Dynamic EEG Features in Neurologic Prognosis of Coma Following Cardiac Arrest

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This project was conducted using data contributed by members of the International Cardiac Arrest EEG Consortium (I-CARE), of which all contributing centers are members.

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Data Characteristics

Cerebral Performance Category	1	2	3	4	5
Number of Subjects	138	31	17	10	340
Age (Years)	53(16)	60(13)	68(12)	53(21)	61(16)
Gender (% Male)	61	71	30	41	65
ROSC (Mins)	20(19)	14(12)	13(10)	13(8)	28(61)
Rhythm at Arrest					
Asystole (%)	5	9.6	10	5.8	18.5
PEA (%)	25	29	5	35	34
VF (%)	41	29	10	17.6	16.5
VT (%)	5.8	0	0	17.6	1.5
Other/Unknown (%)	23.2	32.4	75	24	29.5
Arrest Location					
In Hospital (%)	16.7	29	50	5.8	10
Out of Hospital (%)	39	29	0	47	42.6
Unknown (%)	44.3	42	50	47.2	47.4

Table 1: Clinical characteristics of our study population

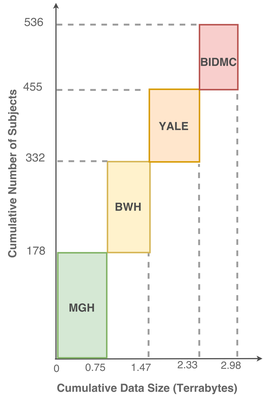
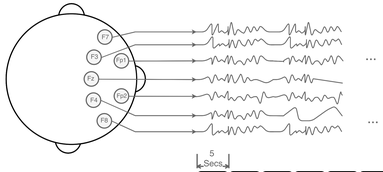
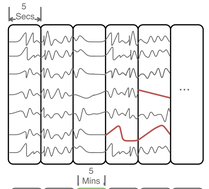


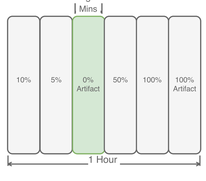
Figure 1: EEG data by institution

Pre-Processing





Epoch data: 5 seconds



Re-epoch data: 5 mins

Standardize and Clean

1. Standardize channel names
2. Apply 1-50Hz Bandpass filter
3. Downsample: Fs=100
4. Remove corrupt channels
5. Re-reference to average montage
6. Remove DC offset

Detect Artifacts

1. Channel disconnects and saturation
2. Eye and muscle artifact
3. Moment-based artifacts

Identify Epochs for Feature Extraction

1. Generate artifact score
2. Extract cleanest hourly epochs

Figure 2: An overview of our pre-processing approach

Features

Time (Hours)	1-12	13-24	25-36	37-48	49-60	61-72
Time-Insensitive Correlations						
Complexity Features						
Shanon Entropy	-0.09	-0.18	-0.11	-0.15	-0.31	-0.26
Ceptrum Coefficient (2)	-0.10	-0.14	-0.20	-0.14	-0.16	-0.23
Hjorth Mobility	0.09	0.09	0.14	0.09	0.21	0.15
False Nearest Neighbor	0.18	0.11	0.19	0.22	0.27	0.16
Category Features						
Low Voltage EEG (<5 uV)	**0.14**	**0.20**	**0.14**	**0.18**	**0.34**	**0.30**
Number of Spileptiform Spikes	0.21	0.23	0.26	0.24	0.26	0.20
Connectivity Features						
Coherence in delta band	0.21	0.21	0.21	0.29	0.18	0.19
Phase Lag Index	0.20	0.27	0.25	0.24	0.20	0.17
Time-Sensitive Correlations						
Complexity Features						
ARMA Coefficient (1)	-0.13	-0.15	-0.15	-	-	-
Lyapunov Exponent	-	-	-	-	0.13	0.20
Category Features						
Regularity	-0.15	-0.24	-0.19	-0.15	-	-
Mean Supression Length	-	0.19	0.10	0.16	0.26	0.21
Low Voltage EEG (<10 uV)	-	-	-	0.09	0.27	0.26
Alpha/Delta Band Ratio	-	-	-	-	0.13	0.14
Normal EEG (%)	-	-	-	-	0.16	0.16
Diffuse Slowing (%)	-	-	-	-	-0.16	-0.16
Connectivity Features						
Autocorrelation Magnitude	-	-	0.17	0.28	0.30	0.23

Table 2: Univariate correlation between statistically signficant features, and raw CPC

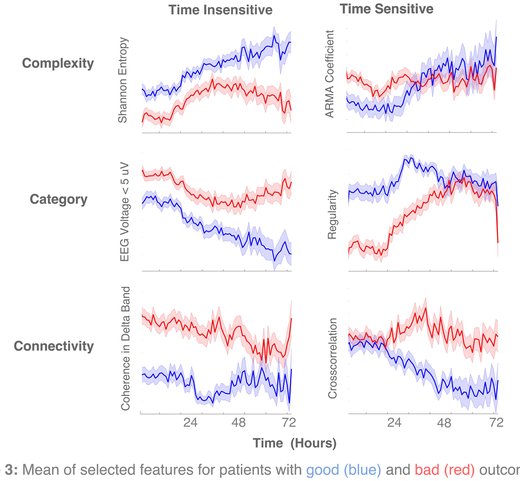
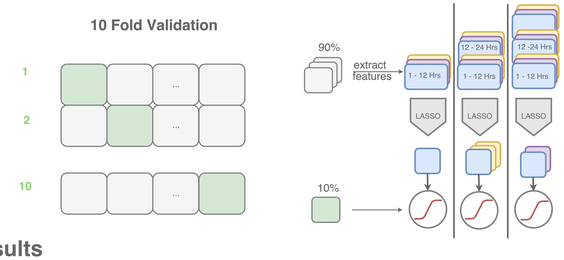


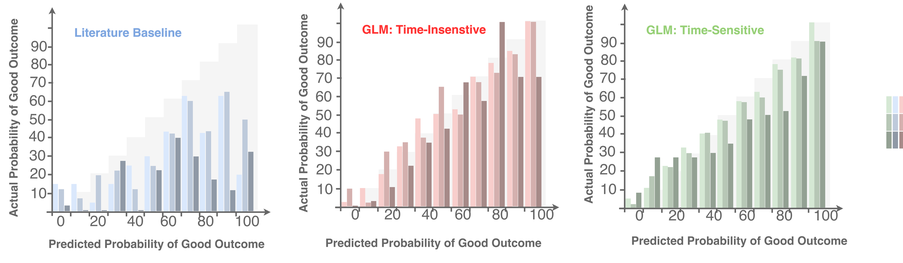
Figure 3: Mean of selected features for patients with good (blue) and bad (red) outcomes.

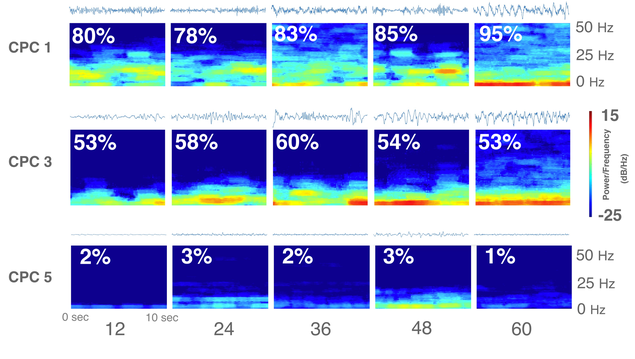
Methods

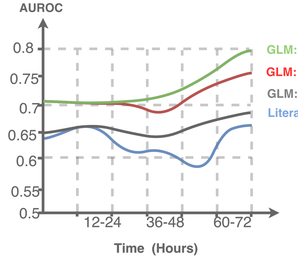


1. Partition training data across time
2. Identify features using 10 folds of LASSO
3. Train Logit GLM with selected features
4. Test models on held out data

Results







Limitations

Information on the time of arrest was unavailable in some cases, so all analysis was performed with respect to the time of EEG initiation.