Complexity of cardiac signals for predicting changes in alpha-waves after stress in patients undergoing cardiac catheterization

Supplementary Information

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Supplementary Table S1 | Classification of patients on the basis of the pretest variables and the difference between pre- and post-test variables.

ECG	Linear Variable	Pre-Test	meanNN, Log-meanNN, sdNN, Log-sdNN, pNN20, Log-pNN20, pNN50, Log-pNN50, rMMSD, Log-rMMSD, LF, Log-LF, HF, Log-HF, LF/HF, Log-LF/HF
		Difference	meanNN, Log-meanNN, sdNN, Log-sdNN, pNN20, Log-pNN20, pNN50, Log-pNN50, rMMSD, Log-rMMSD, LF, Log-LF, HF, Log-HF, LF/HF, Log-LF/HF
	Non-linear Variable	Pre-Test	Slope1-5, Slope6-20, Area1-5, Log_Area1-5, Area6-20, Log_Area6-20 α_1, Log_α_1, α_2, Log_α_2
		Difference	Slope1-5, Slope6-20, Area1-5, Log_Area1-5, Area6-20, Log_Area6-20 α_1, Log-α_1, α_2, Log-α_2
EEG	Linear Variable	Pre-Test	Alpha activity
		Difference	Alpha activity

Clinical Data	Age, Gender, BMI, MBP(Pre-Test), MBP(Difference), Treatment, Smoking, Diabetes Mellitus, Hyperlipidemia, Hypertension, EGFR		
Neurotransmitter	Serotonin, Orphanin_FQ, Dopamine		

**Supplementary Table S2	Classification of patients according to Spearman's rank correlation.**			
ECG	Linear Variable	Pre-Test	meanNN, sdNN, Log-sdNN, pNN20, Log-pNN20, LF/HF, Log-LF/HF
		Difference	meanNN, pNN20, Log_pNN20, rMMSD, LF/HF, Log_LF/HF
	Non-linear Variable	Pre-Test	Slope1-5, Area1-5, Log-Area1-5, α_1, α_2
		Difference	Slope1-5, Area1-5, Log-Area1-5, α_1, α_2
EEG	Linear Variable	Pre-Test	Alpha activity
		Difference	Alpha activity
Clinical Data	Age, Gender, BMI, MBP(Pre-Test), MBP(Difference), Treatment, Smoking, Diabetes Mellitus, Hyperlipidemia, Hypertension, estimated glomerular filtration rate		
Neurotransmitter	Serotonin, Orphanin_FQ, Dopamine		

**Supplementary Table S3 | Classification of methods by using GAMs.**

ECG	Linear Variable	Pre-Test	$3.816 \leq \text{Log\_sdNN} \leq 5.115$, $0.017 \leq \text{pNN50} \leq 0.176$, $56.598 \leq \text{rMSSD} \leq 194.443$, $3.81 \leq \text{Log\_rMSSD} \leq 5.348$, $1071.873 \leq \text{HF} \leq 13485.712$, $1.229 \leq \text{LF/HF} \leq 1.98$,
		Difference	$\text{Log\_sdNN} \leq -0.415$, $-0.164 \leq \text{pNN20} \leq 0.007$, $-0.142 \leq \text{pNN50} \leq 0.007$, $-105.641 \leq \text{rMSSD} \leq 4.677$, $\text{LF} \leq 156.425 \text{ and } \text{LF} \geq 13413.356$, $\text{HF} \leq 376.933 \text{ and } \text{HF} \geq 25327.388$
	Non-linear Variable	Pre-Test	$0.01 \leq \text{Slope6} - 20$, $\text{Log\_Area1} - 5 \leq 1.007$, $2.183 \leq \text{Log\_Area6} - 20 \leq 2.895$, $0.425 \leq \propto_1 \leq 0.756$, $\propto_2 \leq 0.737 \text{ and } \propto_2 \geq 0.876$
		Difference	$\text{Area1} - 5 \leq -1.247 \text{ and Area1} - 5 \geq 0.809$, $\text{Log\_Area6} - 20 \leq -0.042 \text{ and Log\_Area6} - 20 \geq 0.5$

Supplementary Table S4 | Experimental results of the HRV analysis before *treatment, obtained using S*pearman's rank correlation.

	sdNN	Log-sdNN	pNN50	Log-pNN50	rMMSD	Log-rMMSD	LF	Log-LF	LF/HF	Log-LF/HF
pNN50	0.9157	0.9157								
Log- pNN50	0.9157	0.9157								
rMMSD	0.9129	0.9129	0.8638	0.8638						
Log-rMMSD	0.9129	0.9129	0.8638	0.8638						
LF	0.8364	0.8364			0.845	0.845				
Log-LF	0.8364	0.8364			0.845	0.845				
HF	0.8151	0.8151			0.9092	0.9092	0.9487	0.9487		
Log-HF	0.8151	0.8151			0.9092	0.9092	0.9487	0.9487		
$\propto_1$									0.8331	0.8331
Log--$\propto_1$									0.8331	0.8331

Supplementary Table S5 | Experimental results regarding the difference between the pre- and posttest variables obtained using Spearman's rank correlation

|	sdNN	Log-sdNN	LF	Log-LF	LF/HF
rMMSD	0.8979	0.8564			
Log- rMMSD	0.8320	0.8760			
HF			0.9486		
Log-HF				0.9405	
Log-LF/HF					0.9782
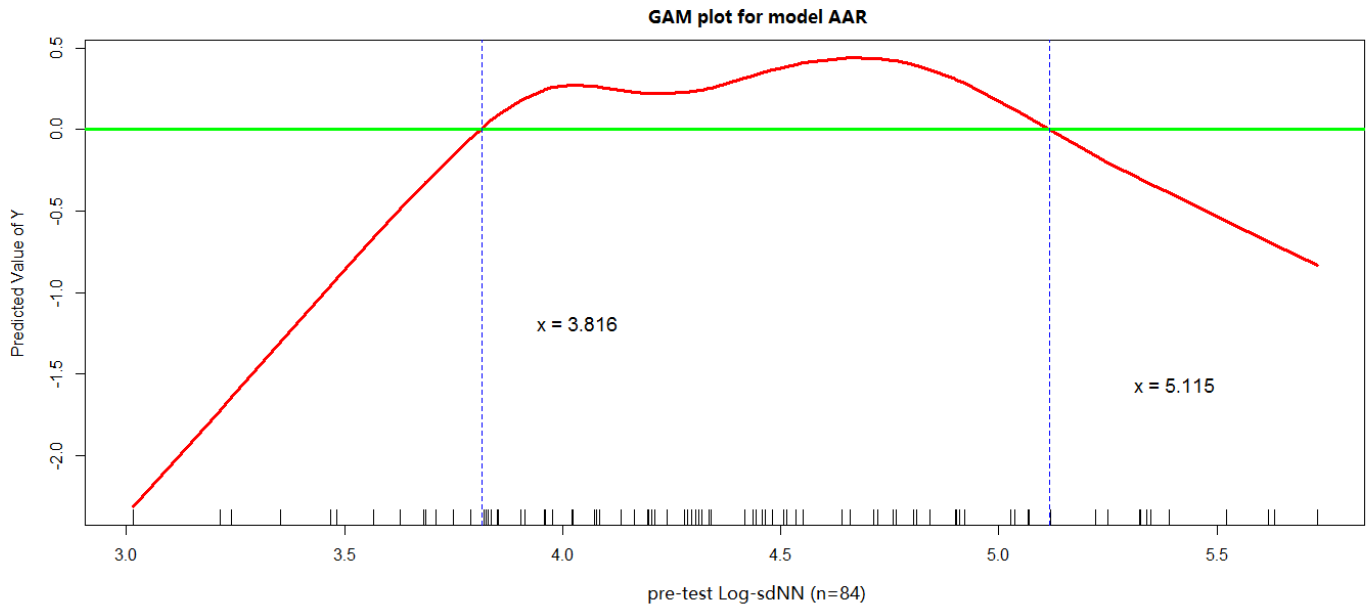
Supplementary Figure S1: GAM plot for modeling the relationship between the change in the alpha wave and pretest log-sdNN. The vertical axis represents the difference in alpha activity. The horizontal axis represents the pretest log-sdNN and number of patients. GAM techniques can be used to show that

$$\text{pre-test Log-sdNN} = \begin{cases} 1, & 3.816 \leq \text{Log-sdNN} \leq 5.115 \\ 0, & \text{others} \end{cases}$$
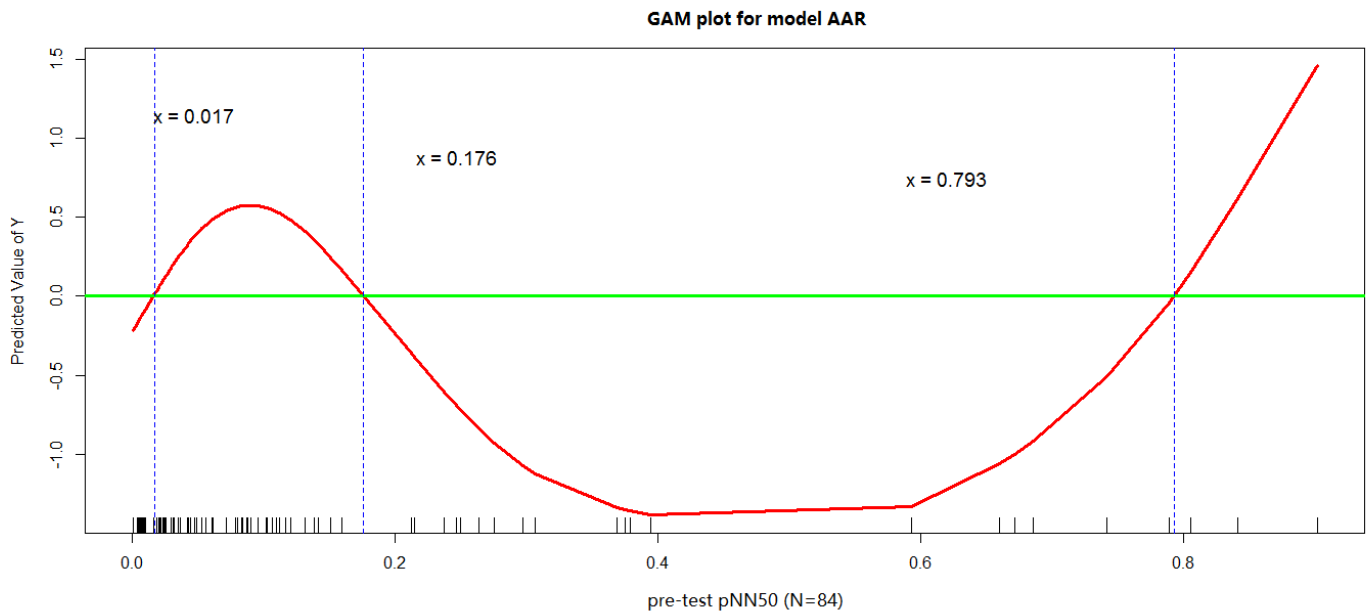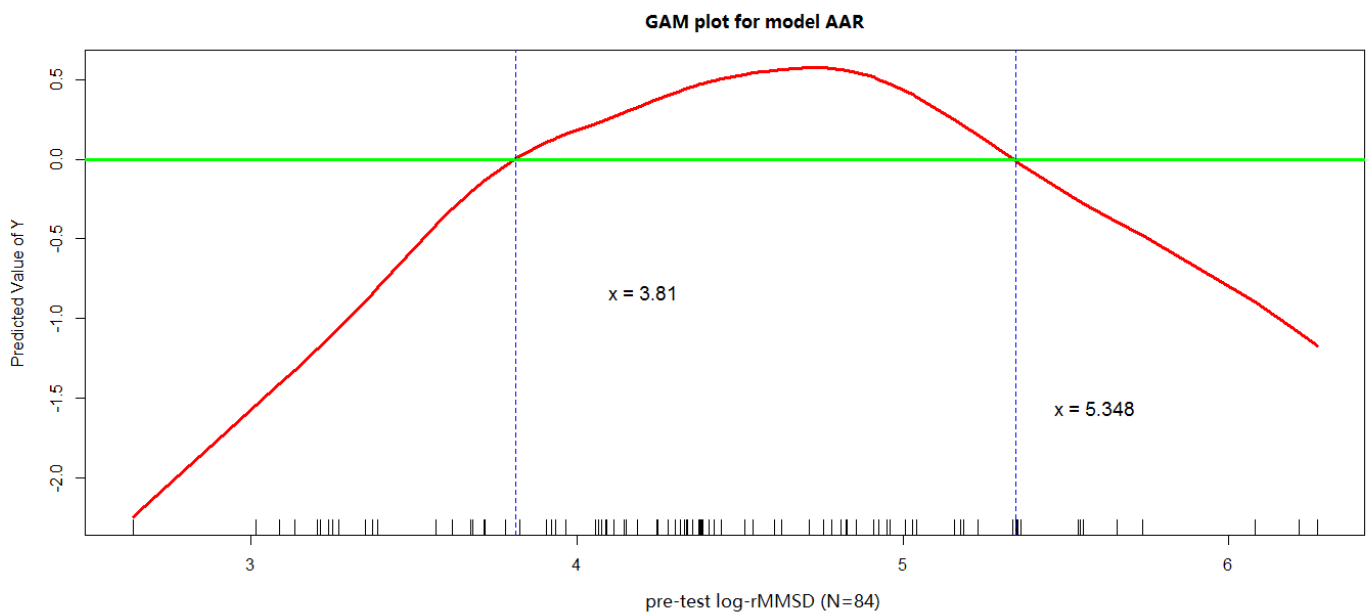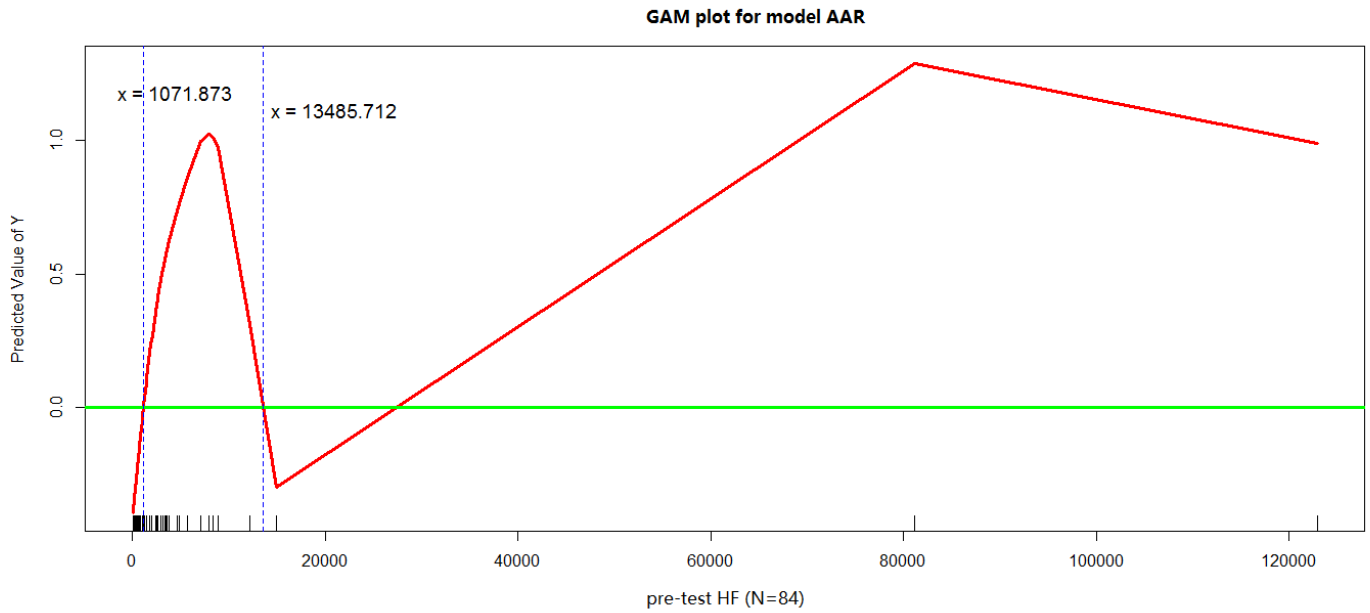

Supplementary Figure S2: GAM plot for modeling the relationship between the change in the alpha wave and pretest pNN50. The vertical axis represents the difference in alpha activity. The horizontal axis represents the pretest pNN50 and number of patients. GAM techniques can be used to show that

$$\text{pre-test pNN50} = \begin{cases} 1, & 0.017 \leq \text{pNN50} \leq 0.176 \\ 0, & \text{others} \end{cases}$$
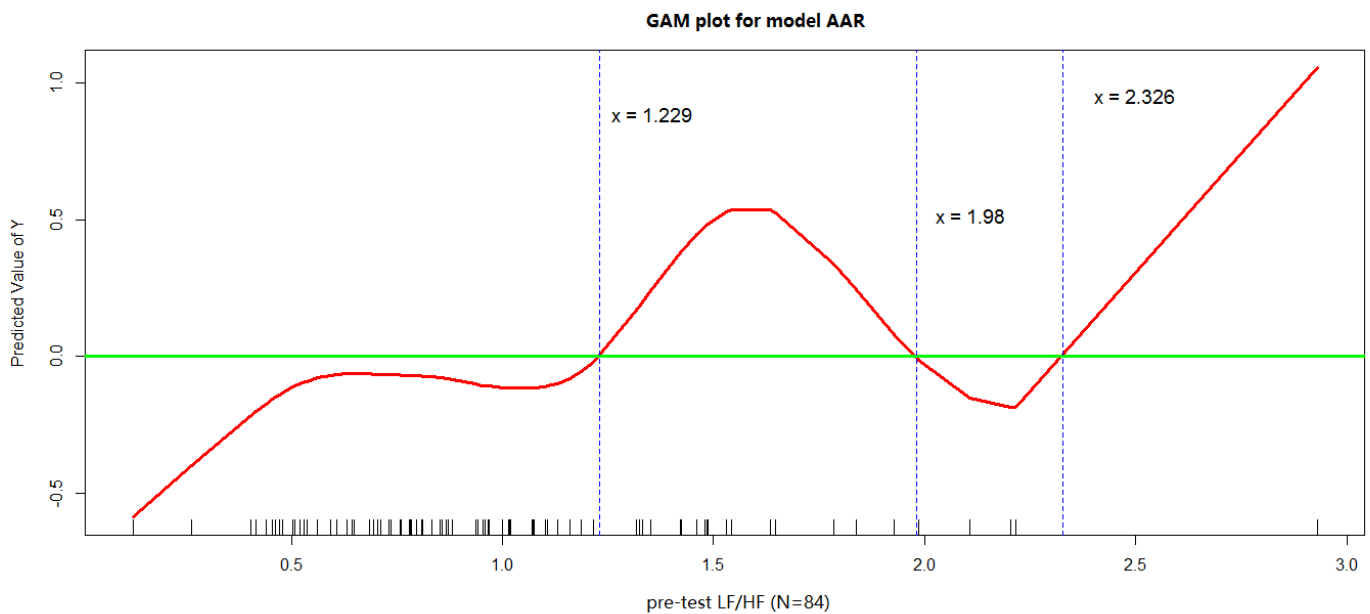
GAM plot for model AAR
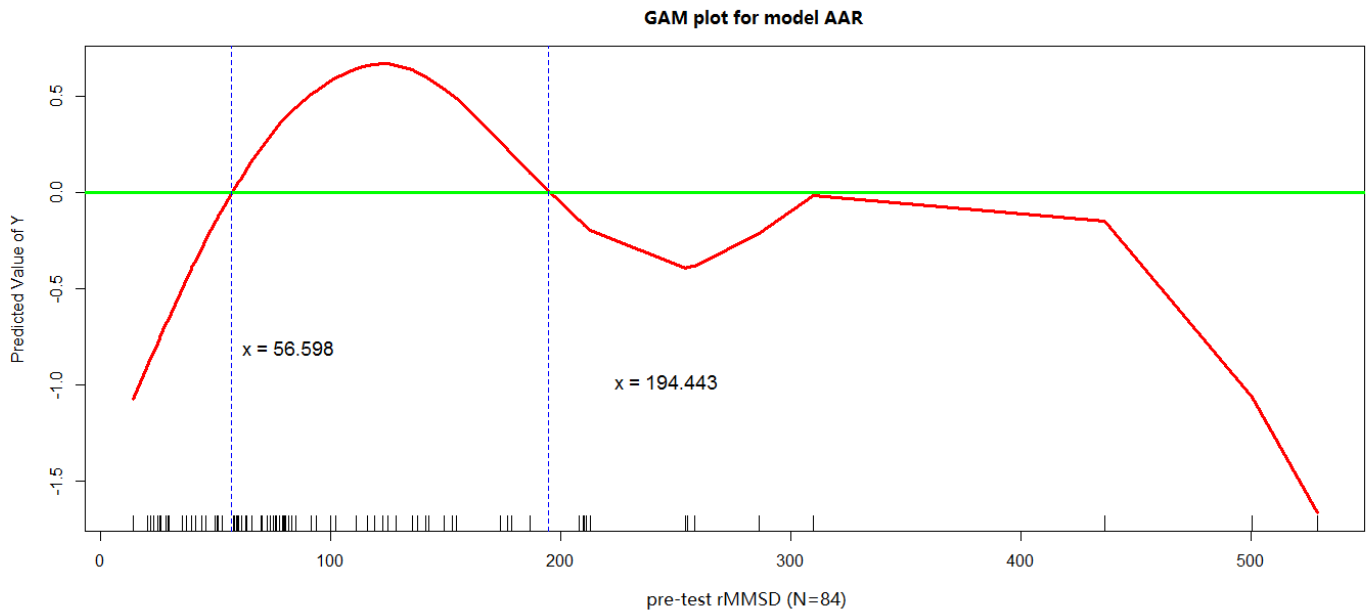
Supplementary Figure S3: GAM plot for modeling the relationship between the change in the alpha wave and pretest rMMSD. The vertical axis represents the difference in alpha activity. The horizontal axis represents the pretest rMMSD and number of patients. GAM techniques can be used to show that

$$\text{pre-test rMMSD} = \begin{cases} 1, & 56.598 \leq \text{rMMSD} \leq 194.443 \\ 0, & \text{others} \end{cases}$$

GAM plot for model AAR

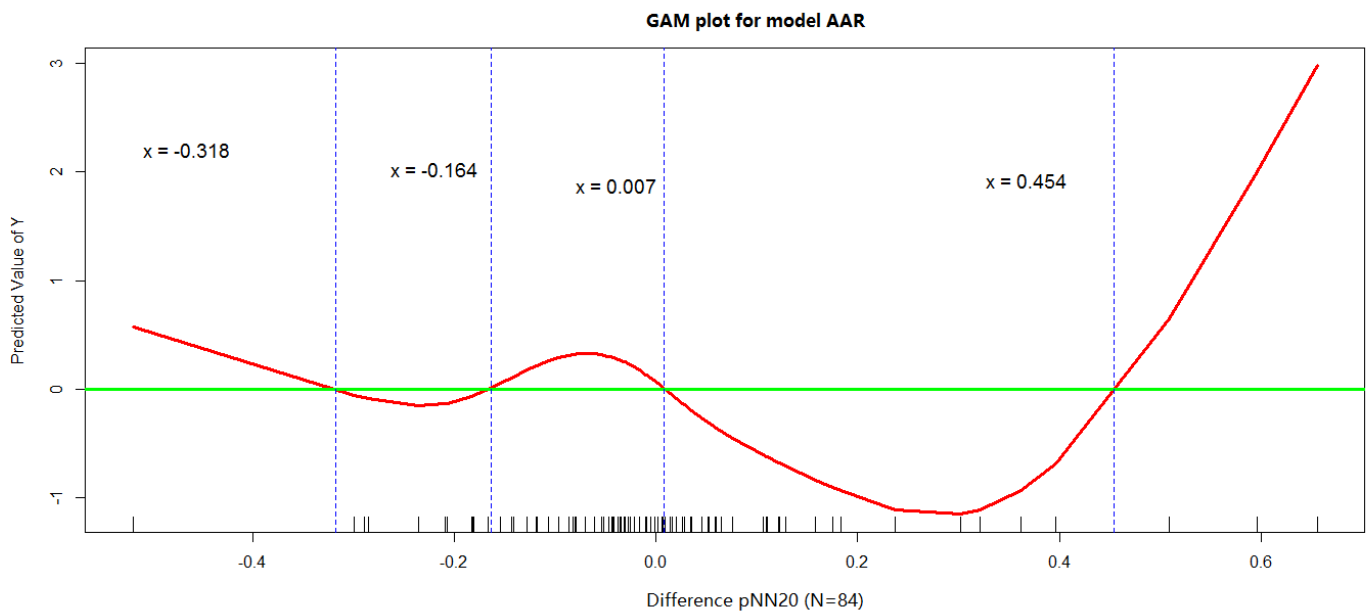**Supplementary Figure S4: GAM plot for modeling the relationship between the change in the alpha wave and pretest log-rMMSD.** The vertical axis represents the difference in alpha activity. The horizontal axis represents the pretest log-rMMSD and number of patients. GAM techniques can be used to show that

$$\text{pre-test log-rMMSD} = \begin{cases} 1, & 3.81 \leq \text{log-rMMSD} \leq 5.348 \\ 0, & \text{others} \end{cases}$$

7

GAM plot for model AAR

Supplementary Figure S5: GAM plot for modeling the relationship between the change in the alpha wave and pretest HF.

The vertical axis represents the difference in alpha activity. The horizontal axis represents the pretest HF and number of patients.

GAM techniques can be used to show that

$$\text{pre-test HF} = \begin{cases} 1, & 1071.873 \leq \text{HF} \leq 13485.712 \\ 0, & \text{others} \end{cases}$$

GAM plot for model AAR

Supplementary Figure S6: GAM plot for modeling the relationship between the change in the alpha wave and pretest LF/HF. The vertical axis represents the difference in alpha activity. The horizontal axis represents the pretest LF/HF and number of patients. GAM techniques can be used to show that

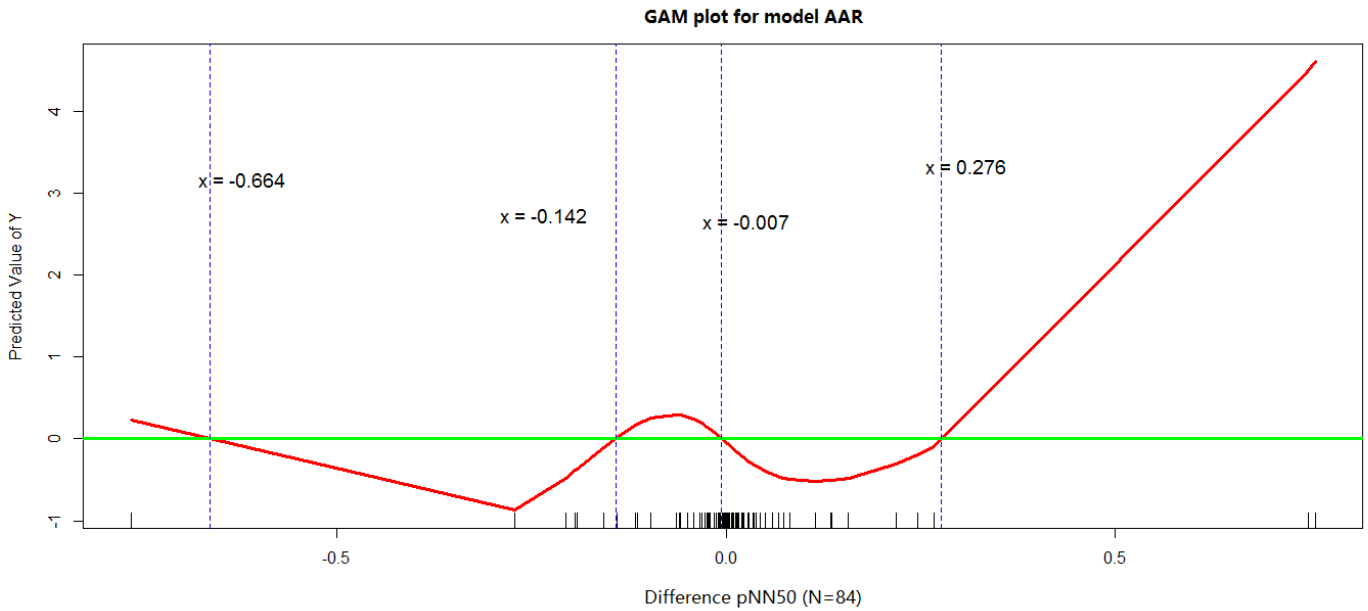$$\text{pre-test LF/HF} = \begin{cases} 1, & 1.229 \leq \text{LF/HF} \leq 1.98 \\ 0, & \text{others} \end{cases}$$

8
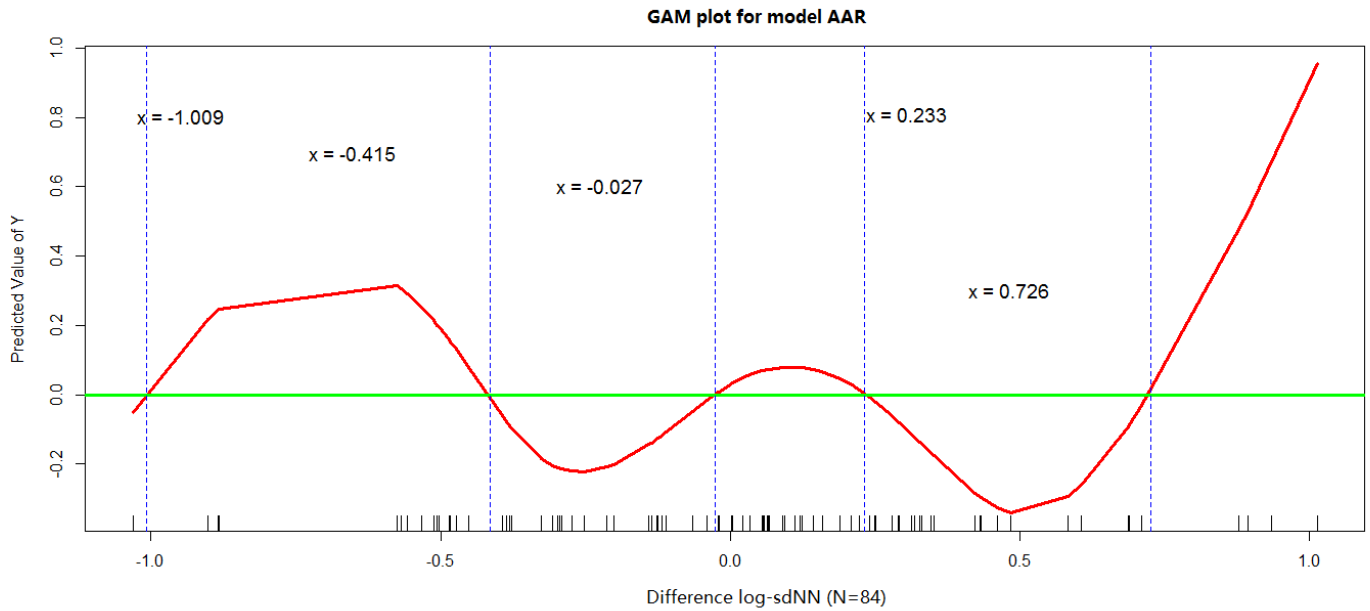
Supplementary Figure S7: GAM plot for modeling the relationship between the change in the alpha wave and Difference log-sdNN. The vertical axis represents the difference in alpha activity. The horizontal axis represents the Difference log-sdNN and number of patients. GAM techniques can be used to show that

$$\text{Difference log-sdNN} = \begin{cases} 1, & \text{log-sdNN} \leq -0.415 \\ 0, & \text{others} \end{cases}$$
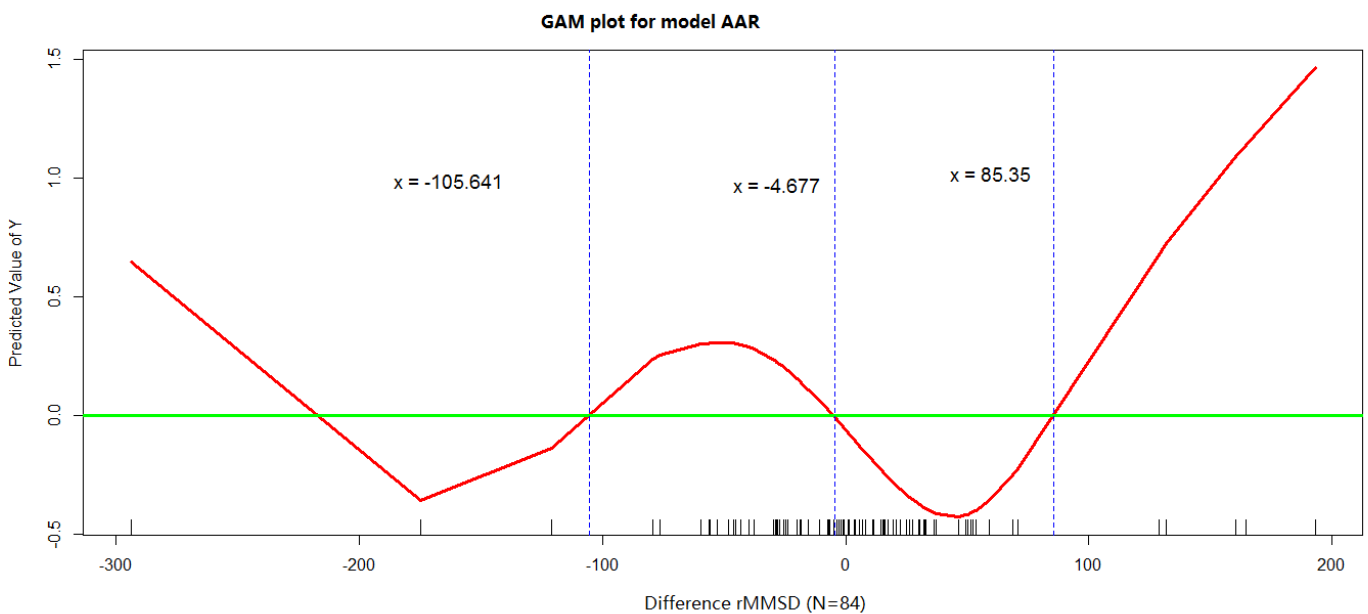

Supplementary Figure S8: GAM plot for modeling the relationship between the change in the alpha wave and Difference pNN20. The vertical axis represents the difference in alpha activity. The horizontal axis represents the Difference pNN20 and number of patients. GAM techniques can be used to show that

$$\text{Difference pNN20} = \begin{cases} 1, & -0.164 \leq \text{pNN20} \leq 0.007 \\ 0, & \text{others} \end{cases}$$
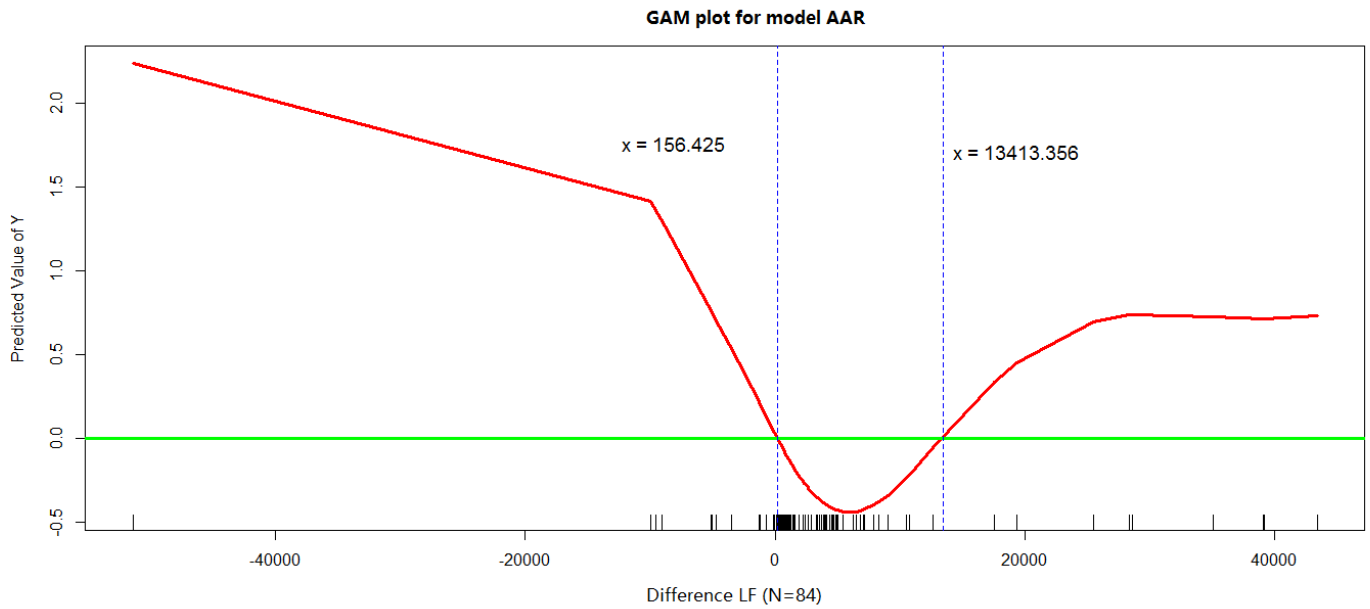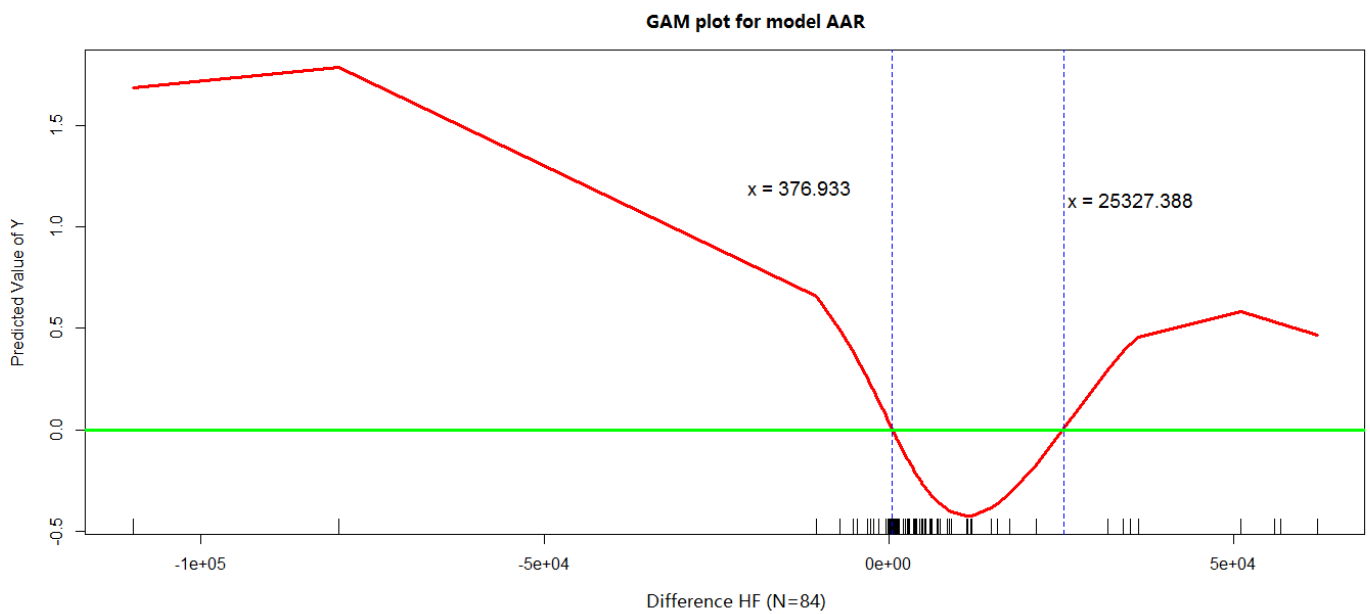
9

Supplementary Figure S9: GAM plot for modeling the relationship between the change in the alpha wave and Difference pNN50. The vertical axis represents the difference in alpha activity. The horizontal axis represents the Difference pNN50 and number of patients. GAM techniques can be used to show that

$$\text{Difference pNN50} = \begin{cases} 1, & -0.142 \leq \text{pNN50} \leq 0.007 \\ 0, & \text{others} \end{cases}$$

Supplementary Figure S10: GAM plot for modeling the relationship between the change in the alpha wave and Difference rMMSD. The vertical axis represents the difference in alpha activity. The horizontal axis represents the Difference rMMSD and number of patients. GAM techniques can be used to show that

$$\text{Difference rMMSD} = \begin{cases} 1, & -105.641 \leq \text{rMMSD} \leq 4.677 \\ 0, & \text{others} \end{cases}$$
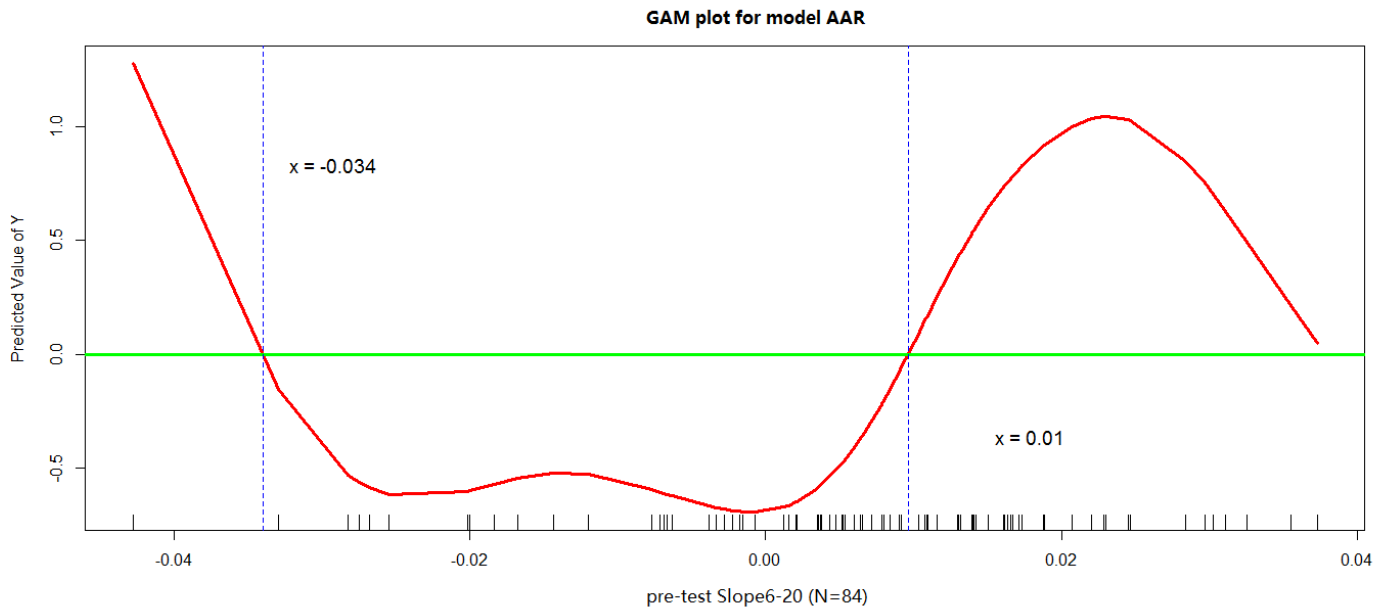
10

Supplementary Figure S11: GAM plot for modeling the relationship between the change in the alpha wave and Difference LF. The vertical axis represents the difference in alpha activity. The horizontal axis represents the Difference LF and number of patients. GAM techniques can be used to show that

$$\text{Difference LF} = \begin{cases} 1, & 156.425 \leq \text{LF} \leq 13413.356 \\ 0, & \text{others} \end{cases}$$
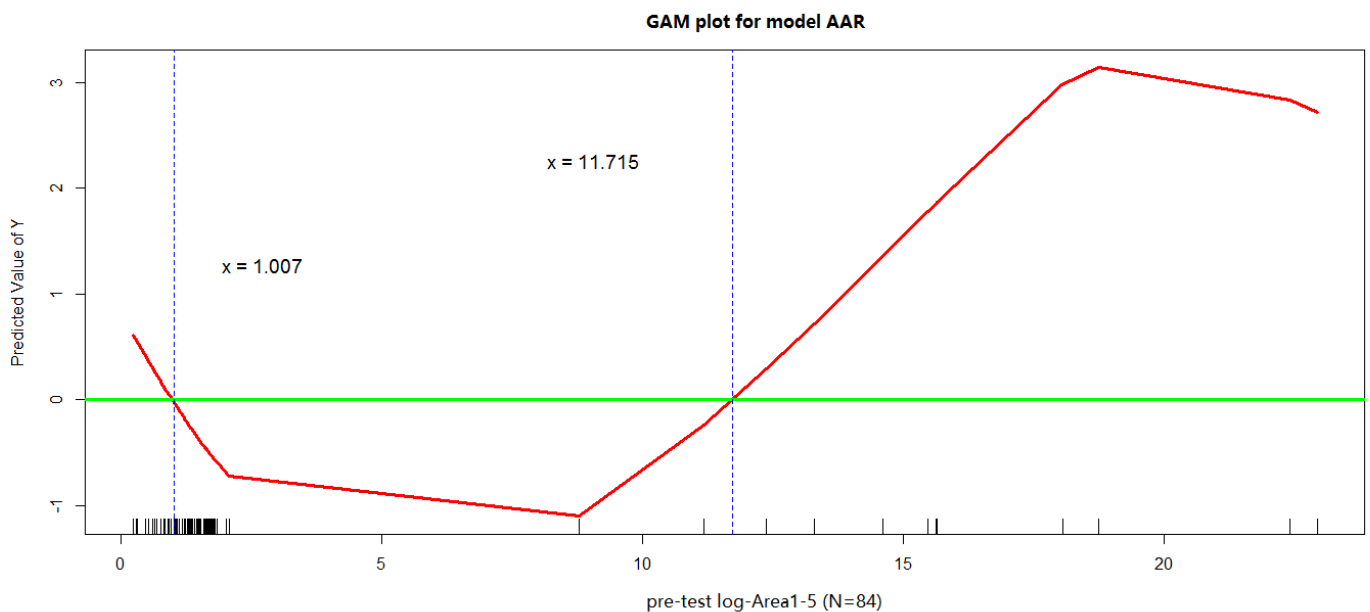

Supplementary Figure S12: GAM plot for modeling the relationship between the change in the alpha wave and Difference HF. The vertical axis represents the difference in alpha activity. The horizontal axis represents the Difference HF and number of patients. GAM techniques can be used to show that

$$\text{Difference HF} = \begin{cases} 1, & 376.933 \leq \text{HF} \leq 25327.388 \\ 0, & \text{others} \end{cases}$$
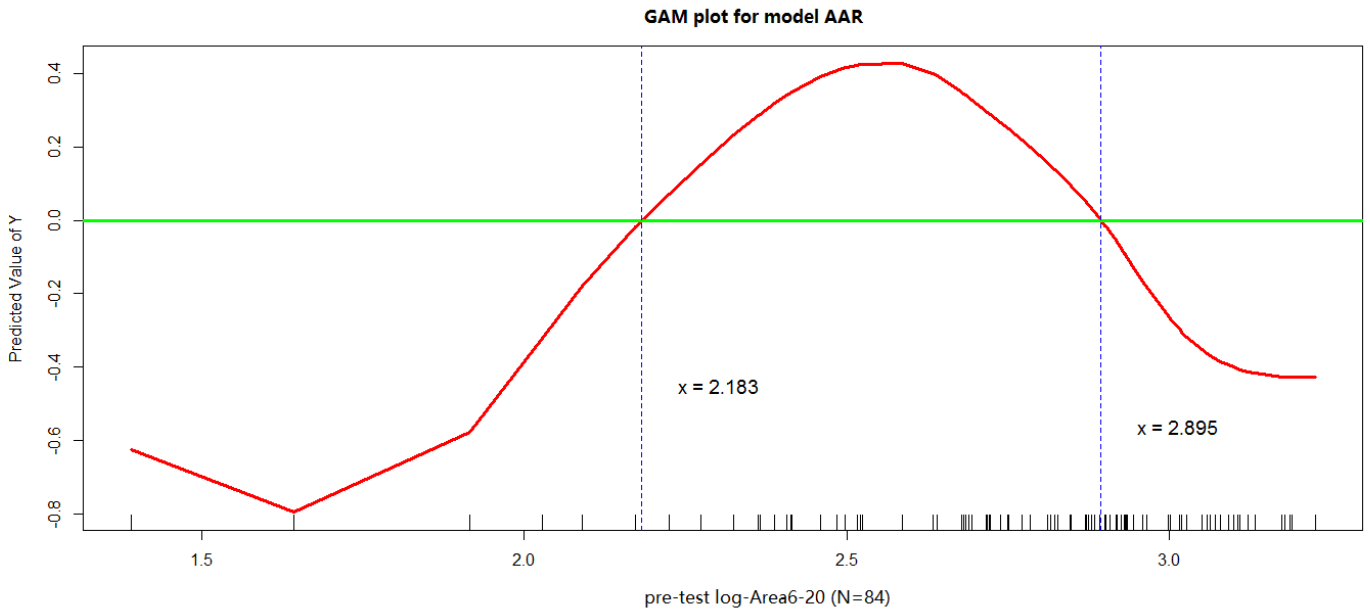
11

Supplementary Figure S13: GAM plot for modeling the relationship between the change in the alpha wave and pre-test Slope6-20. The vertical axis represents the difference in alpha activity. The horizontal axis represents the pretest Slope6-20and number of patients. GAM techniques can be used to show that

$$\text{pre-test Slope6-20} = \begin{cases} 1, & 0.01 \leq \text{Slope6-20} \\ 0, & \text{others} \end{cases}$$
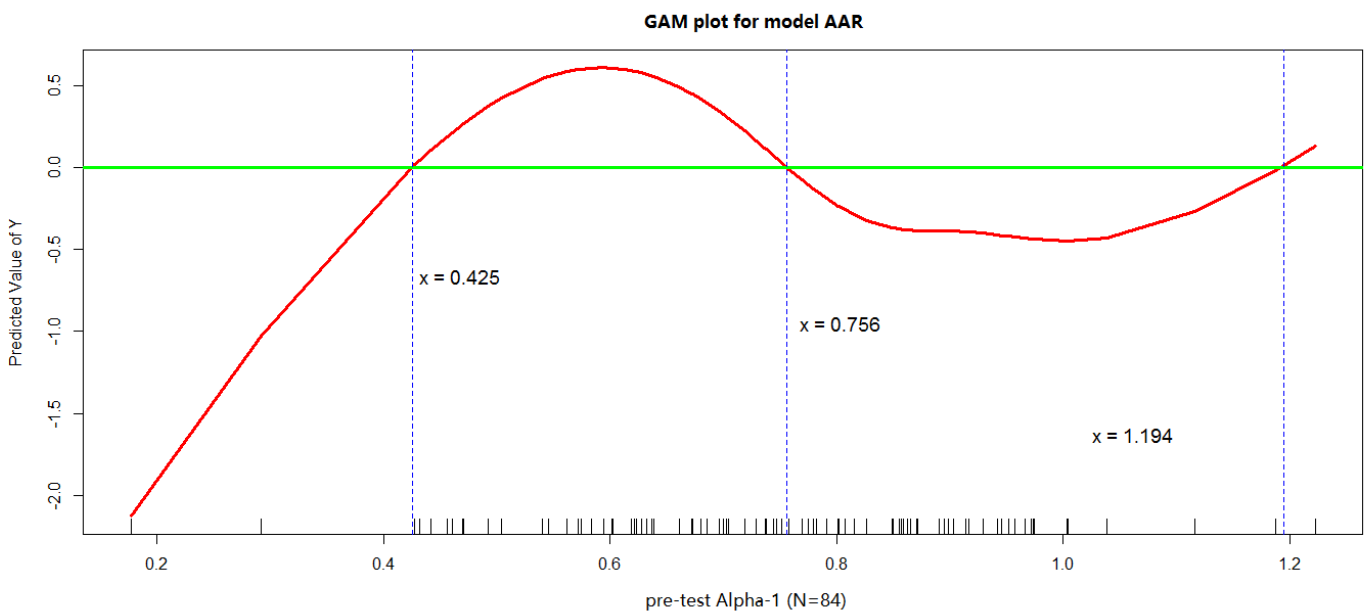

Supplementary Figure S14: GAM plot for modeling the relationship between the change in the alpha wave and pre-test log-Area1-5. The vertical axis represents the difference in alpha activity. The horizontal axis represents the pretest log-Area1-5and number of patients. GAM techniques can be used to show that

$$\text{pre-test log-Area1-5} = \begin{cases} 1, & \text{log-Area1-5} \leq 1.007 \\ 0, & \text{others} \end{cases}$$
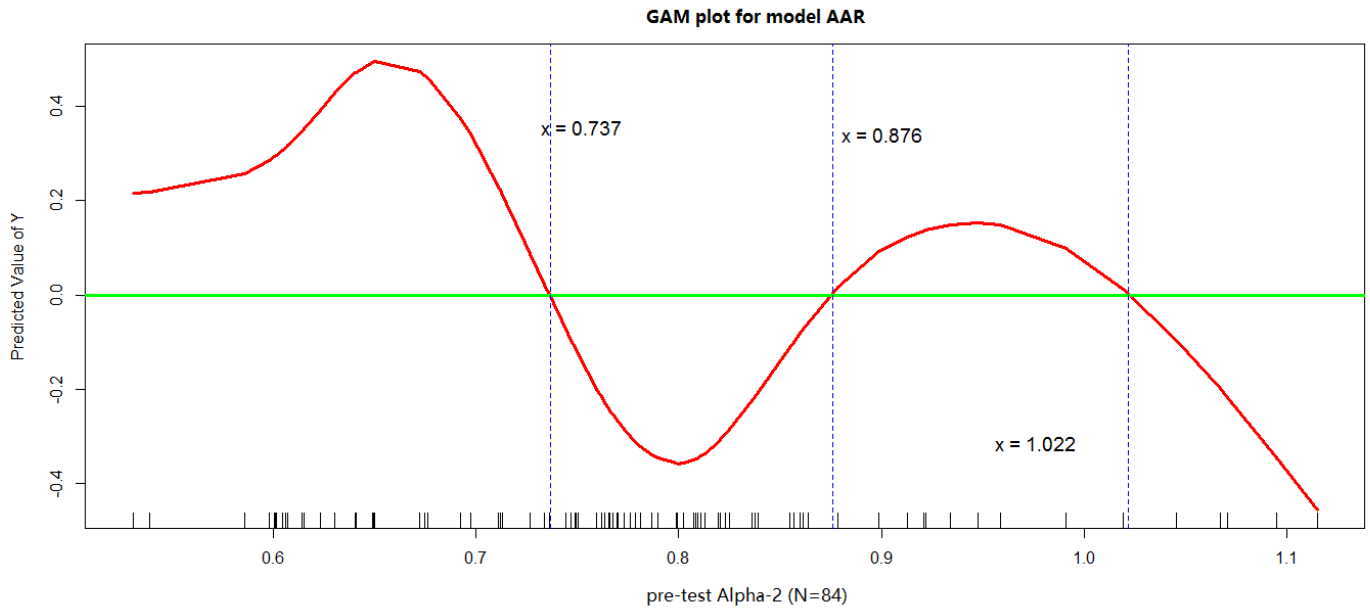
12

GAM plot for model AAR

Supplementary Figure S15: GAM plot for modeling the relationship between the change in the alpha wave and pre-test log-Area6-20. The vertical axis represents the difference in alpha activity. The horizontal axis represents the pretest log-Area6-20 and number of patients. GAM techniques can be used to show that

$$\text{pre-test log-Area6-20} = \begin{cases} 1, & 2.183 \leq \text{log-Area6-20} \leq 2.895 \\ 0, & \text{others} \end{cases}$$
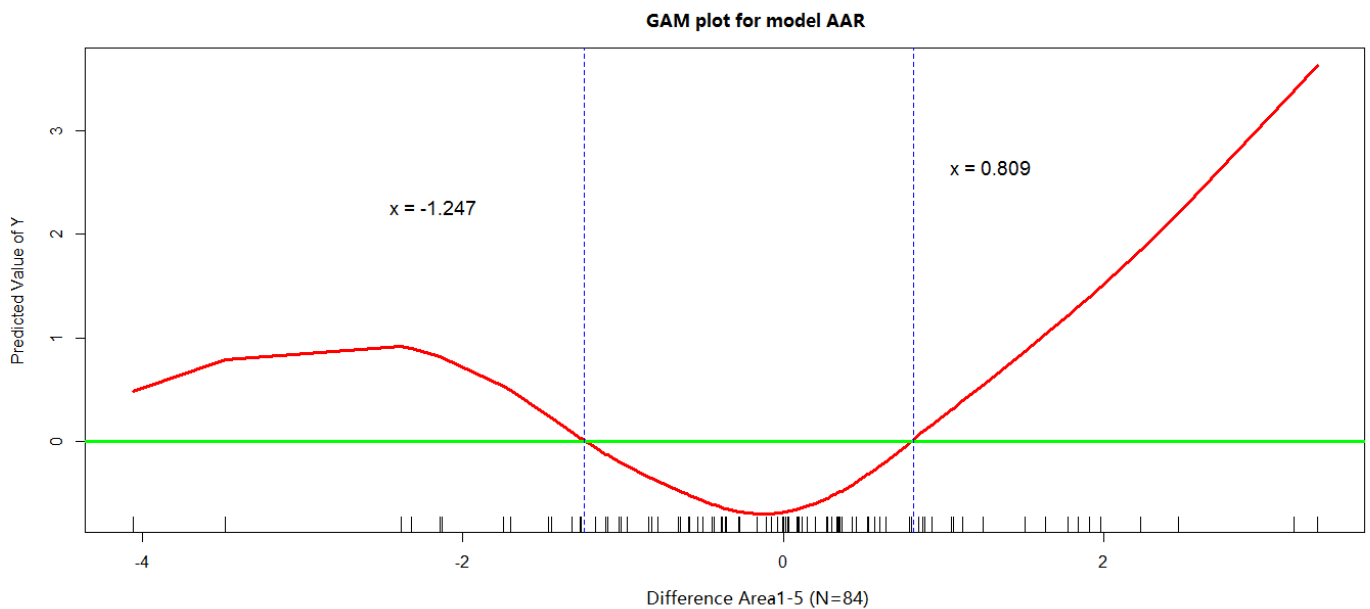

GAM plot for model AAR

Supplementary Figure S16: GAM plot for modeling the relationship between the change in the alpha wave and pre-test Alpha-1. The vertical axis represents the difference in alpha activity. The horizontal axis represents the pretest Alpha-1 and number of patients. GAM techniques can be used to show that

$$\text{pre-test Alpha-1} = \begin{cases} 1, & 0.425 \leq \text{Alpha-1} \leq 0.756 \\ 0, & \text{others} \end{cases}$$
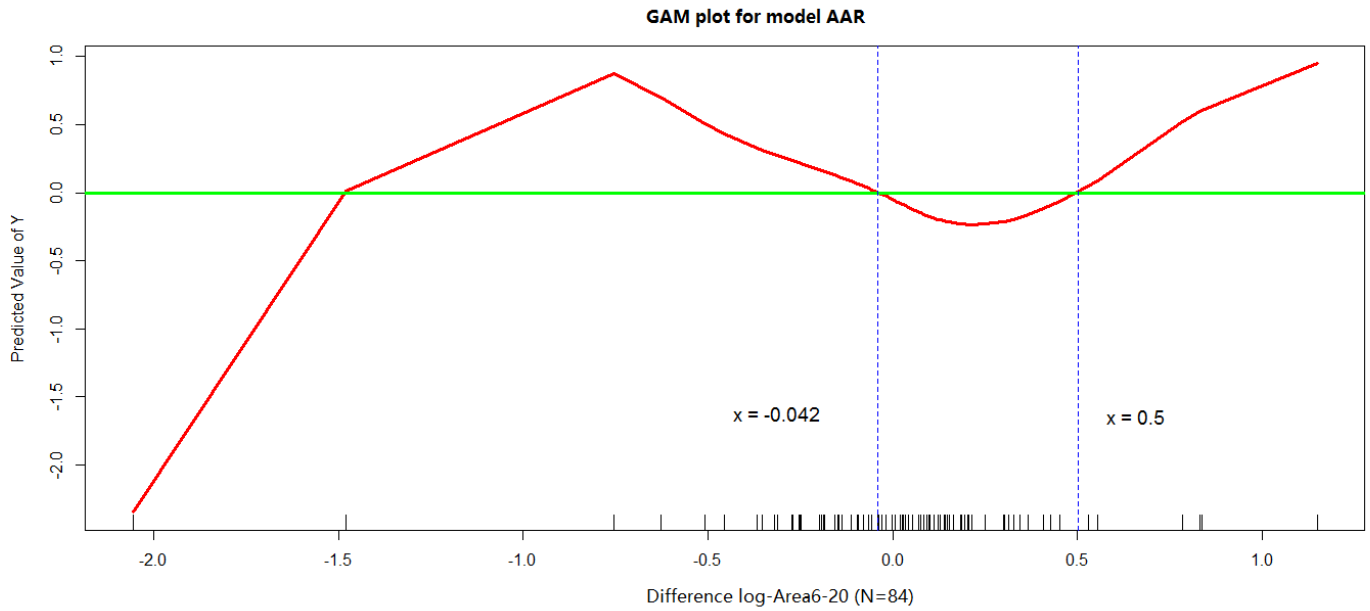
13

Supplementary Figure S17: GAM plot for modeling the relationship between the change in the alpha wave and pre-test Alpha-2. The vertical axis represents the difference in alpha activity. The horizontal axis represents the pretest Alpha-2 and number of patients. GAM techniques can be used to show that

$$\text{pre-test Alpha-2} = \begin{cases} 1, & \text{Alpha-2} \leq 0.737 \text{ and Alpha-2} \geq 0.876 \\ 0, & \text{others} \end{cases}$$

Supplementary Figure S18: GAM plot for modeling the relationship between the change in the alpha wave and Difference Area1-5. The vertical axis represents the difference in alpha activity. The horizontal axis represents the Difference Area1-5 and number of patients. GAM techniques can be used to show that

$$\text{Difference Area1-5} = \begin{cases} 1, & \text{Area1-5} \leq -1.247 \text{ and Area1-5} \geq 0.809 \\ 0, & \text{others} \end{cases}$$

14

Supplementary Figure S19: **GAM plot for modeling the relationship between the change in the alpha wave and Difference log-Area6-20.** The vertical axis represents the difference in alpha activity. The horizontal axis represents the Difference log-Area6-20 and number of patients. GAM techniques can be used to show that

$$\text{Difference log-Area6-20} = \begin{cases} 1, & \text{Area6-20} \le -0.042 \text{ and Area6-20} \ge 0.5 \\ 0, & \text{others} \end{cases}$$