the variables related to VF that came from iRhythm were dropped. Participants were not instructed to press the Zio Patch button to record symptoms, so variables that came from iRhythm related to button presses were dropped.

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| **Variable** | **Description** | **Value Labels** | **Notes** |
| idno | MESA participant ID |  |  |
| **Variables from the single longest patch** |  |  |  |
| starttt6\_c | Time from MESA baseline visit to start of Zio Patch recording (days) |  |  |
| weartimedays6 | Wear Time (days) |  |  |
| analyzabletimedays6 | Analyzable Time (Days) |  |  |
| analyztimenoaf6\_c | Analyzable Time (Days) after excluding time in AF |  |  |
| overallmaxratebpm6 | Overall Max Rate (bpm) |  | maximum heart rate |
| overallminratebpm6 | Overall Min Rate (bpm) |  | minimum heart rate |
| overallaverageratebpm6 | Overall Average Rate (bpm) |  | average heart rate |
| anyaf6\_c | AF present | 0: No  1: Yes | >= 30 seconds of AF |

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| **Variable** | **Description** | **Value Labels** | **Notes** |
| anyaflutter6\_c | Atrial flutter present | 0: No  1: Yes | >= 30 seconds of atrial flutter; Determined by manual review of Zio Patch reports. |
| afburden6\_c | AF Burden (proportion) |  | proportion of analyzable time that the rhythm was AF (range: from 0.0 to 1.0). See **AF burden** note below. |
| afmaxratebpm6 | AF Max Rate (bpm) |  | maximum AF rate |
| afminratebpm6 | AF Min Rate (bpm) |  | minimum AF rate |
| affirstoccurrenceelapseddays6 | AF First Occurrence Elapsed Days |  |  |
| vttotalepsiodecount6 | VT Total Episode Count |  |  |
| vtmaxheartratebpm6 | VT Max Heart Rate (bpm) |  |  |
| vtlongestepisodedurationms6 | VT Longest Episode Duration (ms) |  |  |
| vtlongestepisodebeatcount6 | VT Longest Episode Beat Count |  |  |
| vtfirstoccurrenceelapseddays6 | VT First Occurrence Elapsed Days |  |  |
| svttotalepsiodecount6 | SVT Total Episode Count |  |  |
| svtmaxheartratebpm6 | SVT Max Heart Rate (bpm) |  |  |
| svtlongestepisodedurationms6 | SVT Longest Episode Duration (ms) |  |  |
| svtlongestepisodebeatcount6 | SVT Longest Episode Beat Count |  |  |
| svtfirstoccurrenceelapseddays6 | SVT First Occurrence Elapsed Days |  |  |
| pausetotalcount6 | Pause Total Count |  |  |
| pausefirstoccurrenceelapseddays6 | Pause First Occurrence Elapsed Days |  |  |
| pauselongestepisodedurationms6 | Pause Longest Episode Duration (ms) |  |  |
| avblocktotalcount6 | AV Block Total Count |  | 2nd Degree Mobitz II, High Grade AV Block, or 3rd Degree AV Block |
| avblockminheartratebpm6 | AV Block Min Heart Rate (bpm) |  |  |
| avblockfirstoccurrenceelapseday6 | AV Block First Occurrence Elapsed Days |  |  |
| bigeminytotaldurationms6 | Bigeminy Total Duration (ms) |  |  |
| trigeminytotaldurationms6 | Trigeminy Total Duration (ms) |  |  |
| isolatedsvetotalcount6 | Isolated SVE Total Count |  |  |
| isolatedsvepercentage6 | Isolated SVE Percentage |  |  |
| svecouplettotalcount6 | SVE Couplet Total Count |  |  |

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| **Variable** | **Description** | **Value Labels** | **Notes** |
| svecoupletpercentage6 | SVE Couplet Percentage |  | % of all beats that are in supraventricular couplets |
| svetriplettotalcount6 | SVE Triplet Total Count |  |  |
| svetripletpercentage6 | SVE Triplet Percentage |  | % of all beats that are in supraventircular triplets |
| isolatedvetotalcount6 | Isolated VE Total Count |  |  |
| isolatedvepercentage6 | Isolated VE Percentage |  |  |
| vecouplettotalcount6 | VE Couplet Total Count |  |  |
| vecoupletpercentage6 | VE Couplet Percentage |  | % of all beats that are in ventricular couplets |
| vetriplettotalcount6 | VE Triplet Total Count |  |  |
| vetripletpercentage6 | VE Triplet Percentage |  | % of all beats that are in ventricular triplets |
| pachr6\_c | Average PACs per hour of analyzable time |  | Calculated from ([isolatedsvetotalcount6 + 2\* svecouplettotalcount6 + 3\* svetriplettotalcount6] +1); divided by (analyztimenoaf6\_c\*24) |
| pvchr6\_c | Average PVCs per hour of analyzable time |  | Total N of PVCs is calculated as ([isolatedvetotalcount6 + 2\* vecouplettotalcount6 + 3\* vetriplettotalcount6] +1); divided by (analyzabletimedays6\*24) |
| svtday6\_c | Average runs of SVT per day of analyzable time |  | Calculated from (svttotalepsiodecount6 +1) divided by analyztimenoaf6\_c |
| vtday6\_c | Average runs of VT per day of analyzable time |  | Calculated from vttotalepsiodecount6 divided by analyzabletimedays6 |
| pacedrhythm6\_c | Presence of paced rhythm detected on a patch | 0: No  1: Yes | Determined by manual review of Zio Patch reports, looking for mention of any paced beats during monitoring on any patch |
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| **Calculated variables, with names beginning with “tot\_”, combine all available monitoring data: from 1 patch in 980 participants and from 2 patches in 577 participants** |  |  |  |
| tot\_npatches6\_c | Number of patches completed |  |  |
| tot\_starttt6\_c | Time from MESA baseline visit to start of first Zio Patch recording included in “tot\_” variables (days) |  |  |

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| **Variable** | **Description** | **Value Labels** | **Notes** |
| tot\_interval6\_c | Interval between 2 patches (days), from end of patch #1 to start of patch #2 |  | Missing for those who wore only 1 patch |
| tot\_weartime6\_c | Total wear time (days) from 1 or 2 patches |  |  |
| tot\_analyztime6\_c | Total analyzable time (days) from 1 or 2 patches |  |  |
| tot\_analyztimenoaf6\_c | Total analyzable time (days) from 1 or 2 patches after excluding time in AF |  |  |
| tot\_anyaf6\_c | AF present on 1 or 2 patches | 0: No  1: Yes |  |
| tot\_anyaflutter6\_c | Atrial flutter present on 1 or 2 patches | 0: No  1: Yes |  |
| tot\_afburden6\_c | Average AF burden from 1 or 2 patches (proportion) |  | proportion of analyzable time across all available patches that the rhythm was AF |
| tot\_pachr6\_c | Average PACs per hour of analyzable time from 1 or 2 patches |  | (sum of [isolatedsvetotalcount6 + 2\* svecouplettotalcount6 + 3\* svetriplettotalcount6] from all available patches +1)­; divided by (tot\_analyztimenoaf6\_c \*24) |
| tot\_pvchr6\_c | Average PVCs per hour of analyzable time from 1 or 2 patches |  | (sum of [isolatedvetotalcount6 + 2\* vecouplettotalcount6 + 3\*vetriplettotalcount6] from all available patches +1); divided by (tot\_analyztime6\_c \*24) |
| tot\_svtday6\_c | Average runs of SVT per day of analyzable time from 1 or 2 patches |  | (sum of svttotalepsiodecount6 from all available patches +1); divided by tot\_analyztimenoaf6\_c |
| tot\_vtday6\_c | Average runs of VT per day of analyzable time from 1 or 2 patches |  | sum of vttotalepsiodecount6 from all available patches; divided by tot\_analyztime6\_c |
| tot\_pause6 | Total number of pauses |  | sum of pausetotalcount6 from all available patches |
| tot\_avblock6 | Total number of episodes of 2nd or 3rd degree AV block |  | sum of avblocktotalcount6 from all available patches (includes 2nd Degree Mobitz II, High Grade AV Block, 3rd Degree AV Block) |

**NOTES ON CALCULATED VARIABLES**

***AF burden*** *(afburden6\_c and tot\_afburden6\_c)*

iRhythm reports on very short episodes of AF but does not calculate AF burden unless the participant has an AF episode lasting >=30 seconds AND the total burden of AF is >=0.1% of analyzable time. For 14 days of analyzable time, 0.1% of analyzable time amounts to 20 minutes. We wanted to have a value of AF burden for everyone who had an episode of AF lasting >=30 seconds. Therefore, we calculated our own afburden6\_c and tot\_afburden6\_c variables. For the 9 patches with AF for which iRhythm did not calculate AF burden, we imputed a very low value of AF burden; we set afburden6\_c to 0.0009 (equivalent to 0.09%, just under the lowest value allowed by iRhythm).

***Supraventricular arrhythmias: PACs per hour and runs of SVT per day***

For PACs per hour (pachr6\_c and tot\_pachr6\_c) and for runs of SVT per day (svtday6\_c and tot\_svtday6\_c), we subtracted from the denominator (analyzable time) the amount of time in AF. This is because PACs and runs of SVT cannot be read when the rhythm is AF.

**ANALYSIS RECOMMENDATIONS**

For most analyses, we exclude participants with less than 1 day (24 hours) of total analyzable time (tot\_analyztime6\_c<1); this removes 22 participants. In general, analyses of monitor-detected arrhythmias need to be adjusted for duration of monitoring (analyzable time).

***Analysis of monitor-detected AF as an outcome*** *(tot\_anyaf6\_c)*

If the quantity to be estimated is the relative risk, use logistic regression. Because the outcome, monitor-detected AF, is rare in this MESA sample (~7%), the odds ratio from logistic regression is a good estimate of the relative risk. Analyses should be adjusted for analyzable time.

If the quantity to be estimated is the prevalence difference, use linear regression with robust standard errors, again adjusted for analyzable time. See2 for an example.

***Analysis of AF burden as an outcome*** *(tot\_afburden6\_c)*

We suggest creating 3 categories of AF burden: 0= no AF, 1= intermittent AF (>0% and <100% AF burden) and 2=continuous AF (AF burden=100%) and use multinomial logistic regression with robust SEs.

***Analysis of PACs per hour or PVCs per hour as outcomes***

The distributions of these variables are highly skewed and we suggest the log transform. A few participants have zero values for PACs per hour (n=5) or PVCs per day (n=61), but we can’t take the log of zero. Therefore, in this data set, we added the value of 1 to the PAC count and to the PVC count for all participants, before calculating the PACs per hour and PVCs per hour variables. The resulting variables can be log transformed for analysis without the problem of zero values.

***Analysis of runs of SVT as an outcome***

Runs of SVT per day is also highly skewed, and the proportion of participants with zero values is 18%. In calculating runs of SVT per day in this data set, we added the value of 1 to svttotalepsiodecount6, and then calculated svtday6\_c and tot\_svtday6\_c. The resulting variables can be log transformed for analysis without the problem of zero values.

***Analysis of runs of VT as an outcome***

Runs of VT are considerably less frequent; 72% of participants have zero values across all patches. For analysis of exposures in relation to presence or absence of runs of VT, we suggest creating a binary variable indicating no runs of VT versus any runs of VT, and using logistic regression for analysis. Because having any runs of VT is not uncommon (present in 28% of participants), the odds ratio is not a good approximation of the relative risk, so authors should be careful to express results in terms of odds and odds ratios.

**Study Publications**

1. Heckbert SR, Austin TR, Jensen PN, Floyd JS, Psaty BM, Soliman EZ and Kronmal RA. Yield and consistency of arrhythmia detection with patch electrocardiographic monitoring: The Multi-Ethnic Study of Atherosclerosis. *J Electrocardiol*. 2018;51:997-1002.

2. Heckbert SR, Austin TR, Jensen PN, Chen LY, Post WS, Floyd JS, Soliman EZ, Kronmal RA and Psaty BM. Differences by race/ethnicity in the prevalence of clinically detected and monitor-detected atrial fibrillation: MESA. *Circulation Arrhythmia and electrophysiology*. 2020;13:e007698.