The Role of Long-Term Electroencephalogram Monitoring in the Prognostic Evaluation of Children with Disturbance of Consciousness in Pediatric Intensive Care Unit

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Background:This study aimed to investigate the role of long-term video electroencephalogram (VEEG) monitoring in the diagnosis and prognostic evaluation of children with disturbance of consciousness in pediatric intensive care unit (PICU). Materials and Methods : A retrospective analysis was performed on the medical records of 107 children with severe brain injury (SBI) who admitted to the PICU of The First Hospital of Qinhuangdao from January 2014 to December 2015. The medical records of 100 children with mild disturbance of consciousness were analyzed. All children underwent routine electroencephalogram (REEG) and VEEG detections. The diagnosis was completed by physicians according to the relevant operation instructions. The brain waveform of children was monitored. Result : The diagnostic results of REEG and VEEG were compared with clinical diagnostic results, and the relationship between the two detections and the prognosis of SBI children was analyzed. The sensitivity of VEEG in the diagnosis of SBI children was significantly higher than that of REEG (P<0.050). The specificity of VEEG in the diagnosis of SBI children was higher than that of REEG, with a statistical significance (P<0.050). The diagnostic compliance rate of VEEG in the diagnosis of SBI children was significantly higher than that of REEG (P<0.050). The sensitivity of VEEG in evaluating the prognosis of SBI children was significantly higher than that of REEG (P<0.050). The specificity of VEEG in evaluating the prognosis of SBI children was significantly higher than that of REEG. The coincidence rate of VEEG in evaluating the prognosis of SBI children was significantly higher than that of REEG (P<0.050). Conclusion: The results indicated that VEEG detection is effective in the diagnosis and prognostic evaluation of SBI children with disturbance of consciousness, which is worthy of promotion in clinical practice.

Keywords: long-term EEG, PICU, severe brain injury, disturbance of consciousness, children

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Severe brain injury (SBI), a neurological disease caused by ischemia and hypoxia in brain tissues, is a common disease in pediatric intensive care unit (PICU)[1]. Central nervous system infection, brain trauma, birth injury and other diseases with abnormal organ function and metabolism result in

disturbance of consciousness in SBI children [2]. Impaired brain structure in SBI children may cause severe central nervous system dysfunction, and the children may be in coma and paralysis state. SBI children with severe impaired brain structure may even die, which greatly endangers the children's life and health [3]. With the advancement and development of modern medical technology, the mortality of SBI children has dropped drastically, but the resulting neurological sequelae still have high incidence, which affects the daily life of children and their families and brings heavy burdens to families and society [4]. Therefore, a more comprehensive and objective early evaluation of the brain function of SBI children is beneficial for timely intervention and more important for the prognostic judgment.

At present, the commonly used predictive method for disturbance of consciousness is the Glasgow Coma Scale (GCS) that is simple and reproducible. However, the GCS score has certain subjectivity and limitations; it is difficult to evaluate the brain function when patients are in a state of coma, aphasia and delirium, paralysis, etc. [5,6]. With the advancement of modern imaging, imaging techniques such as brain CT and brain MRI are widely used in clinical diagnosis and treatment, the diagnostic coincidence rate of SBI patients was improved. However, they only reflect organic lesions of the brain but cannot assess changes in the brain function of patients. In addition, SBI patients are often difficult to be moved, and changes in the brain function cannot be continuously observed and evaluated. Therefore, the continuous, real-time detection of SBI patients is not possible [7]. In recent years, electroneurophysiology has been widely used in the prognostic evaluation of SBI. Electroencephalogram (EEG) has been clinically used for the electrophysiological examination due to its non-invasiveness, simplicity and real-time performance [8]. It directly observes the electrical activity of neurons in the brain and reflects changes in the brain function of patients. However, the image limitations of routine electroencephalogram (REEG) make it impossible to monitor continuously, which may misdiagnose patients with brain injury as sleep disorder, depression and other diseases [9]. The acquisition, storage and analysis technology of EEG has been developed in recent years, and long-term video electroencephalogram (VEEG) is also gradually applied to the diagnosis and treatment of brain injury-related diseases [10]. However, there are currently few literatures on long-term EEG monitoring in the prognostic evaluation of SBI children. Therefore, in this study, REEG and VEEG were used to diagnose SBI children, and their predictive values for the prognosis of SBI children were explored, in order to provide a reference for the clinical implementation of SBI treatment.

METHODS AND INFORMATION

Patient Data

A retrospective analysis was performed on the medical records of 107 SBI children admitted to the PICU of The First Hospital of Qinhuangdao from January 2014 to December 2015, including 64 males and 43 females, 7-14 years old, with an average age of (11.74±2.42) years old. The medical records of 100 children with mild disturbance of consciousness were analyzed, including 59 males and 41 females, 6-16 years old, with an average age of (12.56±3.68) years old. Inclusion criteria for SBI children: Children clinically diagnosed with SBI; children with the GCS score <8; children with complete medical records and follow-up data; children who did not receive relevant treatments in other hospitals. Exclusion criteria: Children with skull bandage after surgical operation who were unable to undergo EEG electrode examination; children with previous illnesses affecting EEG interpretation except SBI; children whose families refused to undergo EEG examination; children with severe diseases with poor prognosis, including severe heart, lung, liver, kidney dysfunction or malignant tumors; children who died within 24 hours of coma. All subjects and their families signed an informed consent form and cooperated with medical staff to complete relevant medical treatment.

Methods

All children underwent REEG and VEEG detections. Before the examination, parents were told to remove the hair of their children in order to avoid interference with EEG detection, and the diagnosis was completed by physicians according to the relevant operation instructions. REEG detection (Nanjing Weisi Medical Technology Co., Ltd., REEG instrument) was performed as follows: the scalp electrode was placed in accordance with the standard operation. The filter channel was 0.5~30 Hz, the time constant was 0.3 s, and the paper speed was 30 mm/s. The examination of rest state, opened and closed eye test, flash induction test and sleep EEG were performed. VEEG detection (Trackit Ambulayory Recorder EEG machine from LIFELINES LIMITED, UK) was performed as follows: patients or their families were told not to let patients enter sleep state 5 hours before the examination. According to the relevant operating standards, 12~20 system electrode placement method was used. EEG was routinely recorded for the first 20 minutes, and one detection time was >12h, including two sleep cycles. The brain waveform of children was monitored and the

recorded results were stored to analyze changes in their brain waves. The diagnostic results of REEG and VEEG were compared with clinical diagnostic results, and the relationship between the two detections and the prognosis of SBI children was analyzed.

Results Evaluation Methods

REEG results were evaluated based on the Naqeeb classification [11]. Normal: normal amplitude or no obvious abnormalities. Mildly abnormal: mildly abnormal amplitude or normal amplitude, but with epileptiform electrical activity. Abnormal: obviously abnormal amplitude, with or without epileptiform activity. VEEG results were evaluated based on the synek grading standard [12]. The VEEG results were divided into I-V grades. Grade I was normal αrhythm with a small amount of θwaves. Grade II was dominant θ activity. Grade III was diffusely regular or irregular δ activity, with reactivity. Grade IV was burst-inhibition, without reactivity. Grade V was equipotential (<2 mV), i.e. electrical silence. Grades I and II were defined as mildly abnormal, grades III~V as moderately and severely abnormal. Prognostic evaluation was as follows: good prognosis: normal, mild disability and moderate disability; poor prognosis: severe disability, coma or vegetative state, brain death and clinical death.

Statistical Methods

SPSS19.1 (Beijing Sitron Weida Information Technology Co., Ltd.) software system was used for statistical analysis. Count data were expressed as percentage [n(%)], and chi-square test was used for the difference comparison between the two groups. Measurement data were expressed as mean ± standard deviation, and t test was used for the difference comparison between the two groups. When $P<0.05$, the difference was statistically significant.

RESULTS

Comparison of Basic Data of Children

In order to make the experimental results accurate and credible, the gender, reproductive way, cause of disease, disturbance of consciousness state number, age, height, and body weight were compared between SBI children and children with mild disturbance of consciousness, and there was no significant difference ($P>0.05$), indicating that they are comparable. See Table I for the details of patient basic information.

Table I
Basic information of SBI children and children with mild disturbance of consciousness [n(%)]

	SBI children (n=107)	Children with mild disturbance of consciousness (n=100)	t/chi-square test	P
Gender			0.014	0.905
Male	64 (59.81)	59 (59.00)		
Female	43 (40.19)	41 (41.00)		
Age (Years)			1.201	0.231
	11.74±2.42	12.16±2.61		
Body weight (kg)			0.348	0.728
	20.85±4.76	21.06±3.84		
Height (cm)			1.316	0.190
	125.64±8.51	127.15±7.96		
Reproductive way			0.535	0.766
Caesarean birth	61 (57.01)	54 (54.00)		
Eutocia	44 (41.12)	45 (45.00)		
Fetal head-attracted midwifery	2 (1.87)	1 (1.00)		
Cause of disease			1.666	0.645
Central nervous system infection	24 (22.43)	18 (18.00)		
Brain trauma	67 (62.62)	71 (71.00)		
Birth injury	3 (2.80)	2 (2.00)		
Others	13 (12.15)	9 (9.00)		
Disturbance of consciousness state			3.131	0.077

Hypersomnia	83 (77.57)	87 (87.00)
Delirious state	24 (22.43)	13 (13.00)

Efficacy Analysis of REEG and VEEG in the Diagnosis of SBI Children

There were 107 SBI children clinically diagnosed by EEG, MR and biochemical examination. The sensitivity of REEG in the diagnosis of SBI children was 71.26%, and that of VEEG was 83.18%. The sensitivity of VEEG in the diagnosis of SBI children was significantly higher than that of REEG, with a statistically significant difference (P<0.050). The specificity of REEG in the diagnosis of SBI children was 94.00%, and that of VEEG was 95.00%. The specificity of VEEG in the diagnosis of SBI children was significantly higher than that of REEG, with a statistically significant difference (P<0.050). The diagnostic coincidence rate of REEG in the diagnosis of SBI children was 82.61%, and that of VEEG was 88.89%. The diagnostic compliance rate of VEEG in the diagnosis of SBI children was significantly higher than that of REEG, with a statistically significant difference (P<0.050). See Table II and Table III, Figure 1.

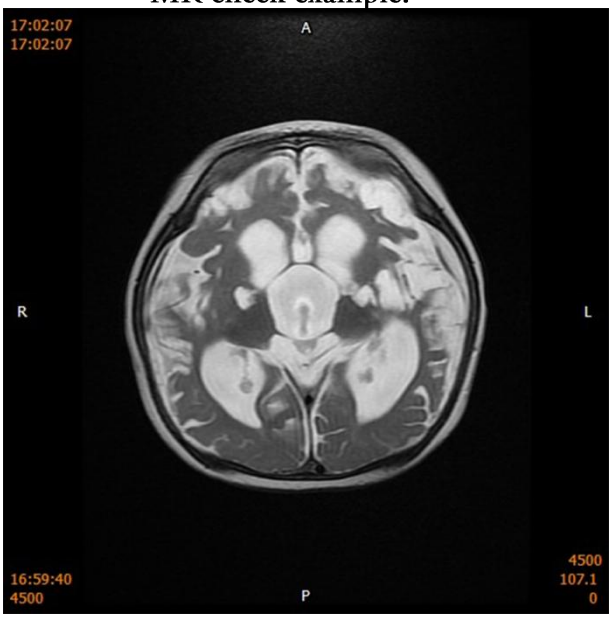
Table II
Efficacy of REEG diagnosis

	Clinical diagnosis (SBI)	Clinical diagnosis (mild disturbance of consciousness)	Total
REEG diagnosis (SBI)	77	6	83
REEG diagnosis (mild disturbance of consciousness)	30	94	124
Total	107	100	207

Table III
Efficacy of VEEGdiagnosis

	Clinical diagnosis (SBI)	Clinical diagnosis (mild disturbance of consciousness)	Total
VEEG diagnosis (SBI)	89	5	94
VEEG diagnosis (mild disturbance of consciousness)	18	95	113
Total	107	100	207

Figure 1
MR check example.



The image realization of 1-year-old boy was as follows: the display of the limitations of the bilateral artery was poor, but the display of the main artery of bilateral internal carotid artery segments, the posterior cerebral artery, the middle cerebral artery, the anterior cerebral artery, the bilateral vertebral artery and the basilar artery was clear. Some of the blood vessels were stiff and the distal branches were thinner.

Prognostic Evaluation of SBI Children by REEG and VEEG and Classification of Follow-Up Results

There were 42 SBI children with good prognosis and 65 SBI children with poor prognosis in the prognostic evaluation by VEEG; 35 SBI children with good prognosis and 72 SBI children with poor prognosis in the prognostic evaluation by REEG. Follow-up was performed on children 6 months after discharge. The follow-up results were as follows: 2 normal children, 6 children with mild disability, 23 children with moderate disability, 35 children with severe disability, 18 children in a coma or vegetative state, 23 children with brain death and clinical death. See Table IV for details.

Table IV
Prognostic evaluation by REEG and VEEG and follow-up results (n=107)

	Prognostic evaluation by REEG	Prognostic evaluation by VEEG	Follow-up results
Good prognosis	42	35	31
Poor prognosis	65	72	76

Efficacy Analysis of Prognosis Evaluation by REEG and VEEG in SBI Children

The sensitivity of REEG in evaluating the prognosis of SBI children was 74.19%, and that of VEEG was 83.87%. The sensitivity of VEEG in evaluating the prognosis of SBI children was significantly higher than that of REEG, with a statistically significant difference (P<0.050). The specificity of REEG in evaluating the prognosis of SBI children was 75.00%, and that of VEEG was 88.16%. The specificity of VEEG in evaluating the prognosis of SBI children was significantly higher than that of REEG, with a statistically significant difference (P<0.050). The coincidence rate of REEG in evaluating the prognosis of SBI children was 74.77%, and that of VEEG was 86.92%. The coincidence rate of VEEG in evaluating the prognosis of SBI children was significantly higher than that of REEG, with a statistically significant difference (P<0.050). See Table V and Table VI.

Table V
Efficacy analysis of prognostic evaluation by REEG

	Follow-up prognosis (good)	Follow-up prognosis (poor)	Total
REEGevaluation (good)	23	19	42
REEGevaluation (poor)	8	57	65
Total	31	76	107

Table VI
Efficacy analysis of prognostic evaluation by VEEG

	Clinical diagnosis (SBI)	Clinical diagnosis (mild disturbance of consciousness)	Total
VEEG evaluation (good)	26	9	35
VEEGevaluation (poor)	5	67	72
Total	31	76	107

DISCUSSION

The main clinical manifestation of SBI is disturbance of consciousness. The most important structures affecting consciousness are the brain stem ascending reticular activation system and the thalamocortical integration system. As long as any of the structures are damaged, patients' responses to external stimuli will be impaired, resulting in different degrees of disturbance of consciousness. A high degree of disturbance of consciousness with a

long duration often indicates a severe condition and a poor prognosis [13]. According to a study by Stevens et al. [14], SBI causes 50,000 deaths per year and 40% of patients with prognosis of disability, which has become one of the leading causes of death in Americans before the age of 50. It is very important to choose reasonable nutrition pathways for children with disturbance of consciousness in order to avoid aspiration, asphyxia and other accidents, and to strengthen the monitoring and support of vital signs and vital organ function in critically ill children [15]. At present, the brain function is clinically evaluated based on the GCS score, neuroimaging evaluation and neuroelectrophysiological evaluation, etc. However, many evaluation methods with limitations restrict their clinical application [16,17]. EEG has been widely used in the PICU and is an effective way to evaluate the coma degree and brain injury in children [18,19]. Although it does not fully show the orderly progression changes in coma, the changes and characteristics of EEG activity in VEEG can be used as a diagnostic indicator of disturbance of consciousness [20] and an observation indicator of the prognosis of patients [21,22]. In this study, the REEG and VEEG of 107 SBI children and 100 children with mild disturbance of consciousness admitted to the PICU of The First Hospital of Qinhuangdao were analyzed, and their diagnosis and prognostic evaluation in SBI children were analyzed, in order to provide a reference for the clinical diagnosis and treatment of SBI children.

In this study, the efficacy analysis of VEEG and REEG in the diagnosis of SBI children was first observed. The sensitivity, specificity and diagnostic coincidence rate of VEEG in the diagnosis of SBI children were significantly higher than those of REEG. As the most commonly used method for evaluating the brain function, REEG reflects the actual condition of cortical injury, such as increased θδactivity, disappearance of exogenous stimuli and abnormal electrical activity [23]. VEEG prolongs the monitoring time of REEG and increases video recordings, realizes diagnoses in combination with abnormal electrical activity and clinical manifestations [24]. A large number of literature studies showed that due to the increased awareness of epileptic attacks (especially non-convulsive epileptic attacks) in critically ill patients, the diagnostic role of REEG in unexplained brain injury has been well evaluated, and VEEG is increasingly used in intensive care unit (ICU). As reported by Saengpattrachai et al. [25], 16% of 141 children in PICU received REEG examination, and no obvious epileptic attacks and non-convulsive epileptic attacks were found. In a study of 139 children with epilepsy status who did not return to baseline, Singh et al. [26] found that 4% of children had electrogram attacks on REEG. These attacks were only seen on VEEG, and 4 of 5 children were in a state of non-convulsion. According to Shahwan et al. [27], all epileptic attacks were initially detected within 3 hours of VEEG. The results underscore the importance of VEEG in determining whether a patient has epileptic attacks, because REEG has a short detection time and cannot make detection in real time. This corroborates our experimental results. Later, Naqeeb and Synek criteria were applied to analyze the results of REEG and VEEG in SBI children. As the grade increased, the abnormal activity of slow wave rhythm, amplitude change, subclinical electrical persistence state and low voltage increased, with increased poor prognosis rate. It was found that the sensitivity, specificity and diagnostic coincidence rate of VEEG in evaluating the prognosis of SBI children were significantly higher than those of REEG. At present, there is no literature related to the comparison of the prognostic evaluation by REEG and VEEG in SBI children, so this study is more innovative and valuable, and further research can be carried out in the future. There is increasing evidence that EEG attacks or epileptic status are correlated with the short-term prognosis of neonates and children with brain injury [28,29].

In this experiment, the number of SBI patients in The First Hospital of Qinhuangdao is small, so the subjects selected are small. The results may have some contingency, and research variables are larger in children. A longer-term follow-up survey of the subjects will be conducted, and the experiments will continue to be improved in the future in order to achieve the best experimental results[30].

In summary, VEEG detection is effective in the diagnosis and prognostic evaluation of SBI children with disturbance of consciousness, which is worthy of promotion in clinical practice.

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AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed during the present study are available from the corresponding author on reasonable request.

AUTHORS' CONTRIBUTIONS

XW, RQ and YS were responsible for REEG and VEEG detections. BL and HG collected and analyzed general data of patients. The final version was read and adopted by all the authors.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Ethics Committee of The First Hospital of Qinhuangdao. Signed written informed consents were obtained from the patients and/or guardians.

CONSENT FOR PUBLICATION

Not applicable.

COMPETING INTERESTS

The authors declare that they have no competing interests.

REFERENCES

1. Hemphill JC, 3rd and Ramirez-Arce J: International neurocritical care: report from the Costa Rica Neurointensive and Neuromonitoring Course. Neurocrit Care 8: 308-309, 2008.
2. Morgan A, Ward E, Murdoch B and Bilbie K: Acute characteristics of pediatric Dysphagia subsequent to traumatic brain injury: videofluoroscopic assessment. J Head Trauma Rehabil 17: 220-241, 2002.
3. Arndt DH, Lerner JT, Matsumoto JH, Madikians A, Yudovin S, Valino H, McArthur DL, Wu JY, Leung M and Buxley F: Subclinical Early Post-Traumatic Seizures Detected by Continuous EEG Monitoring in a Consecutive Pediatric Cohort. Epilepsia 54: 1780-1788, 2013.
4. Schreiber JM, Zelleke T, Gaillard WD, Kaulas H, Dean N and Carpenter JL: Continuous video EEG for patients with acute encephalopathy in a pediatric intensive care unit. Neurocrit Care 17: 31-38, 2012.
5. Kupas DF, Melnychuk EM and Young AJ: Glasgow Coma Scale Motor Component ("Patient Does Not Follow Commands") Performs Similarly to Total Glasgow Coma Scale in Predicting Severe Injury in Trauma Patients. Ann Emerg Med 68: 744-750.e743, 2016.
6. Reith FC, Brennan PM, Maas A and Teasdale GM: Lack of standardization in the use of the Glasgow Coma Scale. Results of international surveys. J Neurotrauma 33: 89-94, 2015.
7. Kennedy JD and Gerard EE: (Continuous EEG monitoring in the intensive care unit. Curr Neurol Neurosci Rep 12: 419–442, 2012.
8. Goldfine AM, Victor JD, Conte MM, Bardin JC and Schiff ND: Determination of awareness in patients with severe brain injury using EEG power spectral analysis. Clinical Neurophysiology 122: 2157-2168, 2011.
9. Goldfine AM, Victor JD, Conte MM, Bardin JC and Schiff ND: Determination of awareness in patients with severe brain injury using EEG power spectral analysis. Clin Neurophysiol 122: 2157-2168, 2011.
10. Hupalo M, Smigielski JW and Jaskolski DJ: Optimal time of duration of a long-term video-EEG monitoring in paroxysmal events - A retrospective analysis of 282 sessions in 202 patients. Neurol Neurochir Pol 50: 331-335, 2016.
11. Toet MC, van der Meij W, de Vries LS, Uiterwaal CS and van Huffelen KC: Comparison between simultaneously recorded amplitude integrated electroencephalogram (cerebral function monitor) and standard electroencephalogram in neonates. Pediatrics 109: 772-779, 2002.
12. Herman ST, Abend NS, Bleck TP, Chapman KE, Drislane FW, Emerson RG, Gerard EE, Hahn CD, Husain AM, Kaplan PW, Consensus statement on continuous EEG in critically ill adults and children, part II: personnel, technical specifications, and clinical practice. J Clin Neurophysiol 32: 96-108, 2015. Herman ST, Abend NS, Bleck TP, Chapman KE, Drislane FW, Emerson RG, Gerard EE, Hahn CD, Husain AM, Kaplan PW, Consensus statement on continuous EEG in critically ill adults and children, part II: personnel, technical specifications, and clinical practice. J Clin Neurophysiol 32: 96-108, 2015.
13. 13 Seshia SS, Bingham WT, Kirkham FJ and Sadanand V: Nontraumatic coma in children and adolescents: diagnosis and management. Neurol Clin 29: 1007-1043, 2011.
14. Stevens RD and Sutter R: Prognosis in severe brain injury. Crit Care Med 41: 1104-1123, 2013.
15. Chambers IR, Jones PA, Lo TY, Forsyth RJ, Fulton B, Andrews PJ, Mendelow AD and Minns RA: Critical thresholds of intracranial pressure and cerebral perfusion pressure related to age in paediatric head injury. J Neurol Neurosurg Psychiatry 77: 234-240, 2006.
16. Meric E, Gunduz A, Turedi S, Cakir E and Yandi M: The prognostic value of neuron-specific enolase in head trauma patients. J Emerg Med 38: 297-301, 2010.
17. Rana OR, Saygili E, Schiefer J, Marx N and Schauerte P: Biochemical markers and somatosensory evoked potentials in patients after cardiac arrest: the role of neurological outcome scores. J Neurol Sci 305: 80-84, 2011.
18. Friedman D, Claassen J and Hirsch LJ: Continuous electroencephalogram monitoring in the intensive care unit. Anesth Analg 109: 506-523, 2009.
19. Hyllienmark L and Amark P: Continuous EEG monitoring in a paediatric intensive care unit. Eur J Paediatr Neurol 11: 70-75, 2007.
20. Admiraal MM, van Rootselaar AF and Horn J: Electroencephalographic reactivity testing in unconscious patients: a systematic review of methods and definitions. Eur J Neurol 24: 245-254, 2017.
21. Kirkham FJ, Wade AM, McElduff F, Boyd SG, Tasker RC, Edwards M, Neville BG, Peshu N and Newton CR: Seizures in 204 comatose children: incidence and outcome. Intensive Care Med 38: 853-862, 2012.
22. Yang LH, Jiang LY, Lu RY, Zhong JQ, Liu SQ, Tao EX and Ye JH: Correlation between the changes in ambulatory electroencephalography findings and epilepsy recurrence after medication withdrawal among the population in southern China. Neurol Med Chir (Tokyo) 53: 12-16, 2013.
23. Hussain E and Nordli D: EEG patterns in acute pediatric encephalopathies. J Clin Neurophysiol 30:

539-544, 2013.
24. Jin B, Zhao Z, Ding Y, Guo Y, Shen C, Wang Z, Tang Y, Zhu J, Ding M and Wang S: Diagnostic yield of inpatient video-electroencephalographic monitoring: experience from a Chinese comprehensive epilepsy center. Epilepsy Behav 34: 77-80, 2014.
25. Saengpattrachai M, Sharma R, Hunjan A, Shroff M, Ochi A, Otsubo H, Cortez MA and Carter Snead O, 3rd: Nonconvulsive seizures in the pediatric intensive care unit: etiology, EEG, and brain imaging findings. Epilepsia 47: 1510-1518, 2006.
26. Singh RK, Stephens S, Berl MM, Chang T, Brown K, Vezina LG and Gaillard WD: Prospective study of new-onset seizures presenting as status epilepticus in childhood. Neurology 74: 636-642, 2010.
27. Shahwan A, Bailey C, Shekerdemian L and Harvey AS: The prevalence of seizures in comatose children in the pediatric intensive care unit: a prospective video-EEG study. Epilepsia 51: 1198-1204, 2010.
28. McBride MC, Laroia N and Guillet R: Electrographic seizures in neonates correlate with poor neurodevelopmental outcome. Neurology 55: 506-513, 2000.
29. Topjian AA, Gutierrez-Colina AM, Sanchez SM, Berg RA, Friess SH, Dlugos DJ and Abend NS: Electrographic status epilepticus is associated with mortality and worse short-term outcome in critically ill children. Crit Care Med 41: 215-223, 2013.
30. Wang Gaihua, Zhang Tianlun, Dai Yingying, Lin Jinhen g and Chen Lei. A Serial-Parallel Self-Attention Networ k Joint With Multi-Scale Dilated Convolution, IEEE Ac cess, 9(5), 2021: 71909-7191.DOI: 10.1109/ACCESS. 2021.3079243