

**Supplementary online-only material:**

**Supplementary Figure 1.** Electroencephalography map of a delirium patient.

**Supplementary Figure 2.** Example of phase shuffling.

**Supplementary Figure 3.** Data distribution.

**Supplementary Figure 4.** Lempel Ziv Complexity correlation with slow wave activity (SWA).

**Supplementary Figure 5.** Surface Laplacian: Delirium severity (DRS) is associated with decreased Lempel Ziv Complexity (LZC).

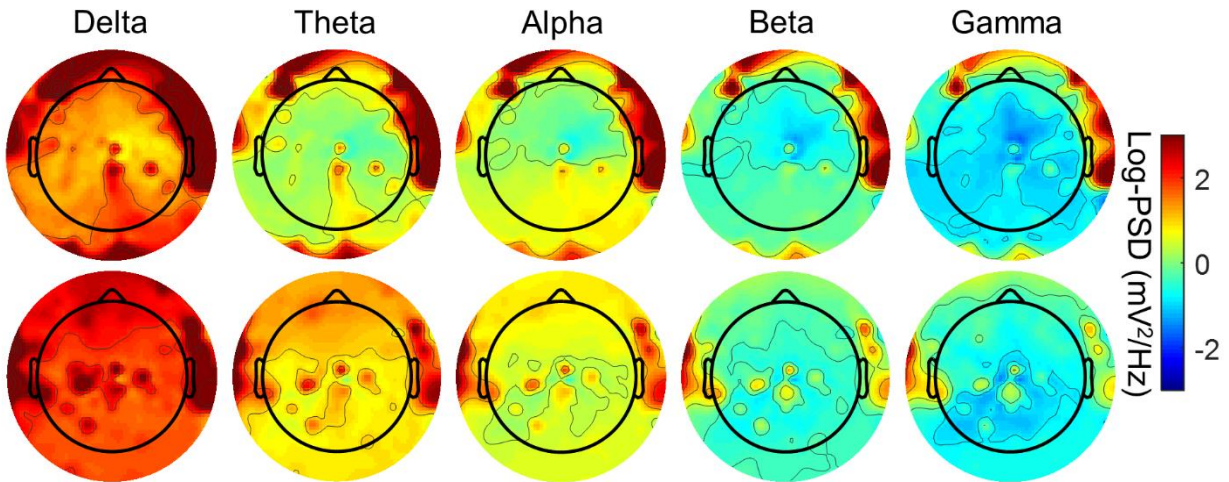
**Supplementary Figure 6.** Surface Laplacian: Delirium severity (DRS) correlation with slow wave activity (SWA).

**Supplementary Table 1.** Inclusion and exclusion criteria for the IPOD-B2 cohort (NCT02926417).

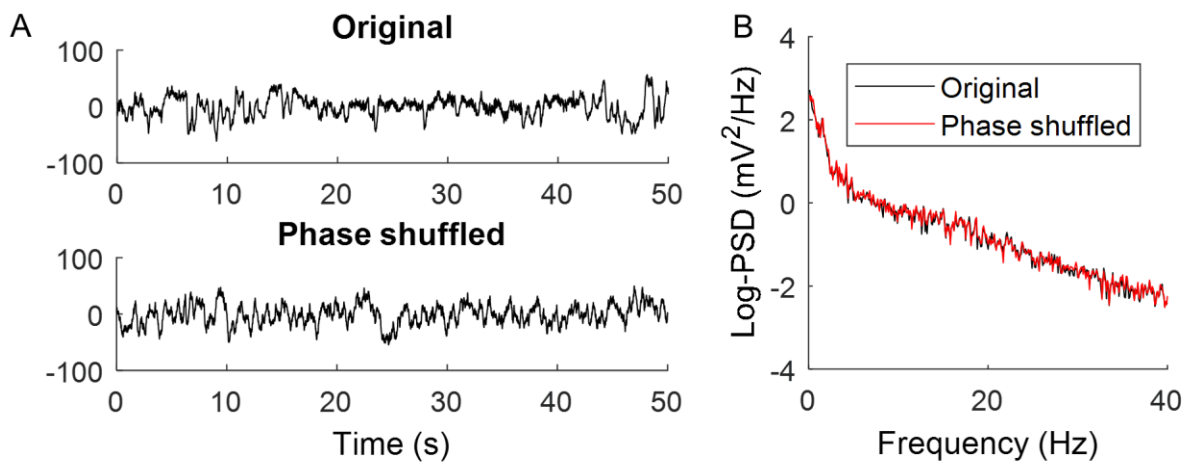
**Supplementary Table 2.** Inclusion and exclusion criteria for the IPOD-B3 cohort (NCT03124303).

**Supplementary Table 3.** Clinical and demographic data for the cohort

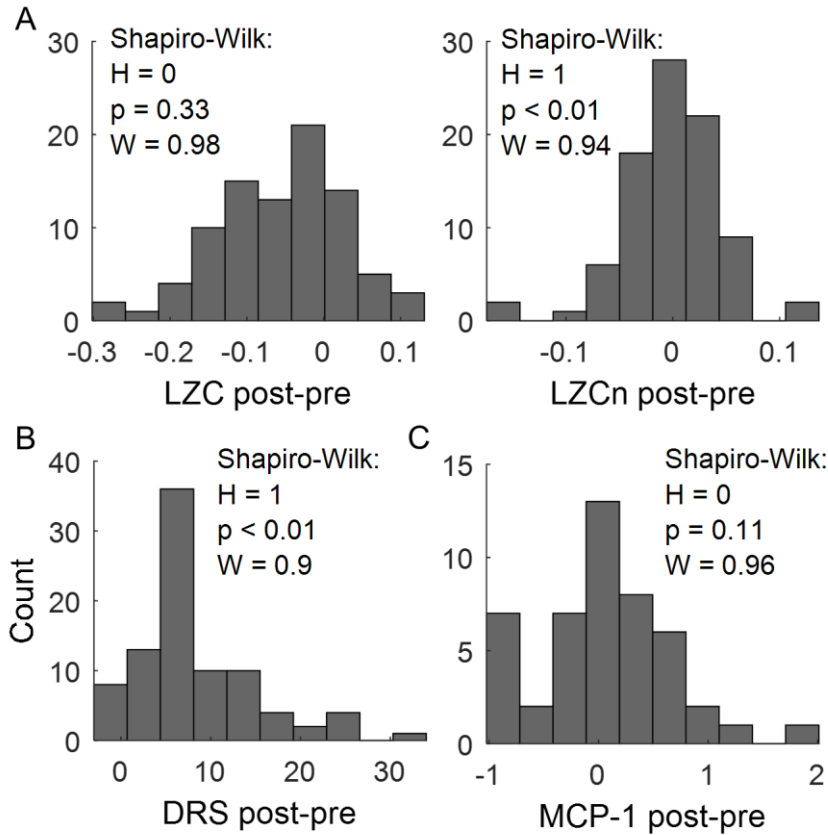
**Supplementary Table 4.** Linear regression



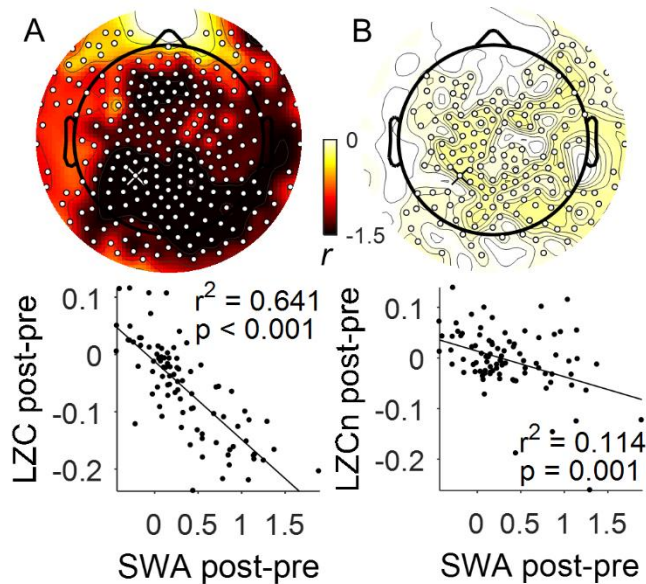
**Supplementary Figure 1. Electroencephalography map of a delirium patient.** Pre-operation (top row) and post-operation (bottom row). Unprocessed data.



**Supplementary Figure 2. Example of phase shuffling.** (A) Electroencephalography timeseries before and after phase shuffling. (B) Phase shuffling sustains the power spectra while randomizing the signal phase.

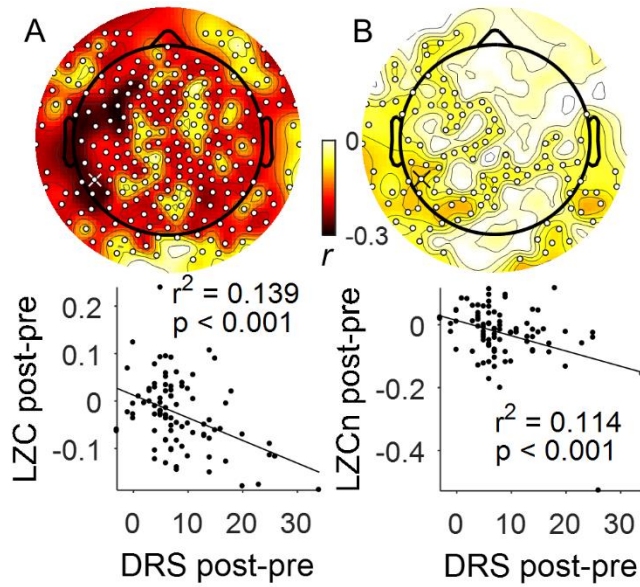


**Supplementary Figure 3. Data distribution.** Shapiro-Walk test for normality on (A) LZC/LZCn ( $n = 88$ , channel 179), (B) DRS ( $n = 88$ ) and (C) MCP-1 ( $n = 47$ ).

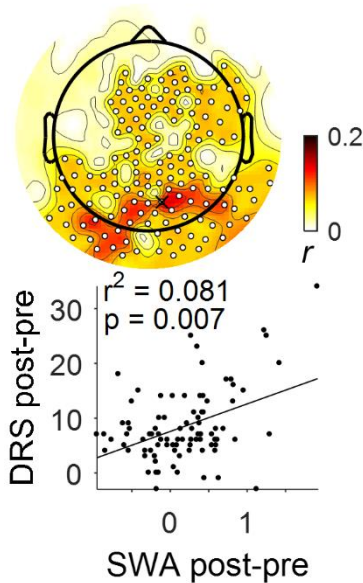


**Supplementary Figure 4. Lempel Ziv Complexity correlation with slow wave activity (SWA).** (A) LZC analysis ( $n = 89$ ) and (B) LZCn analysis ( $n = 89$ ) with statically significant electrodes shown by white dots (corrected TFCE  $P < 0.05$ ). SWA was defined as  $\log_{10}$

transformed power spectral density at 0.5-6Hz. Example Spearman's correlation plotted at 90th percentile effect size overlapping between LZC and LZCn, shown by white and black "X" (channel 87).



**Supplementary Figure 5. Surface Laplacian: Delirium severity (DRS) is associated with decreased Lempel Ziv Complexity (LZC).** Repeating figure 2 after applying surface Laplacian (Legendre polynomial 40,  $\lambda = 10^{-5}$ ) before LZC calculation. Correlation of change in DRS with (A) LZC ( $n = 88$ ) and (B) LZCn ( $n = 88$ ) with statically significant electrodes shown by white dots (corrected TFCE  $P < 0.05$ ). Example channel Spearman's correlation with DRS plotted at 90th percentile effect size overlapping between LZC and LZCn, shown by white "X" in (A) and black "X" in (B) (channel 179).



**Supplementary Figure 6. Surface Laplacian: Delirium severity (DRS) correlation with slow wave activity (SWA).** SWA calculation after surface Laplacian (Legendre polynomial 40,

lambda  $10^{-5}$ ). Correlation of change in DRS with SWA (n = 88) with statically significant electrodes shown by white dots (corrected TFCE  $P < 0.05$ ). Example channel Spearman's correlation with SWA plotted at peak effect size (black "X", channel 139).

**Supplementary Table 1. Inclusion and exclusion criteria for the IPOD-B2 cohort (NCT02926417).**

Inclusion Criteria	Exclusion Criteria
1. Adult (>21 years old)	1. Contraindication for spinal drain
2. Patients scheduled for an elective open thoracoabdominal aortic aneurysm or TEVAR (thoracic endovascular aortic/aneurysm repair)	2. Documented history of dementia
3. Requiring spinal drain for surgery that is predicted to stay in two or more days	3. Unable to communicate with the research staff due to language barriers
4. Willing and able to provide informed consent	4. Individuals who the PI determines are not appropriate for the study such as a history of appointment cancellations.
	5. Pregnant or Nursing
	6. Prisoners

**Supplementary Table 2. Inclusion and exclusion criteria for the IPOD-B3 cohort (NCT03124303).**

Inclusion Criteria	Exclusion Criteria
1. Age $\geq 65$ years	1. Contraindication to EEG,
2. Anticipated length of hospital stay of at least 2 days after surgery that occurs under general or neuraxial anesthesia	2. Unable or unwilling to attend the follow-up appointments,
4. Written Informed Consent prior to surgery	3. Documented history of dementia
	4. Deemed incapable of providing consent by surgical team
	4. Residing in a nursing home,
	5. Undergoing intracranial surgery
	6. Unable to complete neurocognitive testing due to language, vision or hearing impairment,
	7. Unable to communicate with the research staff due to language barriers,
	8. For optional MRI portion of the study: Contraindication to MRI (e.g., implanted devices not safe for MRI studies, claustrophobia, unable to lie flat or still)

**Supplementary Table 3. Clinical and demographic data for the cohort**

	Delirious	Non-delirious
Age (Years)	68.91 ± 8.61	72.13 ± 5.66
Sex (F)	49%	29%
Peak DRS	19.66 ± 6.50	9.25 ± 2.48
ASA score	3.00 ± 0.64	2.72 ± 0.68
Diabetes	20%	82%
Tobacco user	86%	71%
COPD	39%	13%
Obstructive Sleep Apnoea	31%	24%
Body Mass Index	28.34 ± 4.87	28.04 ± 4.82
Hypertension	89%	76%
Stroke/Transient Ischaemic Attack	Stroke: 6%, TIA: 14%	Stroke: 2%, TIA: 2%
Surgery Type	Vascular: 63%, Thoracic: 0%, General: 3%, Orthopedic: 20%, Urological: 3%, Cardiac: 11%	Vascular: 29%, Thoracic: 2%, General: 5%, Orthopedic: 42%, Urological: 7%, Cardiac: 15%
Blood loss (mL)	4230.91 ± 4452.41	680.29 ± 1064.14
Operative time (min)	452.17 ± 219.93	275.11 ± 125.70

*Note:* Values show mean ± SD or percent. DRS, Delirium Rating Scale-98-R.

**Supplementary Table 4. Linear regression**

	Estimate	SE	t	p
DRS~1+LZC+SWA				
LZC	-30.89	10.40	-2.97	0.004
SWA	1.92	2.06	0.93	0.354
DRS~1+LZCn+SWA				
LZCn	-29.87	14.50	-2.06	0.042
SWA	5.48	1.58	3.47	<0.001

*Note:* Linear regression fit on pre- to post-operative changes (channel 179, N = 89). Channel 179 is in the peak effect overlap of LZC and LZCn correlation with DRS. DRS, Delirium Rating Scale-98-R; LZC, Lempel Ziv Complexity; LZCn, phase shuffle normalized Lempel Ziv Complexity; SWA, slow wave activity.