EEG Predictors of Neurologic Injury in Patients Undergoing Extracorporeal Membrane Oxygenation

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OBJECTIVE

To assess electrographic associations of brain injury in children undergoing extracorporeal membrane oxygenation (ECMO).

METHODS

This is a retrospective review of all patients on ECMO admitted to the pediatric and cardiac intensive care units (PICU, CICU) at Children's National Hospital from August 2019 to December 2022. Clinical variables included age, sex, ECMO indication, presence or absence of congenital heart disease, duration on ECMO, initial type of ECMO (veno-arterial (VA)/veno-venous (VV)), and total number of ECMO runs. EEG features collected were based on the duration of the first ECMO run and included EEG background and presence or absence of electrographic seizures (ES). EEG background within the first 24 hours was defined as normal (both neonate and non-neonate), mildly abnormal (slow-disorganized in non-neonate; excess discontinuity in neonate), moderately abnormal (discontinuous in non-neonate), or severely abnormal (attenuated/featureless/burst suppression in neonate and non-neonate). Imaging features included ischemic, anoxic, hemorrhagic (extra-axial, intraparenchymal, or intraventricular hemorrhage), or combined injury. A chi-squared test was used to assess the association of EEG features, ES, and injury.

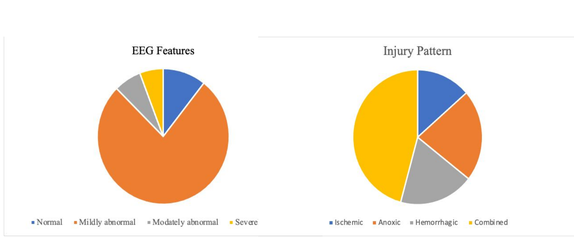
RESULTS

One hundred and twelve patients met inclusion criteria with a mean age of 2.97 years (IQR 0.4-31.2). Forty-four percent (49/112) were female, 84% had congenital heart disease, 93% (104/112) had EEG, and 95% (106/112) had neuroimaging. The most common indication for ECMO was cardiopulmonary arrest (50/112). Nineteen percent (21/112) were admitted to the PICU and 81% (92/112) were admitted to the CICU with a mean duration on ECMO of 67.66 hours (IQR 49.1-155.6). VA ECMO, including both central and peripheral, was the most common approach to cannulation (90%, 101/112). Seventy-nine percent (89/112) had a single ECMO run, whereas 21% (23/112) had multiple ECMO runs. A mildly abnormal EEG background was the most common finding (77%, 80/112), and 6% (6/104) had a severely abnormal background. Thirty-eight percent (40/104) had ES, the majority of which occurred on the first day of cannulation (25%; 10/40). Fifty-three percent (59/112) had brain injury and the most common injury type was anoxic (22%, 13/59). A severely abnormal EEG background (p=0.028) and presence of electrographic seizures (p<0.0001) while on ECMO was associated with the development of brain injury.

Demographics	
Age on ECMO	2.97 years
Female:Male	49 (44%) : 63 (56%)
Reason for ECMO	
Cardiac Arrest	50 (45%)
Cardiac Failure	21 (19%)
Post-operative	23 (20%)
Respiratory Illness	11 (10%)
Systemic Illness	6 (5%)
More than one indication	1 (1%)
Clinical Features	
Congenital heart disease	94 (84%)
PICU	21 (19%)
CICU	92 (81%)
Duration on ECMO	67.66 hours
VA ECMO- peripheral	56 (50%)
VA ECMO- central	45 (40%)
VV ECMO	11 (10%)
Number of ECMO runs	
Single	89 (79%)
Multiple	23 (21%)
EEG Features	
Patients with EEG	104 (93%)
Background	
Normal	11 (10%)
Mildly abnormal	80 (77%)
Moderately abnormal	7 (7%)
Severely abnormal	6 (6%)
Electrographic seizures	40 (38%)
Injury	
Brain Injury	59 (53%)
Type of Injury	
Ischemic	8 (14%)
Anoxic	13 (22%)
Hemorrhagic	11 (19%)
Combined	27 (45%)
Mortality	52 (46%)

CONCLUSIONS

Severity of EEG background and presence of ES was associated with the development of brain injury in patients on ECMO. We hope to further explore the ability of EEG background and ES to localize and predict degree of brain injury in this population.



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